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Sevgili Meslektaşlarımız,

Değerli meslektaşlarımıza akademik çalışmalarını yayınlanmak üzere Emerging Sources Citation Index (ESCI) tarafından indekslenen dergimize düzenli olarak ilettikleri için çok teşekkür ederiz. Dergimiz kapsamında bu akademik çalışmaları yayınlamaktan ve çalışmalarımıza aynı hızla devam etmekten büyük mutluluk duyuyoruz.

26. Dünya Osteoporoz, Osteoartrit ve Kas İskelet Sistemi Hastalıkları Kongresi (WCO-IOF-ESCEO Congress) 16-19 Nisan 2026 tarihlerinde Prag-Çek Cumhuriyeti'nde yapılacaktır. Dünya çapındaki bu kongrede konularında önde gelen uluslararası bilim insanlarının konuşmacı olarak yer almasıyla, kas iskelet sistemi sağlığı ve hastalıklarındaki son araştırmalar, klinik bakış açıları ve terapötik ilerlemeler katılımcılara sunulma olanağı bulacaktır. Bu kongre kapsamında Türkiye Osteoporoz Derneği'nin aktivitelerinin Ulusal Dernekler Köyü'nde bir stant alanında sunulması planlanmıştır.

Siz değerli meslektaşlarımıza mutluluğun ve başarının yaşamınızdan eksik olmamasını dileyerek, sevgi ve saygılarımı sunarım.

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Evaluation of the Knowledge, Attitudes and Behaviors of Family Physicians Regarding Vitamin D Deficiency and Osteomalacia

D Vitamini Eksikliği ve Osteomalazi Hakkında Aile Hekimlerinin Bilgi, Tutum ve Davranışlarının Değerlendirilmesi

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Abstract

Objective: Vitamin D acts as a hormone in many systems in the body, especially in the context of bone health. Osteomalacia is a condition characterized by widespread muscle and bone pain and is associated with vitamin D deficiency in most patients. The aim of this study was to evaluate the knowledge, attitudes and treatment approaches of family physicians in Türkiye regarding vitamin D deficiency and osteomalacia.

Materials and Methods: A total of 202 family physicians were included in our descriptive and cross-sectional study. A questionnaire form prepared by reviewing the literature and using Google forms was used to collect the data. The questionnaire included a total of 37 questions.

Results: Approximately three-quarters of the physicians who participated in the study stated that they frequently encountered vitamin D deficiency in outpatient clinics and that vitamin D levels should be checked in family health centers. With respect to their awareness of osteomalacia, there was a statistically significant greater awareness in favor of family medicine specialists and more experienced physicians ($p<0.001$). When the results regarding the participants' level of self-efficacy in the management of vitamin D deficiency were analyzed, family medicine specialists felt more competent than general practitioner family physicians did. When asked about postgraduate education related to vitamin D deficiency and osteomalacia, 87.6% of the physicians stated that they had not received any education.

Conclusion: There are differences in the approaches used to treat vitamin D deficiency and osteomalacia between specialists and general practitioners working as family physicians in Türkiye and a standardized approach has not yet been established. Postgraduate education sessions should be an indispensable part of continuous medical education to refresh and update the knowledge of physicians.

Keywords: Family physicians, vitamin D, osteomalacia

Öz

Amaç: D vitamini kemik sağlığında başta olmak üzere vücutta birçok sistem üzerinde bir hormon görevi görmektedir. Osteomalazi yaygın kas ve kemik ağrısı ile seyreden ve hastaların birçoğunda D vitamini eksikliğine bağlı gelişen bir durumdur. Bu çalışmanın amacı, Türkiye'deki aile hekimlerinin D vitamini eksikliği ve osteomalazi hakkındaki bilgilerini, tutumlarını ve tedavi yaklaşımlarını değerlendirmektir.

Gereç ve Yöntem: Tanımlayıcı ve kesitsel tipte yürütülen çalışmamıza toplam 202 aile hekimi dahil edildi. Çalışmada veri toplamak amacıyla literatür taranarak Google forms aracılığıyla hazırlanan anket formu kullanıldı. Anket, toplam 37 soru içermekteydi.

Bulgular: Çalışmaya katılan hekimlerin yaklaşık dörtte üçü poliklinikte D vitamini eksikliği ile sık karşılaştıklarını ve aile sağlığı merkezlerinde D vitamini düzeyi bakılması gerektiğini belirtti. Osteomalazi konusunda farkındalıklarına bakıldığında aile hekimliği uzmanları ve daha tecrübeli hekimler lehine istatistiksel olarak anlamlı daha yüksek farkındalık mevcuttu ($p<0,001$). Katılımcıların D vitamini eksikliği yönetiminde kendi yeterlilik seviyelerine ilişkin sonuçlar incelendiğinde aile hekimliği uzmanları pratisyen aile hekimlerine göre kendilerini daha yeterli hissediyorlardı. D vitamini eksikliği ve osteomalaziyle alakalı hizmet içi eğitim alma durumları sorgulandığında ise %87,6 hekim eğitim almadığını belirtti.

Sonuç: Ülkemizde aile hekimi olarak çalışan uzman hekimler ve pratisyenler arasında D vitamini eksikliği ve osteomalaziye yaklaşımlarında farklılıklar olduğu ve standart bir yaklaşımın henüz yerleşmediğini düşünebiliriz. Doktorların bilgisini tazelemek ve güncellemek adına hizmet içi eğitimler sürekli tıp eğitiminin vazgeçilmez bir parçası olmalıdır.

Anahtar kelimeler: Aile hekimi, D vitamini, osteomalazi

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Introduction

Vitamin D is a steroid hormone that plays an important role in calcium and bone homeostasis as well as in a number of biological processes with pleiotropic effects (1). Recent studies have shown that the vitamin D receptor is present in many tissues. Vitamin D is very important for bone health, cell growth, cancer prevention, immune function enhancement, infection control and prevention, blood pressure control and cardiovascular disease, as many studies have shown, and there is a strong association between vitamin D deficiency and mortality (2). Maintaining optimal levels of vitamin D in the body can prevent the occurrence of many chronic health problems (3).

Vitamin D deficiency leads to hypocalcemia, severe hyperparathyroidism and increased bone turnover. This may be associated with osteoporosis and fractures. In prolonged and severe cases, osteomalacia and childhood rickets may occur, resulting in bone pain, myopathy and difficulty walking (4). Osteomalacia is a condition characterized by widespread muscle and bone pain and is associated with vitamin D deficiency in most patients.

Today, the diagnosis, treatment and, more importantly, prevention of vitamin D deficiency are at the forefront of health policies. In addition, knowledge of the risk factors that can lead to vitamin D deficiency and the signs/symptoms and findings that allow early detection of vitamin D deficiency by primary care physicians will enable primary care physicians, who have an important public health responsibility, to better intervene in this issue. The aim of this study was to evaluate the knowledge, attitudes and treatment approaches of family physicians in Türkiye regarding vitamin D deficiency and osteomalacia. With this study, we aimed to draw attention to the relationship between vitamin D deficiency and osteomalacia to identify patients in need of vitamin D supplementation and to ensure that they can be treated with an appropriate and safe dose.

Materials and Methods

Our study is a descriptive and cross-sectional study. In this study, family medicine specialists and general practitioner family physicians composed the target population. There was no condition other than being a family physician for participation, and physicians of all ages and experiences were consulted. A total of 202 family physicians who voluntarily agreed to participate in the study and completed the questionnaire completely were included in the study.

In this study, a questionnaire form prepared through Google forms were used to collect data. This questionnaire was prepared by 2 family physicians with at least 10 years of field experience in the field on the basis of the literature and their experiences. The questionnaire form prepared for this study was applied to 10 people as a preliminary questionnaire, and necessary corrections were made in line with the results. The questionnaire form was sent to all participants via e-mail. Informed consent was obtained from the participants before they filled out the questionnaire, indicating that they gave permission to participate in the study.

The questionnaire includes 37 questions in total. One question was open-ended, while the other questions provided the participant with options. Some of the questions with options were designed to allow a single response option, whereas others were designed to allow more than one response option at the same time. The questionnaire included a total of 31 questions concerning the sociodemographic characteristics of the participants, their level of knowledge about vitamin D, their attitudes toward vitamin D deficiency, and 6 questions concerning their knowledge and attitudes toward osteomalacia.

Approval for the study was granted by Düzce University Non-Invasive Clinical Research Ethics Committee (decision no: 2023/47, date: 20.03.2023).

In addition, necessary permissions were obtained from Düzce Provincial Health Directorate to conduct a survey with physicians working in family health centers (decision no: 213428761, date: 27.04.2023).

Statistical Analysis

The SPSS version 26 package program was used for statistical analysis to evaluate the findings obtained in the study. By examining similar studies, the sample size was calculated considering Type I error (0.05) and targeted power (0.80), and it was concluded that at least 196 people should be surveyed (5). Descriptive statistical methods (minimum, maximum, mean, standard deviation, percentage value) were used to evaluate the study data. Difference analyses were applied to the variables. For the selection of the appropriate difference analysis, the compatibility of the variables with a normal distribution was examined visually (histogram and probability graphs) and analytically (Kolmogorov-Smirnov/Shapiro-Wilks tests). Analyses revealed that the variables did not have a normal distribution, so non-parametric test methods were used. The Mann-Whitney U test was used for comparisons between two independent groups, and the Kruskal-Wallis test was used for comparisons involving more than two independent groups. The Pearson chi-square test was used to analyze categorical variables in 2x2 eyes. For more than 2x2 eyes, post hoc analyses were performed with Bonferroni correction. The significance level was set at 95% ($p<0.05$). Pie and column graphs were used to present the data, which are presented in detail in the tables.

Results

A total of 202 physicians participated in the study. The mean age of the participants was 38.66±7.93 years (minimum=26, maximum=58). The mean ages of the general practitioner family physicians and family medicine specialists were 40.29±8.61 and 36.34±6.19 years, respectively. Other characteristics of the physicians are given in Table 1. All of the general practitioner family physicians (n=119, 58.9%) who participated in the study were working in family health centers (FHCs). Among family medicine specialists, 71.1% (n=59) were working in FHCs, 12% (n=10) were working in community health centers, 8.4% (n=7) were working

in university hospitals, 4.8% (n=4) were working in training and research hospitals, and 3.6% (n=3) were working in state hospitals. The participants were questioned about their in-service training related to vitamin D deficiency and osteomalacia. There was a statistically significant difference between the two groups, with 94.1% (n=112) among general practitioners and 78.3% (n=65) among family medicine specialists (p=0.001). However, 95.5% of the physicians (n=193) thought that clinical guidelines would be useful. The participants were asked to determine their own level of competence in the management of vitamin D deficiency by giving a score between 1 and 10. When the results were analyzed, significant difference was found between the groups (p=0.002). There was no statistically significant difference between the groups in terms of years of occupation (Table 2).

The participants were asked questions to measure their level of knowledge about vitamin D and its deficiency. Some of these questions were multiple-choice questions, and participants were allowed to mark more than one option.

The participants were asked about the body systems/organs that are most affected and important by vitamin D, allowing them to select more than one option. A total of 98.5% (n=199) of the physicians selected the bone system, and 93.6% (n=189) selected the immune system as important (Table 3). The participants were asked about signs/symptoms that may be associated with vitamin D deficiency. The most common response was fatigue (n=191, 94.6%), and the least common response was gait disturbance (n=138, 68.3%). When the risk factors for vitamin D deficiency were examined according to the participants, the most common answers were indoor lifestyle (n=194, 96%) and old age (n=179, 88.6), whereas the least common answers were dark skin color (n=89, 44.1%) and genetics (n=93, 46%). The laboratory parameters requested by the participants in addition to serum 25(OH)D levels when they suspected vitamin D deficiency are shown in Table 3.

When the attitudes of the physicians participating in the study toward the propositions related to vitamin D sources were examined, no significant difference was found between family medicine specialists and general practitioner family physicians. Notably, approximately half of the participants' answers to the proposition "Using sunscreen prevents vitamin D synthesis from the skin" were correct. The physicians who participated in the study were asked whether they could check 25(OH)D levels at the institution where they worked, and 95.5% of them stated that they could not. All 9 participants who could check 25(OH) D levels were family medicine specialists. None of the physicians working in an FHC could check 25(OH)D levels. Physicians were also asked "Is it necessary to check 25(OH)D levels at the FHC?". A total of 72.3% (n=146) answered that it was necessary. There was a significant difference between specialist (n=53, 63.9%) and general practitioner family physicians (n=48, 40.3%), who correctly answered the statement "Community screening should be done for vitamin D deficiency" (p=0.004). The frequency of encountering vitamin D deficiency in the outpatient clinic was questioned, and family medicine specialists stated that they encountered vitamin D deficiency significantly more frequently than general practitioner family physicians (p=0.019).

When the 25(OH)D levels at which the participants considered vitamin D deficiency were analyzed, 77.1% of the family medicine specialists and 65.6% of the family practitioners stated that the level was <30 ng/mL. Remarkably, 25.2% of the general practitioner family physicians considered vitamin D deficiency to be less than 10 ng/mL (Figure 1).

All of the physicians who participated in the study recommended vitamin D to adults who were found to be deficient. Details are given in Table 4.

When evaluated according to the participants' years of experience, the proportion of physicians who recommended vitamin D supplementation to healthy adults decreased with increasing experience.

Table 1. Socio-demographic data of the participants

		n	%
Gender	Woman	99	49
	Male	103	51
Title	Practitioner	119	58.9
	Expert	83	41.1
Profession year	<5 years	27	13.4
	5-10 years	63	31.2
	10-20 years	69	34.2
	>20 years	43	21.3

Table 2. Data on participants' level of self-efficacy in the management of vitamin D deficiency

			n	Average	p
On a scale of 0 to 10, how would you rate your own level of competence in the management of vitamin D deficiency?	Employment status	Practitioner	119	6.43±1.505	**0.004***
		Expert	83	7.13±1.716	
	Year of profession	<5 years	27	6.70±1.489	
		5-10 years	63	6.70±1.672	**0.995****
		10-20 years	69	6.74±1.559	
		>20 years	43	6.72±1.804	

*: The Mann-Whitney U test, **: Kruskal-Wallis test

When the dose of vitamin D supplementation recommended by the participants for healthy adults was analyzed, 36.6% stated that they used 600 IU/day, which is a correct approach (Figure 2). When the loading dose preferences of the participants in the treatment of vitamin D deficiency were analyzed, 31.2% stated that they used 50000 IU/week, which is a correct approach. A total of 24.7% of the participants stated that they used a dose of 20000 IU/week. In addition, 31.2% of the participants stated that they did not use a loading dose.

When the maintenance dose preferences of the participants in the treatment of vitamin D deficiency were analyzed, 43.6% stated that they used 2000 IU/day (Figure 3).

In our study, the percentage of physicians who accepted a 25(OH)D level less than 20 as deficient and stated that they administered a loading dose of 50000 IU/week was 14.9% of all physicians. In our study, the percentage of physicians who accepted a 25(OH)D level <20 as deficient and stated that they administered a 2000 IU/day maintenance dose was 24.8% of all physicians. When the 25(OH)D levels determined as the treatment target by the physicians participating in our study were analyzed, 54.2% (n=45) of family medicine specialists and 57.1% (n=68) of family practitioners considered the level of 30-50 ng/mL to be appropriate. In the treatment of vitamin D deficiency, 44.6% (n=90) preferred oral drops, 37.6% (n=76) preferred oral capsules, 16.3% (n=33) preferred oral tablets, and 1.5% (n=3) preferred oral ampoules. Family practitioners preferred the oral drop form the most (47.9%, n=57), whereas family medicine specialists preferred the oral capsule form the most (50.6%, n=42).

A significant difference was found between family medicine specialists (n=66, 79.5%) and general practitioners (n=76, 63.9%) when the participants' responses to the statement "Osteomalacia rather than osteoporosis should be considered in patients with diffuse bone and joint pain, bone tenderness, muscle weakness and difficulty walking" were analyzed (p=0.044). The percentage of correct answers to the statement "Initial bone mineral density should be requested to support the diagnosis in a patient with suspected osteomalacia" was 35% for family medicine specialists (n=29) and 13.4% for general practitioners (n=16), and a significant difference was found between the groups (p<0.001). All the physicians provided correct answers to the statements "Vitamin D deficiency is the most common cause of osteomalacia" and "Vitamin D and calcium treatment is effective in most patients with osteomalacia" (Table 5).

When the physicians who participated in the study were evaluated according to their years of experience, a statistically significant difference was found between the correct responses of those with 20 years or more of experience to the statements in Table 6 and those with other years of experience (p=0.001).

The participants were asked about the laboratory findings observed in the osteomalacia by allowing them to mark more than one option. Low 25(OH)D levels and low serum calcium levels were detected at high rates.

Table 3. Participants' responses to questions about vitamin D

Distribution of participants' answers to the question "for which is vitamin D important"		
	n	**%**
Bone	199	98.5
Muscle	164	81.2
Cardiovasculer system	145	71.8
Immune system	189	93.6
Brain	126	62.4
Skin	144	71.3
Distribution of participants' answers to the question on laboratory tests to be ordered in vitamin D deficiency		
	n	**%**
Hemogram	75	37.1
Creatinin	95	47
Ure	83	41.1
ALT	76	37.6
AST	73	36.1
GGT	34	16.8
ALP	85	42.1
Magnesium	80	39.6
Calcium	169	83.7
Phosphor	127	62.9
Albumin	40	19.8
TSH	93	46
T4	61	30.2
Parathormon	172	85.1
Calcitonin	136	67.3

ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, GGT: Gamma-glutamyl transferase, ALP: Alkaline phosphatase, TSH: Thyroid-stimulating hormone

Discussion

In the literature, studies have examined the level of vitamin D knowledge of family physicians and whether they make supplements (5-7). However, only one study has examined the attitudes of general practitioners about vitamin D deficiency and vitamin D supplementation in Türkiye (8). This study was conducted before the transition to the family medicine system in Türkiye; it included only general practitioners and focused on their knowledge of rickets. To the best of our knowledge, no study has evaluated the knowledge, attitudes and practices of family physicians in Türkiye regarding vitamin D deficiency, supplementation and osteomalacia.

A review of the literature revealed that 77% of participants in an Australian study and 54% in a New Zealand study were confident in their knowledge of vitamin D (9,10). In our study, participants were asked to determine their own level of competence in the management of vitamin D deficiency. As a result, the mean

Table 4. Clinical approaches of physicians to patients admitted to the outpatient clinic regarding vitamin D according to employment status

		Expert		Practitioner		
		n	%	n	%	p
Do you recommend vitamin D supplements to patients who apply to your outpatient clinic?	Always	23	27.7	14	11.8	**0.005**
	Frequently	43	51.8	63	52.9	
	Occasionally	17	20.5	42	35.3	
In which cases do you recommend vitamin D supplementation to patients who apply to your outpatient clinic?	Most of the patients	58	**69.9**	55	**46.2**	**0.004**
	Only those diagnosed with a deficiency	18	21.7	45	37.8	
	Only in fall and winter	7	8.4	19	16	
Do you recommend vitamin D supplements for healthy adults?	Yes	69	**83.1**	72	**60.5**	**0.001**
	No	14	16.9	47	39.5	
Would you recommend vitamin D supplements for adults diagnosed with a deficiency?	Yes	83	**100**	119	**100**	**<0.001**
	No	0	0	0	0	
Do you recommend vitamin D supplementation for pregnant women and breastfeeding mothers?	Yes	83	**100**	110	**92.4**	**<0.001**
	No	0	0	9	7.6	

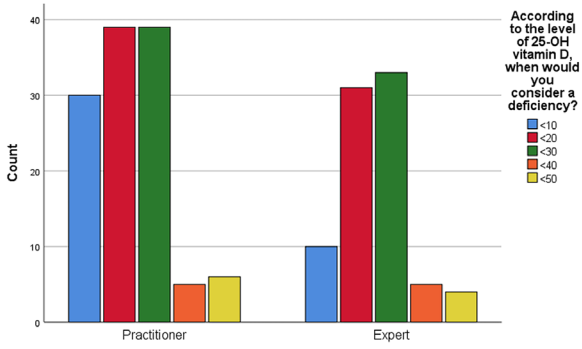

Figure 1. Distribution of 25(OH)D levels of participants' perceived vitamin D deficiency according to employment status

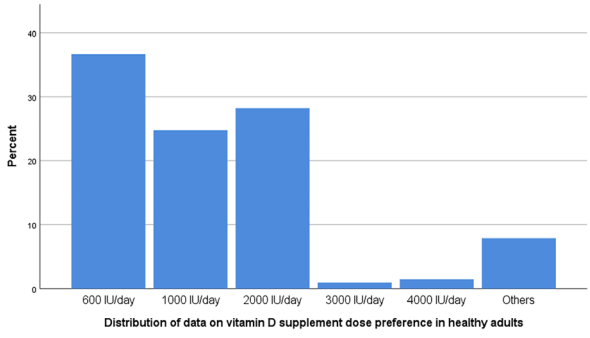

Figure 2. Distribution of data on vitamin D supplement dose preference in healthy adults

score of the physicians was 6.7/10, and a statistically significant difference was found between general practitioner family physicians and family medicine specialists (p=0.002). Moreover, a significant difference was found in favor of family medicine specialists among physicians who stated that they received in-service training (p=0.001). This is consistent with the rates of correct answers given between the groups when evaluating the clinical approach to vitamin D and its deficiency in our study.

Research shows that sunlight is the most important source of vitamin D. On the other hand, there is evidence that prolonged exposure to the sun does not increase vitamin D production in the long term (11,12). According to a study of 2.000 adults conducted by the National Osteoporosis Society in the United Kingdom, only 35% of respondents knew that vitamin D was essential for healthy life and bones. Almost a quarter of those surveyed did not know why they needed vitamin D, and only 6% knew that going outside without sunscreen helped them make better use of sunlight (13). Doctors may disagree on the advisability of sun exposure. This is because overexposure to ultraviolet (UV) radiation is a major risk factor for skin diseases and skin cancer. The American Academy of Dermatology recommends the use of skin protection, including sunscreens, during sun exposure (14). On the other hand, increasing evidence suggests that inadequate exposure to UV radiation is also associated with general health risks and decreases life expectancy (15). Therefore, up-to-date and accurate knowledge of physicians on this subject will be more important in terms of approaching patients and making the right recommendations. In our study, three-quarters of the physicians supported that nutrients are insufficient as a source of vitamin D and that sunlight is the most important source for vitamin D synthesis, whereas approximately half of the physicians reported that sunscreen inhibits vitamin D synthesis from the skin. This may cause physicians' recommendation of vitamin D supplementation to be insufficient, especially in the summer months.

Vitamin D, which is primarily responsible for bone health, is also known to play an important role in modulating the immune system. Many studies have examined the effect of vitamin D on

the course of the disease, both in the prophylaxis and treatment of coronavirus disease-2019 infection, and positive effects have been observed (16). Some researchers have reported that vitamin D supplementation is effective in reducing the risk of viral infections (17). In our study, the physicians stated that the immune system is the second most important system affected by vitamin D and that they are highly aware of this issue.

The most important cause of vitamin D deficiency is insufficient exposure to the sun (18). The physicians who participated in our study identified indoor dwellers and elderly people as the most common causes of vitamin D deficiency, as indicated in the literature.

According to previous studies, dark skin color is also a major risk factor for vitamin D deficiency, and compared with light-skinned individuals, dark-skinned individuals produce less vitamin D when exposed to the same amount of sunlight (11). In our study, similar to other studies in the literature, the dark skin color was marked at a low rate (9,19). Patients with chronic renal failure were also highly flagged by respondents. The development of chronic renal failure is associated with a progressive decrease in vitamin 1.25(OH)D production. Low 25(OH)D levels are observed in all stages of chronic renal failure (20).

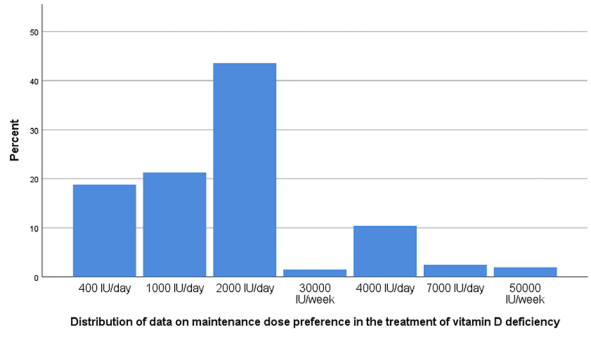

Figure 3. Distribution of data on maintenance dose preference in the treatment of vitamin D deficiency

Since vitamin D deficiency can lead to serious changes in body homeostasis, it should not be overlooked during physician control and should be acted upon each time. In our country, serum 25(OH)D levels cannot be measured in FHCs. Among the physicians who participated in the study, 72.3% stated that vitamin D levels should be checked in FHCs. On the other hand, the cost-effective strategy of many clinicians is to opt for vitamin D supplementation without routine testing on the basis of symptoms (21). In our study, three-quarters of the physicians who stated that they could not measure serum 25(OH)D levels stated that they frequently recommended supplements in the outpatient setting.

The participants were questioned about their 25(OH)D levels, which they considered vitamin D deficiency. When the results were analyzed, 77.1% of family medicine specialists and 65.6% of general practitioner family physicians stated that they considered vitamin D deficiency to be less than 30 ng/mL. Remarkably, in our study, 25.2% of the general practitioner family physicians considered vitamin D deficiency to be less than 10 ng/mL. This may be due to the lack of current knowledge of the physicians who participated in our study because they could not routinely check vitamin D levels.

In cases of severe vitamin D deficiency, laboratory tests [such as calcium, phosphorus, alkaline phosphatase (ALP) and parathyroid hormone)], which are also included in the diagnostic criteria for osteomalacia, may be ordered. Calcium was requested at a high rate, whereas ALP and phosphorus were preferred at a low rate in the responses to the question we asked to the participants

Table 5. Attitudes of physicians toward propositions related to osteomalacia according to employment status

		Expert		Practitioner		
		n	%	n	%	p
In a patient with diffuse bone and joint pain, bone tenderness, muscle weakness and difficulty walking, osteomalacia should be considered rather than osteoporosis.	I agree	66	79.5	76	63.9	**0.044**
	No opinion	8	9.6	25	21	
	Disagree	9	10.8	18	15.1	
Vitamin D deficiency is the most common cause of osteomalacia.	I agree	71	85.5	101	84.9	0.999
	No opinion	10	12	15	12.6	
	Disagree	2	2.4	3	2.5	
In a patient with osteomalacia, initial bone mineral density should be ordered to support the diagnosis.	I agree	44	53	71	59.7	**<0.001**
	No opinion	10	12	32	26.9	
	Disagree	29	35	16	13.4	
Osteomalacia is an incurable disease once it has developed.	I agree	6	7.2	11	9.2	0.366
	No opinion	13	15.7	27	22.7	
	Disagree	64	77.1	81	68.1	
In osteomalacia, vitamin D and calcium treatment is effective in most patients.	I agree	78	94	106	89.1	0.516
	No opinion	4	4.8	11	9.2	
	Disagree	1	1.2	2	1.7	

Table 6. Attitudes of physicians toward propositions related to osteomalacia according to years of occupation

Profession year		<5		5-10		10-20		>20		
		n	%	n	%	n	%	n	%	p
In a patient with diffuse bone and joint pain, bone tenderness, muscle weakness and difficulty walking, osteomalacia should be considered rather than osteoporosis.	I agree	18	**66.7**	44	**69.8**	41	**59.4**	39	90.7	**0.001**
	No opinion	2	7.4	8	12.7	19	27.5	4	9.3	
	Disagree	7	25.9	11	17.5	9	13.1	0	0	
Vitamin D deficiency is the most common cause of osteomalacia.	I agree	19	**70.4**	50	**79.4**	61	**88.4**	42	**97.7**	**0.015**
	No opinion	6	22.2	12	19	6	8.7	1	2.3	
	Disagree	2	7.4	1	1.6	2	2.9	0	0	
In a patient with osteomalacia, initial bone mineral density should be ordered to support the diagnosis.	I agree	12	44.4	34	54	41	59.4	28	65.1	0.194
	No opinion	5	18.5	11	17.5	17	24.6	9	20.9	
	Disagree	10	**37**	18	**28.6**	11	**15.9**	6	**14**	
Osteomalacia is an incurable disease once it has developed.	I agree	1	3.7	7	11.1	4	5.8	5	11.6	0.603
	No opinion	4	14.8	10	15.9	17	24.6	9	20.9	
	Disagree	22	**81.5**	46	**73**	48	**69.6**	29	**67.4**	
In osteomalacia, vitamin D and calcium treatment is effective in most patients.	I agree	25	**92.6**	58	**92.1**	60	**87**	41	**95.3**	0.588
	No opinion	2	7.4	4	6.3	7	10.1	2	4.7	
	Disagree	0	0	1	1.6	2	2.9	0	0	

on this subject. In our study, the answers to the questions asked about laboratory diagnostic criteria in patients with osteomalacia also confirmed this approach.

A United States study has shown that doctors often do not consider vitamin D deficiency in adult patient management (22). This may be because patients believe that they are exposed to enough sunlight. However, often, especially in older people, they are housebound and do not receive enough sunlight. In addition, vitamin D deficiency often goes unrecognized because the clinical picture is insidious or non-specific. In our study, to measure physicians' awareness of vitamin D deficiency, the frequency of encountering vitamin D deficiency in the outpatient clinic was investigated. Most physicians reported frequent encounters, with family medicine specialists reporting significantly more frequent encounters than general practitioners did.

Patients with vitamin D deficiency often complain of widespread body pain (23). In a study conducted in Türkiye, the prevalence of vitamin D deficiency was found to be 71.7% in patients with widespread body pain (24). Osteomalacia is a condition characterized by widespread muscle and bone pain and is associated with vitamin D deficiency in most patients. In these patients, vitamin D replacement plays an important role in the remission of complaints. Therefore, it is important to consider osteomalacia in patients presenting with diffuse muscle pain and to refer patients for vitamin D level measurement or to start prophylactic treatment in centers where vitamin D measurement is not available. In our study, a significant difference was found between specialist and general practitioner family physicians (p=0.044) when the participants' responses to the statement "Osteomalacia should be considered rather than osteoporosis in a patient with diffuse bone and joint pain, bone tenderness, muscle weakness and difficulty walking" were analyzed. This may be because clinical rotations, especially physical medicine and rehabilitation, in family medicine education increase the awareness of physicians about vitamin D deficiency and osteomalacia. We believe that increasing in-service training for physicians, especially supporting general practitioner family physicians on this issue and clinical guidelines that can be created for family physicians on vitamin D deficiency and common related diseases, may help increase the awareness of physicians on this issue.

The treatment goal is to maintain serum 25(OH)D levels at 30-50 ng/mL (25,26). Approximately 50% of the physicians who participated in our study considered 30-50 ng/mL to be an appropriate treatment target. According to the results published by Costa-Fernandes et al. (27), the level of knowledge of healthcare professionals in the United Kingdom on the management of vitamin D deficiency was found to be adequate. According to a previous study, 75% of pediatricians and 65% of general practitioners correctly defined maintenance and treatment doses for vitamin D deficiency. In another study, the general knowledge of prescribing physicians in Khartoum (Sudan) on the treatment of vitamin D deficiency was rated as poor (28). In our study, physicians' knowledge of treatment dosage was also evaluated as inadequate. The loading and maintenance treatment dose preferences of approximately 30% and 40% of the physicians, respectively, were consistent with the literature. In addition, when loading dose preferences were analyzed, 31% of the physicians did not recommend a loading dose. According to these results, the loading dose recommendation rate is low, and those who recommend loading and maintenance have different approaches to the dose amount.

The percentage of physicians who recommended the correct supplement dose for healthy adults was 36%. When evaluated according to the professional years of the participants, the proportion of physicians who recommended vitamin D supplementation to healthy adults decreased with increasing experience. This may be due to the recent increase in developments in vitamin D and the inability of physicians to follow current information sufficiently.

In the treatment of vitamin D deficiency, the most preferred forms of vitamin D by the physicians participating in the study were oral drops and oral capsules. In recent years, oral capsules accounted for an important share of the preferences of physicians in our study. Daily administration is more effective at increasing serum 25(OH)D levels, but weekly administration is often preferred because of its ease of use (29). When evaluated according to years of practice, the preference for capsules over drops increased with decreasing years of practice (younger physicians). Family medicine specialists preferred the capsule form, whereas general practitioner family physicians preferred the drop form. The oral ampoule form, which is less preferred in treatment today, was preferred by only 3 family practitioners.

Vitamin D deficiency is common in women, but during pregnancy, the fetus is even more susceptible to deficiency because of the need for vitamin D for growth and development. Maternal vitamin D stores are the only source of vitamin D for the developing fetus (30). In a study conducted with healthcare professionals in Türkiye, 55.6% of the participants recommended vitamin D supplementation to pregnant women, while the rate of vitamin D supplementation recommended by family medicine specialists (66.7%) was higher than that recommended by other groups (31). In our study, 95.5% of the participants stated that they recommended vitamin D supplementation to pregnant women and breastfeeding mothers. This result suggests that the awareness of physicians about vitamin D supplementation for pregnant women has increased in recent years.

Study Limitations

The small sample size is the most important limitation of our study. Another limitation of our study is that the guideline data on vitamin D and osteomalacia were not clarified when the questionnaire data were prepared; therefore, the questionnaire questions were open to interpretation.

Conclusion

In conclusion, there is no uniform approach to the diagnosis and treatment of vitamin D deficiency among family physicians. There is wide variation in prescription options, dosing frequency and dosing duration. There is a lack of clarity on the normal range of vitamin D levels and doses for the treatment of vitamin D deficiency. Taken together, our results suggest that family physicians need more training, especially in vitamin D therapy. Moreover, as knowledge about vitamin D is rapidly evolving, in-service training should be an essential part of continuing medical education to refresh and update physicians' knowledge.

Ethics

Ethics Committee Approval: Approval for the study was granted by Düzce University Non-Invasive Clinical Research Ethics Committee (decision no: 2023/47, date: 20.03.2023). In addition, necessary permissions were obtained from Düzce Provincial Health Directorate to conduct a survey with physicians working in family health centers (decision no: 213428761, date: 27.04.2023).

Informed Consent: Informed consent was obtained from the participants before they filled out the questionnaire, indicating that they gave permission to participate in the study.

Footnotes

Authorship Contributions

Concept: V.M.S., Z.G., R.S., Design: V.M.S., Z.G., R.S., Data Collection or Processing: V.M.S., Analysis or Interpretation: V.M.S., Literature Search: V.M.S., Z.G., R.S., Writing: V.M.S., Z.G., R.S.

Conflict of Interest: No conflict of interest was declared by the authors.

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Posterior Cruciate Ligament-preserving (CR) and Posterior Cruciate Ligament-cutting (PS) Total Knee Arthroplasty Surgery: Effects on Tibiofemoral Angle and Tibial Slope

Arka Çapraz Bağı Koruyan (CR) ve Kesen (PS) Total Diz Artroplasti Cerrahisi: Tibiofemoral Açı ve Tibial Eğim Üzerindeki Etkileri

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Abstract

Objective: Discussions on optimal implant selection and surgical approaches in total knee arthroplasty (TKA) surgery are ongoing. There are differing opinions, particularly regarding the clinical and radiological outcomes of TKA procedures performed with preservation or resection of the posterior cruciate ligament (PCL). The aim of the study is to contribute to the surgical decision-making process in TKA based on the findings obtained.

Materials and Methods: The data of patients who underwent cruciate preserving (CR) or cutting (PS) TKA due to knee osteoarthritis in our clinic were retrospectively analyzed. Age and gender distribution, as well as radiological measurements taken from preoperative and postoperative radiographs, were evaluated. A total of 66 patients (ages 55-79) who underwent TKA (31 CR, 35 PS) between January 2017 and January 2023 were included in the study. Measurements were performed on preoperative and postoperative standing radiographs of the patients. Tibiofemoral angle and tibial slope values were evaluated.

Results: When the results of our study were analyzed, a statistically significant difference was found between the two groups in terms of age distribution (p=0.006), preoperative tibiofemoral angle (p=0.009) and postoperative tibial slope values (p<0.001).

Conclusion: The findings suggest that patient-specific evaluation is necessary when selecting the surgical technique, and that both methods can achieve successful outcomes in appropriately selected patient groups. Retaining the PCL to replicate the native knee may preserve proprioception and lead to improved knee scores in theory. So, the rehabilitation team needs to know this and act accordingly.

Keywords: Total knee arthroplasty, posterior cruciate ligament, tibiofemoral angle, tibial slope

Öz

Amaç: Total diz artroplastisi (TDA) cerrahisinde optimal implant seçimi ve cerrahi yaklaşımlar konusundaki tartışmalar devam etmektedir. Özellikle arka çapraz bağın (AÇB) korunması veya kesilmesi ile yapılan TDA uygulamalarının klinik ve radyolojik sonuçları üzerine farklı görüşler bulunmaktadır. Çalışmanın amacı elde edilen bulgularla, TDA uygulamalarında cerrahi karar sürecine katkı sağlamaktır.

Gereç ve Yöntem: Kliniğimizde diz osteoartriti nedeni bağ koruyan (CR) veya kesen tipte TDA uygulanmış hastaların verileri retrospektif olarak incelenmiştir. Yaş, cinsiyet dağılımları ile ameliyat öncesi ve sonrası dönemde çekilmiş grafileri üzerinde radyolojik ölçümler yapılmıştır. Çalışmaya Ocak 2017 ile Ocak 2023 tarihleri arasında TDA (31 CR, 35 PS) uygulanan 55-79 yaş aralığındaki toplam 66 hasta dahil edilmiştir. Hastaların ameliyat öncesi ve sonrası ayakta radyografilerinde ölçümler yapılarak, tibiofemoral açı ve tibial eğim değerleri değerlendirildi.

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Bulgular: Çalışmamızın sonuçları incelendiğinde, ameliyatında AÇB'yi koruyan ve kesen tipte total diz protezi kullanılmış olan bu iki grup hastanın, yaş grubu (p=0,006), ameliyat öncesi tibiofemoral açı (p=0,009) ve ameliyat sonrası tibial eğim değerleri (p<0,001) arasında istatistiksel anlamda fark bulunmuştur.

Sonuç: Elde edilen bulgular, cerrahi teknik seçiminde hastaya özel değerlendirme yapılması gerektiğini ve her iki yöntemin de uygun hasta grubunda başarılı sonuçlar sağlayabileceğini göstermektedir. AÇB'yi koruyarak doğal dizi taklit etmek, propriosepsiyonun korunmasına ve teoride diz skorlarının iyileşmesine yol açabilir. Dolayısıyla, rehabilitasyon ekibinin bunu bilmesi ve buna göre hareket etmesi gerekir.

Anahtar kelimeler: Total diz artroplastisi, arka çapraz bağ, tibiofemoral açı, tibial eğim

Introduction

Osteoarthritis is a degenerative disease characterized by progressive cartilage destruction, osteophyte formation, subchondral sclerosis, synovium and a series of biochemical and morphological changes in the joint capsule, especially in weight-bearing joints, due to the effects of genetic, mechanical and biochemical factors. The knee is the most frequently affected joint symptomatically in osteoarthritis. Epidemiological studies conducted in various parts of the world have reported that 10-30% of people over the age of 65 have symptomatic knee osteoarthritis. Therefore, knee osteoarthritis is a significant health problem worldwide and this problem is increasing with the aging population (1,2).

Total knee arthroplasty (TKA) is a commonly used surgical method aimed at reducing pain and restoring joint function in patients with advanced-stage knee osteoarthritis. Advances in surgical techniques continue discussions on optimal implant selection and surgical approaches. In particular, there are different opinions regarding the preservation or resection of the posterior cruciate ligament (PCL) in TKA applications and their clinical and radiological outcomes (3,4).

Surgeons advocating for PCL preservation argue that this ligament supports natural knee biomechanics, providing more stable joint movements and a more natural knee functions for patients (5). On the other hand, some studies report advantages such as easier surgical application and long-term prosthesis stability when the PCL is resected. Among these approaches, whether factors like tibiofemoral angle and tibial slope play a role remains debated (6).

In this study, we retrospectively examined demographic and radiological data of patients who underwent both CR and PS TKA in our clinic. The statistical comparison of their effects on tibiofemoral angle and tibial slope has been conducted.

Materials and Methods

Ethical approval was obtained for the clinical study (Izmir Bakirçay University, decision no: 1210, research no: 1190, date: 27.09.2023).

Patients who underwent total knee prosthesis surgery in our clinic between January 2017-January 2023 and were diagnosed with primary knee osteoarthritis were retrospectively included in the study. AP and lateral knee radiographs were taken preoperatively and postoperatively.

Patients who underwent surgery outside of our clinic, underwent revision knee replacement surgery, underwent knee replacement surgery due to rheumatologic involvement or secondary osteoarthritis secondary to trauma, or lacked appropriate preoperative and postoperative radiographs were excluded from the study. A review of the criteria used to select patients at the clinic ensured that the patients who underwent total knee replacement surgery constituted a homogeneous group.

Demographic data (age, gender, side) of the patients were determined from hospital records. Measurements were made using the picture archiving and communication system on direct radiographs. Measurements were conducted on radiographs taken while standing preoperatively and postoperatively by two different physicians who participate in this study. The tibiofemoral angle and tibial slope values were evaluated (Figure 1).

Statistical Analysis

Statistical comparisons were made between the patients who underwent cruciate-retaining (CR) and posterior-stabilized (PS) knee prosthesis surgeries. The chi-square test was used to compare categorical data. The normality of numerical data distribution was tested (Shapiro-Wilk test). In cases like normal distribution criteria were met, parametric tests were applied; otherwise, non-parametric tests were used.

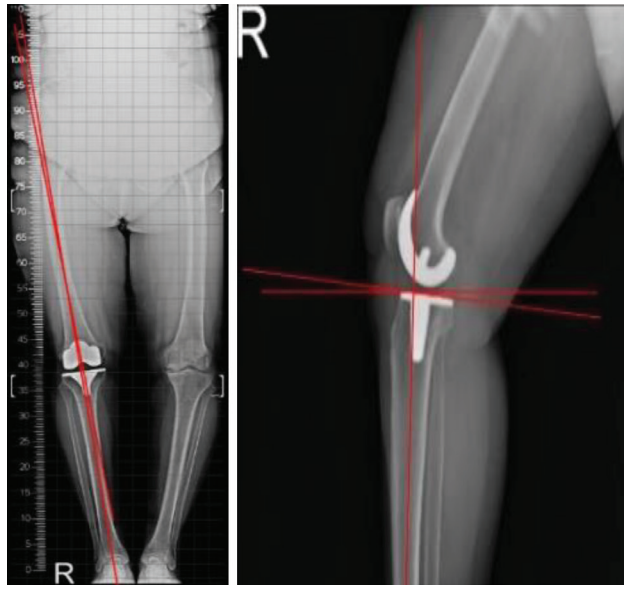

Figure 1. Measurement of tibiofemoral angle and tibial slope

Results

A total of 66 patients were included in the study, consisting of 11 men (16.7%) and 55 women (83.3%). PS knee prosthesis was used in 31 patients (47.0%), while CR knee prosthesis was used in 35 patients (53.0%).

The average age of the patients was 66.89 years (range: 55-79). A total of 33 patients underwent surgery on the right side, 22 on the left side, and 11 on both sides (bilateral). Statistical comparisons revealed a significant age difference between the two groups. Patients who underwent CR knee prosthesis surgery were significantly younger (p=0.006, Mann-Whitney U test).

There was no significant difference in gender and side distribution between the two groups (p=0.912 and 0.225, Pearson chi-square test) (Table 1).

The mean preoperative tibiofemoral angle of the patients was 3.37° varus (range: -19° to +18°), while the mean postoperative angle was 5.56° valgus (range: -9° to +3°). Statistical analysis showed a significant difference in preoperative tibiofemoral angle values between the two groups. Patients who underwent PS total knee prosthesis had a significantly higher tibiofemoral angle (p=0.009, Mann-Whitney U test). However, there was no significant difference in postoperative tibiofemoral angle measurements between the two groups (p=0.224, Mann-Whitney U test).

The preoperative tibial slope angle averaged 6.82° (range: 0-16°), while the postoperative angle averaged 2.91° (range: -3° to +11°). There was no significant difference between the two groups in terms of preoperative tibial slope measurements (p=0.941, Mann-Whitney U test). However, a statistically significant difference was found in postoperative tibial slope values between the two groups. Patients who underwent PS prosthesis had significantly higher postoperative tibial slope values (p<0.001, Mann-Whitney U test) (Table 2).

In summary, in our study, a statistically significant difference was found between the two patient groups who underwent posterior cruciate retaining (CR) and posterior stabilized (PS) total knee prosthesis in terms of preoperative tibiofemoral angle and postoperative tibial slope values in our study.

Discussion

This study focused on the evaluation of radiological results in patients who underwent CR and PS TKA. Our findings help us to choose the appropriate prosthesis for the patient during the preoperative evaluation and to plan the correct surgery, as well as to understand the potential effects of the selected prosthesis type on the radiological and functional outcomes of the patients in the postoperative period.

Different designs have been used during the development of knee prostheses, some of these designs were abandoned according to their clinical results, while some of them continued to be used, and their design and development continued to determine their current forms.

We can classify knee prostheses in different ways. They can be classified as protecting, cutting or stabilizing the PCL; cemented or uncemented, restrictive, semi-restrictive or non-restrictive,

Table 1. Demografic features of the patients

		PS TKA		CR TKA		Total		p-value
Number of patients		31	47.0%	35	53.0%	66	-	-
Age		69.00	5.556 SD	65.03	5.628 SD	66.89	5.899 SD	**0.006***
Gender	Male	5	16.1%	6	17.1%	11	16.7%	0.912**
	Female	26	83.9%	29	82.9%	55	83.3%	
Side	Right	19	61.3%	14	40.0%	33	50.0%	0.225**
	Left	8	25.8%	14	40.0%	22	33.3%	
	Bilateral	4	12.9%	7	20.0%	11	16.7%	

SD: Standard deviation, *: Mann-Whitney U test, **: Pearson chi-square test, p-value <0.05 is considered statistically significant, PS: Posterior-stabilized, TKA: Total knee arthroplasty, CR: Cruciate-retaining

Table 2. Radiologic findings of the patients

	PS TKA	SD (range)	CR TKA	SD (range)	Total	SD (range)	p-value
Preoperative tibiofemoral angle	5.40	6.700 (-19, 18)	1.75	4.952 (-9, 12)	3.37	6.034 (-19, 18)	**0.009***
Preoperative tibial slope	6.86	3.499 (1-16)	6.80	3.897 (0, 16)	6.82	3.703 (0, 16)	0.941*
Postoperative tibiofemoral angle	-5.23	1.987 (-9, -1)	-5.82	2.285 (-9, 3)	-5.56	2.165 (-9, 3)	0.224*
Postoperative tibial slope	4.11	2.610 (-3, 11)	1.95	2.542 (-3, 10)	2.91	2.774 (-3, 11)	**<0.001***

PS: Posterior-stabilized, TKA: Total knee arthroplasty, SD: Standard deviation, *: Mann-Whitney U test, p-value <0.05 is considered statistically significant

fixed or movable insert, patella-replacing or non-replacing, modular or non-modular (7).

It is difficult to say that there is a serious consensus on the necessity of preserving the cruciate ligaments and replacing the patellar component.

There is no significant difference in functional outcomes in terms of proprioception and gait analysis between prosthesis designs that preserve or cut the PCL. The type of prosthesis to be used in the patient's surgery depends on the surgeon's experience, preference and habit of using implants (8).

Some advantages of models that preserve the posterior cruciate ligament are the ligament's contribution to proprioception, greater preservation of bone stock, better imitation of knee kinetics, and less load on the prosthetic bone junctions due to less joint compliance (9).

Since prostheses that preserve the PCL allow for roll-back and have flatter insert designs, they offer a wider range of motion than prostheses that cut the PCL (10).

Since soft tissue balance can be achieved more easily in prostheses that cut the PCL, they can be considered advantageous in this respect (11).

Posterior cruciate ligament incision is considered as a general principle in cases of knee arthrosis developing on the basis of rheumatoid arthritis, in cases with extreme varus-valgus deformity or extreme extension limitation, and in patients who have previously undergone patellectomy or high tibial osteotomy surgery (12).

TKA is an effective method for treating advanced-stage knee osteoarthritis. However, there is still ongoing debate about whether the PCL should be retained or sacrificed (13-16). In our study, we compared the tibiofemoral angle, tibial slope, and demographic characteristics of patients who underwent CR and PS knee prosthesis and revealed significant differences between the two groups.

In our study, the average age of patients who underwent CR prosthesis surgery was lower (p=0.006). Similarly, literature suggests that preserving the PCL in younger and more active patients provides more natural joint biomechanics and enhances knee stability (17). Conversely, it has been emphasized that the surgical technique for PS prostheses is more standardized, and especially in elderly patients, the need for ligament preservation is lower (18,19).

Radiological evaluation revealed a significant difference in preoperative tibiofemoral angle between the two groups (p=0.009). Patients who underwent PS prosthesis exhibited greater preoperative varus deformity. However, it was observed that this difference decreased in the postoperative values and was corrected regardless of the type of prosthesis. This situation reveals that in cases with high varus values in the preoperative measurements, it is necessary to plan with a prosthesis that primarily cuts the PCL. Our study also provided results that support the studies recommending the use of a prosthesis that cuts the PCL in the presence of advanced varus deformity (20).

Correct prosthesis selection and being compatible with the studies recommending cutting the PCL during surgical technique, eliminating the effect of the ligament against the correction of the deformity (21) and performing a very good medial release (22) are other similarities. Similarly, Bellemans et al. (23) observed that PS prostheses had more pronounced varus deformities. However, in the postoperative period, tibiofemoral angle correction was successfully achieved in both groups. In our study, no significant difference was found between the two groups regarding postoperative tibiofemoral angle values (p=0.224), suggesting that both techniques can yield successful outcomes with appropriate surgical planning.

Regarding postoperative tibial slope, patients with PS prosthesis had higher tibial slope values (p<0.001). This finding indicates that tibial cuts were made at a greater angle when the PCL was sacrificed. Bellemans et al. (23) reported that an increased tibial slope may compromise posterior stability and affect long-term outcomes. However, it has also been suggested that the greater tibial slope in PS prostheses could enhance postoperative range of motion (24,25).

Retaining the PCL to replicate the native knee may preserve proprioception and lead to improved knee scores in theory. So, the rehabilitation team needs to know this and act accordingly.

Study Limitations

Our study has some limitations. First, due to this retrospective method, ensuring complete homogeneity in patient selection and surgical techniques was not possible. Second, since our study focuses on radiological evaluation, future studies assessing long-term functional and clinical outcomes in different patient groups would be beneficial.

Conclusion

These findings suggest that surgical technique selection should be tailored to the patient, and both methods can yield successful outcomes in appropriate patient groups.

Ethics

Ethics Committee Approval: Ethical approval was obtained for the clinical study (Izmir Bakirçay University, decision no: 1210, research no: 1190, date: 27.09.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: C.K., Concept: C.K., E.K., Design: M.A., E.K., A.İ.K., Data Collection or Processing: E.K., A.İ.K., Analysis or Interpretation: M.A., S.Ç., Literature Search: C.K., S.Ç., Writing: C.K., M.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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Association of Abdominal Fat Percentage, Body Mass Index, and Bone Mineral Density in Male Osteoporosis Patients

Erkek Osteoporoz Hastalarında Abdominal Yağ Yüzdesi, Vücut Kitle İndeksi ve Kemik Mineral Dansitesi İlişkisi

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Abstract

Objective: We aimed to investigate the relationship between bone mineral density (BMD), body mass index (BMI), and abdominal fat percentage in men with osteopenia and osteoporosis.

Materials and Methods: This single-center cross-sectional study included 156 men aged 50-75 years (86 with osteopenia, 70 with osteoporosis). Demographic, anthropometric, and laboratory data were collected. BMD and abdominal fat percentage were measured using dual-energy X-ray absorptiometry. Group comparisons were performed with the independent samples t-test or Mann-Whitney U test. Correlations were assessed with Spearman's coefficient, and subgroup analyses were conducted according to BMI categories.

Results: Men with osteoporosis had significantly lower height, weight, BMI, and abdominal fat percentage compared with those with osteopenia. Laboratory values were similar between groups. Abdominal fat percentage was weakly but positively associated with lumbar T-score and femur total BMD. BMI correlated positively with BMD at all skeletal sites. C-reactive protein was inversely associated with femur total BMD and positively with abdominal fat. In BMI-stratified analyses, abdominal fat percentage was positively correlated with femoral neck (r=0.275; p=0.042) and femur total BMD (r=0.374; p=0.005) only in normal-weight men, but not in overweight or obese men.

Conclusion: These findings suggest a biphasic relationship between adiposity and bone health, depending on BMI. Moderate abdominal fat may be associated with higher BMD in normal-weight men, whereas in overweight and obese individuals, inflammatory pathways may attenuate or abolish this benefit.

Keywords: Male osteoporosis, osteopenia, abdominal fat, body mass index, bone mineral density

Öz

Amaç: Erkek osteopeni ve osteoporoz hastalarında kemik mineral dansitesi (KMD), vücut kitle indeksi (VKİ) ve abdominal yağ yüzdesi arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntem: Tek merkezli kesitsel çalışmaya 50-75 yaş arası toplam 156 erkek hasta dahil edildi (86 osteopeni, 70 osteoporoz). Demografik, antropometrik ve laboratuvar verileri kaydedildi. KMD ve abdominal yağ yüzdesi çift enerjili X-ışını absorbsiyometrisi ile ölçüldü. Gruplar t-testi veya Mann-Whitney U testi ile karşılaştırıldı. Spearman korelasyonu ve VKİ kategorilerine göre alt grup analizleri yapıldı.

Bulgular: Osteoporoz grubunda boy, kilo, VKİ ve abdominal yağ yüzdesi osteopeni grubuna göre anlamlı olarak daha düşüktü. Laboratuvar parametreleri benzer bulundu. Abdominal yağ yüzdesi lomber T-skoru ve femur total KMD ile zayıf fakat pozitif ilişkiliydi. VKİ tüm iskelet bölgelerinde KMD ile pozitif koreleydi. C-reaktif protein femur total KMD ile ters, abdominal yağ yüzdesi ile pozitif ilişkiliydi. VKİ'ye göre stratifikasyonda abdominal yağ yüzdesi yalnızca normal kilolu erkeklerde femur boynu (r=0.275; p=0.042) ve femur total KMD (r=0.374; p=0.005) ile pozitif ilişkili bulundu; fazla kilolu veya obezlerde ilişki gözlenmedi.

Sonuç: Bulgular, yağ dokusu ile kemik sağlığı arasında VKİ'ye bağlı çift fazlı bir ilişki olduğunu göstermektedir. Orta düzeyde abdominal yağ, normal kilolu erkeklerde daha yüksek KMD ile ilişkili olabilirken, fazla kilolu ve obezlerde enflamatuvar mekanizmalar bu faydayı azaltabilir veya ortadan kaldırabilir.

Anahtar kelimeler: Erkek osteoporozu, osteopeni, abdominal yağ, vücut kitle indeksi, kemik mineral dansitesi

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Introduction

Osteoporosis and obesity are major public health problems that substantially contribute to morbidity and mortality worldwide (1). Traditionally, obesity was considered protective against osteoporosis by increasing mechanical loading and thereby preserving bone mineral density (BMD) (2,3). However, recent studies indicate that obesity may increase the risk of osteoporotic fractures depending on fat distribution (4,5). These inconsistencies may be due to reliance on general measures such as body mass index (BMI) or total body fat percentage, which do not capture the physiological differences between fat depots (6).

In men, osteoporosis remains a major health issue, largely due to underdiagnosis and undertreatment compared with women (7). In addition to age-related primary osteoporosis, secondary causes such as glucocorticoid use, alcohol consumption, hypogonadism, and diabetes mellitus are common in men (8). Declining testosterone levels play a critical role in the acceleration of bone loss, while increased adiposity contributes to hormonal imbalance by enhancing the aromatization of testosterone into estrogen (9).

Abdominal adiposity, particularly visceral fat, is a metabolically active depot that promotes low-grade inflammation, insulin resistance, and dysregulated secretion of adipokines and proinflammatory cytokines, thereby impairing bone remodeling and enhancing osteoclast activity (10,11). Indeed, the relationship between abdominal fat and BMD has been shown to vary by BMI category, with a positive association in normal-weight men and a negative association in overweight or obese men (12).

Although magnetic resonance imaging and computed tomography (CT) are considered gold standards for assessing fat distribution, their use is limited by cost, scan time, and radiation exposure in CT (13). In contrast, dual-energy X-ray absorptiometry (DXA), originally developed to evaluate BMD, is widely used because it can reliably assess both bone and body composition with low radiation exposure and short scan times (14,15).

Previous studies investigating the relationship between obesity and bone health in men have reported conflicting results (16-18). Therefore, this cross-sectional study aimed to investigate the association between BMD, BMI, and abdominal fat percentage in male patients with osteoporosis.

Materials and Methods

Data Source and Ethics

This single-center, cross-sectional study was conducted at the AIBU İzzet Baysal Physical Therapy and Rehabilitation Training and Research Hospital. Medical records of male patients with low bone mass who were evaluated between March 1, 2023, and March 1, 2025, were retrospectively reviewed. The study complied with the principles of the Declaration of Helsinki and received approval from the Institutional Review Board of Bolu Abant İzzet Baysal University (approval no: 2025/192, date: May 06, 2025). Written informed consent was obtained from all participants prior to enrollment.

Study Population

A total of 156 male patients aged 50-75 years with a confirmed diagnosis of osteopenia or osteoporosis were retrospectively included. Patients with a history of malignancy, inflammatory or infectious disease, diabetes mellitus (due to its potential to independently and profoundly affect adiposity and bone metabolism) (19,20), or corticosteroid use were excluded. In addition, participants with missing BMD measurements at the lumbar or femoral sites, metallic implants at measurement sites, advanced skeletal deformities, or missing or erroneous BMD data were not included in the analysis.

Patients were diagnosed according to the lowest T-score value obtained at the lumbar spine (L1-L4), femoral neck, or femur total regions. A T-score between -1.0 and -2.5 standard deviations (SD) was classified as osteopenia, and ≤-2.5 SD as osteoporosis (21).

Data Collection

Demographic and clinical characteristics, including age, height, weight, BMI, comorbidities, and medications, were extracted from patient files. Laboratory data obtained at the time of DXA scanning were recorded, including hemoglobin, leukocyte and platelet counts, C-reactive protein (CRP), calcium, parathyroid hormone (PTH), and vitamin D levels.

Anthropometric Measurements

Height and weight were measured manually during routine clinical assessment, and BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²). BMI categories were defined according to World Health Organization classification as underweight (BMI <18.5), normal weight (BMI ≥18.5 and <25.0), overweight (BMI ≥25.0 and <30.0), and obese (BMI ≥30.0) (22).

DXA Scans

DXA scans were performed using an Osteosys Primus device (OsteoSys, South Korea) in accordance with standard acquisition protocols. Areal BMD values were obtained for the lumbar spine and femur. Additionally, abdominal fat percentage was assessed directly from the lumbar spine scan image using the manufacturer's automated region-of-interest (ROI) analysis. While this approach provides a practical surrogate of abdominal adiposity, it does not allow differentiation between visceral adipose tissue (VAT) and subcutaneous adipose tissue (SAT). Calibration of the DXA machine was routinely performed using a standard phantom according to manufacturer recommendations.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY, USA) and JMP Pro 18 Student Edition

(SAS Institute Inc., Cary, NC, USA). Continuous variables were expressed as mean ± SD for normally distributed data or median with interquartile range for non-normally distributed data, as assessed by the Shapiro-Wilk test. Categorical variables were presented as numbers and percentages. Group comparisons were conducted using the independent samples t-test or Mann-Whitney U test for two groups.

Correlations between variables (e.g., abdominal fat percentage, BMI, CRP, and BMD parameters) were analyzed using Spearman's correlation coefficient. A two-tailed p-value <0.05 was considered statistically significant. Correlation strength was interpreted as follows: r≤0.29, weak; r=0.30-0.49, moderate; r≥0.50, strong.

Results

A total of 156 male patients were included, comprising 86 with osteopenia and 70 with osteoporosis. There was no significant difference in age between groups [66.5 (61.3-72.0) vs. 67.0 (62.3-74.0) years; p=0.621]. Patients with osteoporosis had significantly lower height (166±7.4 cm vs. 170±7.0 cm; p=0.004), weight [70.0 (62.0-79.8) vs. 78.0 (72.3-85.8) kg; p<0.001], and BMI [25.7 (23.5-29.1) vs. 26.8 (25.0-29.39) kg/m²; p=0.014] compared with the osteopenia group (Table 1). The abdominal fat percentage was slightly but significantly lower in the osteoporosis group [28.9 (19.1-35.0) % vs. 30.9 (25.9-36.1) %; p=0.040]. The prevalence of BMI <25 kg/m² was higher in the osteoporosis group (47.1% vs. 25.6%), whereas obesity (BMI >30 kg/m²) was more frequent in the osteopenia group (24.4% vs. 17.1%).

Table 1. Demographic, biochemical, and densitometric characteristics of male patients with osteopenia and osteoporosis

Variable	Osteopenia (n=86)	Osteoporosis (n=70)	p-value
Demographics			
Age (years)	66.5 (61.3-72)	67 (62.3-74)	0.621
Height (cm)	170±7.0	166±7.4	**0.004**
Body weight (kg)	78 (72.3-85.8)	70 (62-79.8)	**<0.001**
BMI (kg/m²)	26.8 (25-29.3)	25.7 (23.5-29.1)	**0.014**
Weight status			
BMI <25	22 (25.6%)	33 (47.1%)	**0.020**
BMI 25-29.9	43 (50%)	25 (35.7%)	
BMI ≥30	21 (24.4%)	12 (17.1%)	
Hematological indices			
White blood cell count (10³/µL)	6.7 (5.8-7.7)	6.7 (5.5-8.5)	0.692
Neutrophil count (10³/µL)	3.8 (3.1-4.4)	3.8 (3-5)	0.708
Monocyte count (10³/µL)	0.6 (0.5-0.7)	0.6 (0.5-0.7)	0.845
Lymphocyte count (10³/µL)	2 (1.7-2.5)	2 (1.6-2.6)	0.685
Hemoglobin (g/dL)	14.7 (13.9-15.5)	14.4 (13.4-15.3)	0.088
Platelet count (10³/µL)	209 (182.3-245)	218.5 (191.5-255)	0.505
Laboratory values			
Serum calcium (mg/dL)	9.3 (8.8-9.5)	9.3 (8.9-9.6)	0.844
Serum vitamin D (ng/mL)	21.1 (13.9-27.4)	23.4 (19-30.2)	0.068
Parathyroid hormone (pg/mL)	53.6 (41.2-70.2)	61 (46.4-82.9)	0.082
C-reactive protein (mg/L)	2 (2-4.3)	2.5 (2-5)	0.090
DXA measurements			
Lumbar spine T-score	0.1 (-1.1-1.2)	-0.85 (-1.6-0.2)	**0.002**
Lumbar total BMD (g/cm²)	1.185 (1.059-1.317)	1.069 (0.975-1.187)	**<0.001**
Femoral neck T-score	-1.9 (-2.2- -1.5)	-2.9 (-3.3- -2.6)	**<0.001**
Femoral neck BMD (g/cm²)	0.879 (0.850-0.933)	0.760 (0.715-0.794)	**<0.001**
Femur total T-score	-1.5 (-1.8- -1.2)	-2.6 (-3.0- -2.2)	**<0.001**
Femur total BMD (g/cm²)	0.982 (0.932-1.052)	0.845 (0.771-0.911)	**<0.001**
Abdominal fat percentage (%)	30.9 (25.9-36.1)	28.9 (19.1-35)	**0.040**

Values are presented as mean ± standard deviation (SD) or median (interquartile range) as appropriate, based on data distribution. Group comparisons were performed using independent samples t-test or Mann-Whitney U test. DXA: Dual-energy X-ray absorptiometry, BMD: Bone mineral density, BMI: Body mass index

Laboratory parameters, including calcium, vitamin D, PTH, CRP and hematological indices, showed no significant differences between the groups (all p>0.05).

Correlation analysis revealed a weak but significant positive association between abdominal fat percentage and lumbar T-score (r=0.168; p=0.036) and femur total BMD (r=0.202; p=0.011). BMI was also positively correlated with BMD at all skeletal sites (r-values between 0.174 and 0.308; all p<0.05). CRP was inversely associated with femur total BMD (r=-0.163; p=0.040) and weakly correlated with abdominal fat percentage (r=0.173; p=0.031). When stratified by BMI categories, no correlation was observed between abdominal fat percentage and BMD in overweight or obese individuals. However, among normal-weight participants, abdominal fat percentage was positively correlated with femoral neck BMD (r=0.275; p=0.042) and femur total BMD (r=0.374; p=0.005).

Correlation analysis revealed a weak but significant positive association between abdominal fat percentage and lumbar T-score (r=0.168; p=0.036) and femur total BMD (r=0.202; p=0.011). BMI was also positively correlated with BMD at all skeletal sites (r-values between 0.174 and 0.308; all p<0.05). CRP was inversely associated with femur total BMD (r=-0.163; p=0.040) and weakly correlated with abdominal fat percentage (r=0.173; p=0.031). When stratified by BMI categories, no correlation was observed between abdominal fat percentage and BMD in overweight (n=68) or obese (n=33) individuals. However, among normal-weight participants (n=55), abdominal fat percentage was positively correlated with femoral neck BMD (r=0.275; p=0.042) and femur total BMD (r=0.374; p=0.005) (Figure 1).

Discussion

In this cross-sectional study of 156 men with low bone mass, we found that those with osteoporosis had significantly lower height, weight, BMI, and abdominal fat percentage compared with men with osteopenia. Abdominal fat percentage was positively associated with lumbar and femur total BMD. This relationship was evident only in men with normal BMI, where femoral neck BMD showed a weak correlation and femur total BMD a moderate correlation. In contrast, overweight and obese men did not demonstrate such associations. CRP was inversely related to femur total BMD. These findings highlight the complex, context-dependent interplay between body composition, inflammation, and skeletal health.

The observation that men with osteoporosis had lower weight, BMI, and abdominal fat percentage than those with osteopenia is consistent with previous studies linking low body weight and fat mass to reduced bone strength and increased fracture risk (23,24). The higher prevalence of normal weight (BMI <25) in the osteoporosis group and obesity (BMI >30) in the osteopenia group further supports the notion that higher BMI may exert a protective effect against bone loss. This may potentially delay the progression to osteoporosis. Mechanical loading from body weight stimulates adaptive bone remodeling, whereas reduced weight diminishes this osteogenic stimulus. Several epidemiological studies also reported that higher BMI is protective against hip fractures in men (25), although this benefit may not extend to obese individuals (26). Our data support this biphasic model: Insufficient adiposity is detrimental, but excessive adiposity does not confer additional skeletal benefit.

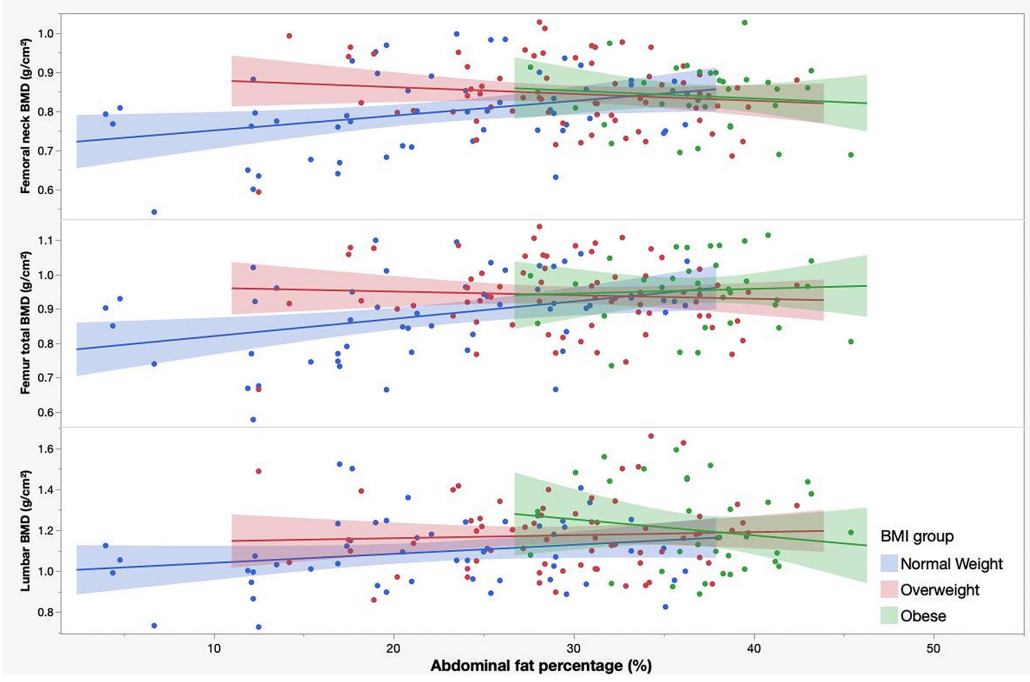

Figure 1. Interaction plots with 95% confidence intervals between abdominal fat percentage and body mass index (BMI) groups on bone mineral density (BMD) at lumbar and femoral sites in males

The positive association between abdominal fat percentage and BMD in normal-weight men, but not in overweight or obese men, suggests a threshold effect of adiposity on bone. This finding is consistent with Bland et al. (12), who observed positive correlations between adiposity and BMD in normal-weight men but negative associations in obese men at the whole body and lumbar spine. Importantly, and in agreement with our results, they found no significant relationship between adiposity and BMD at femoral sites in any BMI group. Our BMI-stratified observations are further supported by Zhu et al. (27), who reported similar variations across weight categories. The negative relationship we observed in obese men parallels the findings of Katzmarzyk et al. (16), who described an inverse VAT-BMD association in overweight and obese individuals, although their study did not include normal-weight participants—a gap addressed by our analysis.

Several mechanisms may underlie this biphasic relationship. In men with normal BMI, the dominant protective factor for bone appears to be mechanical loading from overall body weight, which enhances bone remodeling. Moderate adiposity may also contribute indirectly by providing estrogen through aromatization of androgens and by secreting adipokines such as leptin that support osteoblast activity (28,29). In contrast, in overweight and obese individuals, these benefits may be outweighed by metabolic and inflammatory consequences specific to abdominal adiposity. VAT is particularly metabolically active and secretes pro-inflammatory cytokines such as tumor necrosis factor-α and interleukin-6, which stimulate osteoclastogenesis and bone resorption (30). This distinction suggests that while BMI reflects a primarily mechanical influence on bone, abdominal fat represents a metabolically driven pathway that can shift from supportive to detrimental as fat mass increases. Our finding that CRP correlated negatively with femoral BMD supports this inflammatory mechanism and aligns with prior evidence linking obesity-related inflammation to bone loss (31).

Age also showed significant associations with BMD in our cohort, consistent with established patterns in male skeletal aging. Older age has been linked to lower hip BMD but paradoxically higher spine BMD, likely reflecting spinal osteophyte formation and other age-related changes (32). CRP was inversely associated with femur total BMD and modestly correlated with abdominal fat percentage, supporting the concept that obesity-induced inflammation contributes to bone fragility. Chronic low-grade inflammation increases osteoclast activity while impairing osteoblast function, leading to net bone loss (33). Prior studies also demonstrated that elevated CRP predicts lower hip and spine BMD in men (34).

Taken together, these findings suggest that moderate adiposity is associated with higher BMD in normal-weight men, whereas this positive association plateaus or becomes negative in overweight and obese individuals, potentially due to inflammatory and metabolic factors. Clinically, osteoporosis management in men should address not only weight optimization but also reduction of abdominal adiposity and preservation of lean mass. Lifestyle strategies such as resistance training and adequate protein intake are particularly important, as they counteract sarcopenic obesity, a condition characterized by concurrent muscle loss and fat accumulation that further compromises skeletal integrity (35).

Study Limitations

A strength of this study is the use of DXA-derived abdominal fat percentage, which provides a more direct and objective assessment of central adiposity compared with anthropometric measures such as waist circumference (36). However, an important limitation is the inability to distinguish between VAT and SAT. Recent evidence suggests that in obesity, both VAT and SAT may negatively affect bone health, potentially mitigating this limitation (12). Another limitation is the lack of physical activity data, as sedentary behavior—commonly associated with central obesity—is an important determinant of both VAT accumulation and bone loss (25). The positive association observed in normal-weight men may therefore partly reflect a healthier balance between mechanical loading and metabolic profile. Furthermore, data on supplementation and medication use (e.g., calcium, vitamin D, antiresorptives) and dietary intake (specifically of calcium and protein) were not available, which could have confounded associations. Finally, the cross-sectional design precludes causal inference. Longitudinal studies are needed to determine whether central adiposity contributes to, or merely reflects, bone loss in men.

Conclusion

In summary, men with osteoporosis had lower BMI and abdominal fat percentage compared with those with osteopenia, and abdominal fat percentage was positively associated with BMD only in normal-weight individuals. These findings support a biphasic relationship between adiposity and bone, where moderate fat levels may be associated with higher BMD, but excessive adiposity confers no benefit and may even be detrimental through inflammatory pathways. Given the cross-sectional design, these associations (particularly in normal-weight men) should be interpreted with caution, and confirmation in longitudinal studies is warranted. Nonetheless, the results suggest that clinical strategies should focus on maintaining adequate but not excessive body fat, reducing abdominal adiposity, and preserving muscle mass to optimize skeletal health in men.

Ethics

Ethics Committee Approval: The study complied with the principles of the Declaration of Helsinki and received approval from the Institutional Review Board of Bolu Abant İzzet Baysal University (approval no: 2025/192, date: May 06, 2025).

Informed Consent: Written informed consent was obtained from all participants prior to enrollment.

Footnotes

Authorship Contributions

Concept: T.A., Y.E., Design: T.A., Y.E., Data Collection or Processing: Y.E., E.Ö., Analysis or Interpretation: T.A., Literature Search: Y.E., Writing: Y.E., T.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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Awareness of Post-stroke Osteoporosis Among Physical Medicine and Rehabilitation Physicians in Türkiye: A Cross-sectional Study

Türkiye'deki Fiziksel Tıp ve Rehabilitasyon Hekimleri Arasında İnme Sonrası Osteoporoz Farkındalığı: Kesitsel Bir Çalışma

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Abstract

Objective: The aim of this study is to evaluate the level of knowledge and awareness regarding post-stroke osteoporosis among physical medicine and rehabilitation (PMR) physicians in Türkiye.

Materials and Methods: Our study, designed as an observational cross-sectional study, included 151 PMR physicians. An online survey system was used to collect data. The survey consisted of a total of 20 questions categorized under the following headings: General information, the relationship between stroke and osteoporosis, evaluation and diagnosis, management and treatment, and education and awareness.

Results: Among the participants, 51% (n=77) reported having a moderate level of knowledge about osteoporosis, 27.2% (n=41) good, 12.6% (n=19) poor, 4.6% (n=7) very poor, and 4.6% (n=7) very good. Thitry-eigh out of 151 physicians (25.2%) always, 67 (44.4%) often, 37 (24.5%) sometimes, and 8 (5.3%) rarely evaluated their patients after stroke for osteoporosis. One-hundred thirty-three physicians (88.1%) answered yes to the question of whether they needed training and resources on post-stroke osteoporosis.

Conclusion: In our country, the knowledge level of PMR physicians about post-stroke osteoporosis was determined to be moderate. Our physicians stated that they frequently evaluate patients after stroke in terms of osteoporosis.

Keywords: Stroke, osteoporosis, physician, awareness

Öz

Amaç: Bu çalışmanın amacı, Türkiye'deki fiziksel tıp ve rehabilitasyon (FTR) hekimleri arasında inme sonrası osteoporoz ile ilgili bilgi ve farkındalık düzeyini değerlendirmektir.

Gereç ve Yöntem: Gözlemsel kesitsel bir çalışma olarak tasarlanan çalışmamıza 151 FTR hekimi dahil edildi. Veri toplamak için çevrimiçi bir anket sistemi kullanılmıştır. Anket, genel bilgiler, inme ve osteoporoz ilişkisi, değerlendirme ve tanı, yönetim ve tedavi (3 soru) ve eğitim ve farkındalık başlıkları altında kategorize edilmiş toplam 20 sorudan oluşmaktadır.

Bulgular: Katılımcıların %51'i (n=77) osteoporoz hakkında orta, %27,2'si (n=41) iyi, %12,6'sı (n=19) kötü, %4,6'sı (n=7) çok kötü ve %4,6'sı (n=7) çok iyi düzeyde bilgi sahibi olduğunu bildirdi. Yüz elli bir hekimden 38'i (%25,2) her zaman, 67'si (%44,4) sıklıkla, 37'si (%24,5) bazen ve 8'i (%5,3) nadiren inme sonrası hastalarını osteoporoz açısından değerlendirmektedir. Yüz otuz üç hekim (%88,1) inme sonrası osteoporoz konusunda eğitim ve kaynağa ihtiyaç duyup duymadıkları sorusuna evet yanıtını vermiştir.

Sonuç: Ülkemizde FTR hekimlerinin inme sonrası osteoporoz hakkındaki bilgi düzeyinin orta düzeyde olduğu belirlenmiştir. Hekimlerimiz inme sonrası hastaları osteoporoz açısından sıklıkla değerlendirdiklerini belirtmişlerdir.

Anahtar kelimeler: İnme, osteoporoz, hekim, farkındalık

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Introduction

Stroke is the second leading cause of death worldwide and the leading cause of long-term disability, affecting millions of people each year (1,2). Beyond its obvious neurological effects, stroke has important but often understudied effects on a variety of physiological systems (3,4). One area that requires greater attention is the effect of stroke on bone density, a critical determinant of overall skeletal health and integrity (5).

Accumulating evidence suggests that stroke may negatively impact bone density, increasing the risk of osteoporosis (OP) and subsequent major fractures, thereby increasing patient morbidity and mortality (5,6). A study conducted in Türkiye found the prevalence of post-stroke OP to be 40.5% in women and 12.7% in men (7). This phenomenon may be attributed to immobility, neurological impairment, and endocrine dysregulation after stroke (8,9). The risk of fragility fractures is approximately sevenfold higher after stroke and is associated with prolonged disability and increased mortality (10).

Post-stroke bone loss is focal, affecting the paretic side more than the non-paretic side, and is most evident within the first few months following the stroke (8). Despite the known risks of OP and fractures after a stroke, stroke patients are rarely screened or treated for OP. One large study found that dual-energy X-ray absorptiometry (DXA) testing was performed in only 5.1% of stroke survivors, and only 3.2% of those who had not previously received treatment were prescribed anti-OP medications within 12 months (11).

In light of this information, the aim of our study is to evaluate the level of knowledge among physical medicine and rehabilitation (PMR) physicians in Türkiye regarding OP as a complication of stroke, as well as their clinical approaches in daily practice. We believe that the findings of this study will help raise awareness of post-stroke OP among PMR physicians.

Materials and Methods

This study was approved by the University of Health Sciences Türkiye Hamidiye Scientific Research Ethics Committee (decision number: 2025-25-22, date: 09.01.2025). All procedures involving human participants were conducted in accordance with the 1964 Helsinki Declaration and its later amendments.

Our study was designed as an observational cross-sectional study and included 151 PMR physicians. Only PMR physicians who were actively involved in the clinical assessment of patients and at least 3 years experience were eligible for inclusion; individuals who were not practicing PMR or not engaged in direct patient evaluation were excluded from the study. Participants voluntarily completed the online survey and, since online surveys were anonymous, the participant stated that they agreed to participate in the study.

Communication with PMR physicians was established through online health portals and professional email channels. The survey assessed participants' general information (including professional title and working hours), as well as their knowledge and awareness regarding post-stroke OP. The survey was developed by the authors of this study and reliability analysis was performed. All questions were prepared in accordance with the current guidelines and compilations. The survey consisted of a total of 20 questions, categorized under the following headings: general information (2 questions), the relationship between stroke and OP (6 questions), evaluation and diagnosis (7 questions), management and treatment (3 questions), and education and awareness (2 questions). In addition to assessing the overall knowledge and awareness of PMR physicians, the study also analyzed the relationship between these variables and professional characteristics such as title and working hours.

Sample Selection of the Research

The exact number of actively practicing PMR physicians in Türkiye could not be determined from any available database. Therefore, calculations were made based on known or estimated values. Assuming a total of approximately 10,000 PMR physicians in Türkiye—based on the assumption that the distribution of medical specialties is relatively balanced—sample size calculations were performed. When the confidence interval was accepted as 95%, the error rate as 5%, the population rate as 90% and the population size as 10,000 PMR physicians, it was concluded that at least 137 PMR physicians should be included in the study (12).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 22. The conformity of the parameters to normal distribution was evaluated by Kolmogorov-Smirnov and Shapiro-Wilks tests. In addition to descriptive statistics (mean, standard deviation, frequency), inferential statistical methods were applied.

For comparisons between two groups of quantitative data, the Student's t-test was used for normally distributed variables, whereas the Mann-Whitney U test was applied for non-normally distributed variables. To examine the relationships between continuous variables, Pearson correlation analysis was used for normally distributed data, and Spearman's rho correlation analysis for non-normally distributed data. Chi-square tests were used to compare categorical variables. The reliability of the survey was assessed using Cohen's Kappa coefficient. The significance level was evaluated as $p<0.05$.

Results

The demographic characteristics of the PMR physicians are presented in Table 1. According to the findings, 53% of the participants were residents, 41% were specialists, 2% were lecturers, 3.3% were associate professors, and 0.7% were professors. In terms of professional experience, 50.3% of the physicians had 3-4 years of experience, while 17.2% had more than 12 years of experience. Regarding their self-reported knowledge of OP, 51% of the participants described their level of knowledge as moderate, 4.6% as very poor, and 4.6% as very good.

Statistical analyses on the relationship between stroke and OP, evaluation and diagnosis, management and treatment, education and awareness are shown in Tables 2a-d.

The correlation analysis between professional title, years of experience, self-reported OP knowledge, and various survey parameters is presented in Table 3. A statistically significant relationship was found between professional title and several key survey responses. As the academic title of the physicians increased, the proportion of correct answers to the questions "In which period is the decrease in BMD most evident after stroke?" and "In which anatomical location do fractures most commonly occur after stroke?" also increased ($p<0.05$). It was found to be statistically significant that as the title increased, 25-OH vitamin D and calcium tests were requested more frequently, balance exercises were planned more to prevent OP, and there was no need for more training or resources regarding OP ($p<0.05$). It was observed that physicians with longer working duration answered the question "In which localization do fractures most frequently occur in stroke patients?" with statistically significant accuracy. As working duration increased, physicians statistically significantly took gender into account more when assessing the risk of OP, requested 25-OH vitamin D and calcium tests more frequently, and stated that there was no need for more education or resources regarding OP.

Higher self-reported levels of OP knowledge were significantly associated with better performance across multiple survey domains ($p<0.005$). Physicians who reported greater knowledge were more likely to correctly identify the period in which bone mineral density (BMD) loss is most pronounced after stroke. They also demonstrated a more accurate understanding of the laterality and anatomical localization of BMD reduction, and more precisely identified the sites where fractures are most commonly observed in stroke patients. In clinical practice, these physicians more frequently assessed OP risk factors and more regularly evaluated their post-stroke patients for OP. They were also more likely to utilize clinical evaluation methods for OP screening and reported greater awareness of the fracture risk assessment tool-stroke score, a tool used to estimate fracture risk in stroke survivors. Furthermore, physicians with higher knowledge levels placed greater emphasis on nutritional factors

Table 1. Demographic data of participants

		n (%)
Professional title	**Resident**	80 (53)
	Specialist	62 (41)
	Assistant professor	3 (2)
	Associate professor	5 (3.3)
	Professor	1 (0.7)
Working duration (year)	**3-4**	76 (50.3)
	5-8	29 (19.2)
	9-12	20 (13.2)
	>12	26 (17.2)
Osteoporosis knowledge	**Very poor**	7 (4.6)
	Poor	19 (12.6)
	Moderate	77 (51.0)
	Good	41 (27.2)
	Very good	7 (4.6)
Frequency of stroke patients assessment	**Often** **Sometimes** **Rarely or never**	98 (64.9) 53 (35) 0

Table 2a. Relationship between stroke and osteoporosis

Question	Correct answer	n (%)
In which period is the decrease in BMD most prominent following a stroke?	First few months	58 (38.4)
Decrease in BMD occurs only on the hemiplegic side after stroke	False	135 (89.4)
Decrease in BMD is more pronounced in the upper extremity after stroke	True	26 (17.2)
In which location do fractures most frequently occur in stroke patients?	Hip	91 (60.3)
FRAX is sufficient to determine the risk of fracture after stroke	False	104 (68.9)

BMD: Bone mineral density, FRAX: Fracture risk assessment tool

Table 2b. Evaluation and diagnosis parameters		
Question	**Answer**	**n (%)**
Do you assess osteoporosis risk factors in your post-stroke patients?	Yes	125 (82.8)
What factors do you consider when assessing the risk of osteoporosis in your patients?	Age	150 (99.3)
	Gender	144 (95.4)
	Mobility status	146 (96.7)
	Nutritional status All of the above	127 (84.1) 126 (83.4)
	Other (additional disease, medication used, family history, smoking/alcohol use, etc.)	12 (7.9)
How frequently do you assess your patients for osteoporosis following a stroke?	Always	38 (25.2)
	Often	67 (44.4)
	Sometimes	37 (24.5)
	Rarely	8 (5.3)
	Never	1 (0.7)
Which methods do you use to screen for osteoporosis in your post-stroke patients?	Clinical evaluation	102 (67.5)
	Laboratory	127 (84.1)
	DXA All of the above	151 (100.0) 95 (62.9)
	Other (X-ray)	1 (0.6)
How frequently do you request 25-hydroxy vitamin D and calcium tests in stroke patients?	Always	66 (43.7)
	Often	56 (37.1)
	Sometimes	26 (17.2)
	Rarely	3 (2.0)
	Never	0 (0.0)
How often do you request DXA scans for stroke patients?	Always	37 (24.5)
	Often	64 (42.4)
	Sometimes	46 (30.5)
	Rarely	4 (2.6)
	Never	0 (0.0)
Have you ever heard of the FRAC-stroke score for assessing fracture risk in stroke patients?	Yes	52 (34.4)
	No	99 (65.6)

DXA: Dual-energy X-ray absorptiometry, FRAC: Fracture risk after ischemic stroke

in treatment planning, showed a higher preference for vitamin D and calcium supplementation in managing post-stroke OP, and were less likely to report a need for additional education or resources on the subject.

To assess the reliability of the questionnaire, it was administered twice to a group of 20 participants with a two-week interval. The consistency of responses was evaluated using Cohen's Kappa coefficient. Among the 18 items, 3 showed almost perfect agreement (κ>0.80), while 5 demonstrated substantial agreement (κ>0.60). Six items indicated moderate agreement (κ=0.40-0.60), two items showed fair agreement (κ=0.20-0.40), and the remaining two exhibited only slight agreement (κ<0.20). These results suggest that the questionnaire generally demonstrates moderate to high reliability across most items (13). The average Cohen's Kappa value was 0.621, indicating a generally good level of reliability for the survey (Figure 1).

Discussion

Stroke is a risk factor for OP, falls, and fractures (14,15). Stroke is often associated with impairment in motor, sensory or balance functions, all of which predispose to fall-related injuries such as fractures. Moreover, the accelerated loss of bone mass after stroke also contributes to fractures in stroke survivors. When fractures occur in the post-stroke period, they can hinder rehabilitation, delay functional recovery and even lead to further complications.

Table 2c. Management and treatment parameters		
Question	**Answer**	**n (%)**
What treatment approaches do you apply to your stroke patients diagnosed with osteoporosis?	Pharmacological treatment	148 (98.0)
	Exercise	141 (93.4)
	Nutrition counseling	122 (80.8)
	All of the above	116 (76.8)
What types of physical activities or exercises do you recommend to stroke patients for the prevention of osteoporosis?	Walking	145 (96.0)
	Weight bearing exercises	90 (59.6)
	Balance exercises	118 (78.1)
	Flexibility/stretching exercises	61 (40.4)
	All of the above	36 (23.8)
Which pharmacological agents do you prefer in the treatment of post-stroke osteoporosis?	Vitamin D and calcium supplements	148 (98.0)
	Bisphosphonates	143 (94.7)
	Denosumab	135 (89.4)
	Parathyroid hormone analogs (e.g., teriparatide)	21 (13.9)
	All of the above	21 (13.9)

Table 2d. Education and awareness parameters		
Question	**Answer**	**n (%)**
What resources or materials do you use to inform your patients about osteoporosis?	Brochures	90 (59.6)
	Training seminars	43 (28.5)
	Online resources	70 (46.4)
	All of the above	20 (13.2)
	Other (verbal)	13 (8.6)
Do you feel the need for additional education or resources regarding osteoporosis and its management, particularly in post-stroke patients?	Yes	133 (88.1)
	No	18 (11.9)

With appropriate screening and pharmacologic treatment, many post-stroke fractures are potentially preventable (16). However, patients with a recent stroke are rarely screened and treated for OP, which may increase the risk of fractures (11). Therefore, this study was designed to raise awareness of post-stroke OP among healthcare professionals in Türkiye and to inform strategies for its early screening, prevention, and management.

In this study, 4.6% of 151 PMR physicians rated their OP knowledge as very poor, 12.6% as poor, 51.0% as moderate, 27.2% as good, and 4.6% as very good. Regarding knowledge-based questions, 38.4% correctly identified the period when BMD loss is most prominent post-stroke, 89.4% correctly recognized that BMD loss occurs only on the hemiplegic side, and 17.2% correctly responded that it is more pronounced in the upper extremity. Additionally, 60.3% correctly answered the most common fracture location after stroke, and 68.9% accurately assessed the adequacy of the FRAX tool in this context.

A total of 125 physicians (82.8%) reported evaluating OP risk factors after stroke. In terms of frequency of evaluation for OP following stroke, 38 participants (25.2%) stated they always, 67 (44.4%) often, 37 (24.5%) sometimes, and 8 (5.3%) rarely perform such assessments. Regarding post-stroke calcium and vitamin D testing, 66 physicians (43.7%) reported always requesting tests, 56 (37.1%) often, 26 (17.2%) sometimes, and 3 (2.0%) rarely. As for DXA use in OP screening after stroke, 37 participants (24.5%) stated they always, 64 (42.4%) often, 46 (30.5%) sometimes, and 4 (2.6%) rarely use this method. In response to the question regarding the need for further education or resources about OP, 133 of the 151 participants (88.1%) answered affirmatively. These results suggest that, despite certain knowledge limitations, many physicians incorporate OP screening into routine post-stroke management. Kapoor et al. (11) retrospectively evaluated whether patients followed at 11 stroke centers in Ontario, Canada between 2003 and 2013 were evaluated for OP. Of 16,581 stroke patients, 5.1% overall and 2.9% of those who had not had a previous test had undergone a BMD scan, and 15.5% overall and 3.2% of those who had not had a previous treatment were prescribed medications for fracture prevention within 1 year of stroke. An association was found between increased OP pharmacotherapy and female gender, poststroke OP, poststroke falls, and fractures (11). According to the study conducted by Kapoor et al. (11), it can be said that patients after stroke are evaluated more in terms of OP in our country and that DXA screening is performed at higher rates. However, Kapoor et al. (11) utilized patient records, whereas our results are based on physician self-report, which may be influenced by recall bias or an overestimation

Table 3. Correlation analyses between survey questions and demographic data of participants

		Title	Working duration	OP knowledge
In which period is the decrease in BMD most evident?	r	-0.272**	-0.147	-0.347**
	p	**0.001**	0.072	**0.000**
Decrease in BMD occurs only on the hemiplegic side	r	-0.027	-0.018	-0.165*
	p	0.741	0.829	**0.043**
Decrease in BMD is more evident in the upper extremity	r	-0.143	-0.074	-0.270**
	p	0.080	0.368	**0.001**
In which localization do fractures occur most frequently	r	-0.226**	-0.199*	-0.297**
	p	**0.005**	**0.014**	**0.000**
Assessing OP risk factors	r	0.024	0.117	-0.260**
	p	0.771	0.152	**0.001**
Gender as a risk factor	r	0.083	0.169*	0.036
	p	0.313	**0.038**	0.663
OP evaluation frequency	r	0.006	0.030	-0.279**
	p	0.938	0.718	**0.001**
Clinical evaluation as a OP screening method	r	-0.042	-0.021	-0.166*
	p	0.608	0.799	**0.042**
Frequency of requesting vitamin D calcium tests	r	0.206*	0.296**	-0.039
	p	**0.011**	**0.000**	0.636
FRAC-stroke	r	-0.094	-0.041	-0.200*
	p	0.253	0.618	**0.014**
Nutrition as a treatment method	r	-0.128	-0.047	-0.160*
	p	0.117	0.565	**0.050**
Balance exercises as a type of physical activity	r	-0.171*	-0.127	-0.126
	p	**0.035**	0.120	0.122
Vitamin D and calcium as drug therapy	r	-0.046	0.003	-0.189*
	p	0.574	0.968	**0.020**
Training seminar as a information method	r	-0.102	-0.002	-0.063
	p	0.211	0.983	0.439
Training and resource demand	r	0.290**	0.257**	0.316**
	p	**0.000**	**0.001**	**0.000**

BMD: Bone mineral density, OP: Osteoporosis, FRAC: Fracture risk after ischemic stroke, *: Correlation is significant at the 0.05 level **: Correlation is significant at the 0.01 level

of actual clinical behavior. For this reason, it does not seem possible to make a one-to-one comparison. However, in our literature review, there is no survey study among physicians regarding post-stroke OP awareness. Similar studies are aimed at determining the general OP awareness and knowledge level of physicians from various branches.

The study by Rieder et al. (17) reported the attitudes of 251 Austrian physicians towards OP risk factors and prevention methods. Almost half of the physicians believed that OP has less impact on public health than coronary heart disease, stroke or diabetes. They stated that prevention is the most important factor in OP management. The most effective prevention strategies for physicians for both premenopausal and postmenopausal women were physical activity, high calcium intake and postmenopausal estrogen replacement. 83% of physicians thought that lack of exercise had a major impact on the risk of OP, while 64% thought the same about low calcium intake, 95% about estrogen deficiency and 80% about a positive family history (17). In a survey of physicians in China, only 76% of respondents reported treating patients with OP in their offices. 91% of respondents believed that OP was underdiagnosed. The asymptomatic nature of the disease (66%), inaccessibility (45%), and high cost of diagnostic tools (54%) were considered the main reasons for underdiagnosis. DXA was used for diagnosis by only 53% of physicians. 33% of physicians surveyed were unaware of published guidelines

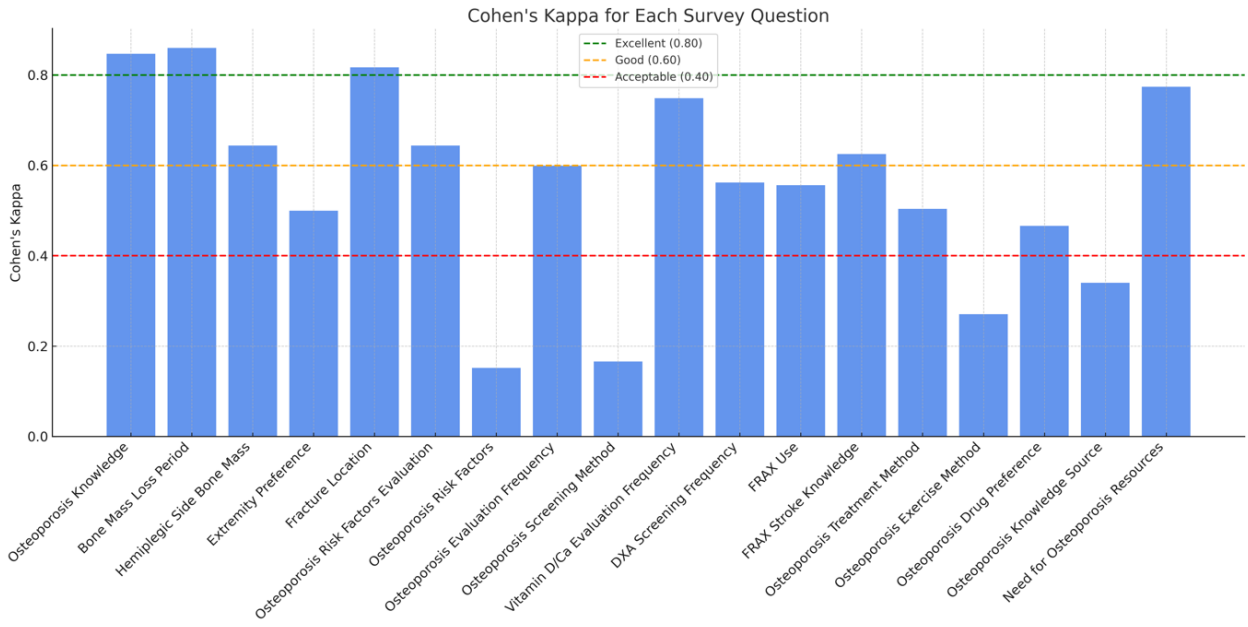

Figure 1. Reliability analysis of the questionnaire

for BMD measurements. Regarding treatment goals, 82% believed that prevention of future fractures and 66% believed that improvement in patients' quality of life were critical or very important, whereas only about half of physicians considered an increase in BMD to be important. On the other hand, 60% of physicians considered treatment cost to be a critical or very important element in OP management (18). In another study, the knowledge and practice scores of Iranian family physicians were at a moderate level, with only 14% and 38.5% having good knowledge and practice, respectively. The attitude score was at a good level, with 64.1% of participants having a positive attitude. The mean knowledge and practice score was significantly higher among family physicians working in the public sector. The attitude score of family physicians who had completed OP training courses was higher (p=0.03). Only 23.5% of family physicians were aware of the existence of a national OP guideline (19). In a study conducted on 141 physicians and nurses in Saudi Arabia, 127 (90.1%) of the participants were found to have good knowledge while 14 (9.9%) had poor knowledge (20). In a study conducted on general practitioners in Germany, the majority of physicians (82.7%) felt competent in the management of OP and only 11.2% did not see OP as a significant problem in their practice. Approximately half reported that they were well acquainted with the national OP guideline (51.7%), while 22.6% admitted that they were not familiar with it at all (21).

In our study, among PMR physicians, the rate of those with moderate knowledge about OP after stroke was 51%, the rate of those who stated that it was good/very good was 31.8%, and the rate of those who stated that it was low/very low was 17.2%. 99.3% of physicians considered age, 95.4% gender, 96.7% mobility status, and 84.1% nutritional status as OP risk factors. In the treatment of post-stroke OP, 98% of physicians preferred medication, 93.4% exercise, and 80.8% nutrition. The rate of preference for vitamin D and calcium as medication was 98%, bisphosphonate was 94%, and denosumab was 89%. The majority of physicians recommended walking and balance exercises (96% and 78%, respectively) as physical activity types. When compared with the literature, the knowledge level of PMR physicians in Türkiye is observed to be higher than in some countries and lower than in some countries. DXA request rates and OP risk factor rates appear to be similar to other survey studies in the literature. However, it does not seem possible to compare the results of our study with other studies in the literature. While general OP awareness and knowledge levels were determined in other studies, our study evaluated post-stroke OP, a special area of OP.

Study Limitations

To the best of our knowledge, our study is the first study in Türkiye regarding post-stroke OP awareness among PMR physicians and provides important information regarding the knowledge level, awareness, and diagnostic and treatment approaches of PMR physicians. However, there are some limitations to our study. First, the study was restricted to PMR physicians, and did not encompass other pertinent specialties like neurology or endocrinology, which may also play a role in post-stroke OP management. Secondly, since the current number of active PMR physicians in Türkiye could not be accessed through any database, the sample calculation was made based on known or estimated values.

Conclusion

This study demonstrates that despite moderate overall knowledge, PMR physicians in Türkiye often exhibit strong clinical awareness and proactive engagement in the diagnosis and treatment of post-stroke OP. The widespread request for further training, as indicated by nearly 90% of participants, reflects a critical gap that can be addressed through formal, evidence-based continuing medical education. Given that many post-stroke fractures can be avoided, comprehensive management—including early detection, medical therapy, and rehabilitation—plays a key role in improving prognosis and reducing long-term disability. We believe that this study will increase attention and awareness about post-stroke OP in our country.

Ethics

Ethics Committee Approval: This study was approved by the University of Health Sciences Türkiye Hamidiye Scientific Research Ethics Committee (decision number: 2025-25-22, date: 09.01.2025). All procedures involving human participants were conducted in accordance with the 1964 Helsinki Declaration and its later amendments.

Informed Consent: Participants voluntarily completed the online survey and, since online surveys were anonymous, the participant stated that they agreed to participate in the study.

Footnotes

Authorship Contributions

Concept: Y.E.D., M.C., Ç.Ç., G.Ö., P.A., A.A., F.Ü.Ö., İ.A., Design: Y.E.D., M.C., Ç.Ç., G.Ö., P.A., A.A., F.Ü.Ö., İ.A., Data Collection or Processing: Y.E.D., M.C., G.Ö., Analysis or Interpretation: Ç.Ç., P.A., A.A., F.Ü.Ö., İ.A., Literature Search: Y.E.D., M.C., P.A., Writing: Y.E.D., M.C., P.A.

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Real-world Effectiveness of Romosozumab: Bone Density Gains and Safety Outcomes in a Turkish Severe Osteoporosis Cohort – A Single-center Retrospective Cross-sectional Study

Romosozumabın Gerçek Yaşam Etkinliği: Türk Şiddetli Osteoporoz Kohortunda Kemik Yoğunluğu Artışı ve Güvenlilik Sonuçları – Tek Merkezli Retrospektif Kesitsel Bir Çalışma

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Abstract

Objective: To determine, in a real-world setting, the 12-month effects of romosozumab on bone mineral density (BMD) and T-scores in Turkish patients with severe osteoporosis.

Materials and Methods: This single-center, retrospective real-life cohort included 124 consecutive patients followed between October 2023 and March 2025. Twenty-nine patients met predefined exclusion criteria and were removed; the final analysis comprised 95 patients who had received monthly subcutaneous romosozumab 210 mg for 12 months. BMD of the lumbar spine (L1-L4 and L2–L4), femoral neck, and total hip was assessed by dual-energy X-ray absorptiometry at baseline, month 6, and month 12. Within-patient changes were analyzed using the Wilcoxon signed-rank test. Comparisons according to sex and prior anti-osteoporotic therapy (treatment-naïve vs. previously treated) were performed using the Mann-Whitney U test.

Results: Of the cohort, 89.5% were women and the median age was 73 years. Median baseline BMD at L1-L4 was 0.671 g/cm² (T-score -3.50) and increased to 0.762 g/cm² at 12 months (+13.6%, p<0.001). At L2–L4, BMD increased to 0.750 g/cm² (+14.9%, p<0.001). Femoral neck BMD rose to 0.548 g/cm² (+4.9%, p<0.001), and total hip BMD to 0.668 g/cm² (+3.7%, p<0.001). Corresponding median T-score gains were +0.47, +0.52, +0.11, and +0.08 SD units, respectively. The magnitude of BMD and T-score improvement did not differ by sex (women n=85, men n=10) or by prior treatment status (treatment-naïve n=24, previously treated n=71) (all p>0.05). Treatment was discontinued in one patient because of palpitations judged unrelated to the drug; nine patients (9.5%) reported mild adverse events such as nasopharyngitis, injection-site reactions, and low back pain.

Conclusion: In this real-world Turkish cohort with severe osteoporosis, 12 months of romosozumab was associated with rapid and clinically meaningful increases in spinal and hip BMD, maintained through 1-year and unaffected by sex or previous pharmacotherapy. The observed safety profile supports the use of romosozumab in high-risk patients.

Keywords: Osteoporosis, romosozumab, bone density, retrospective studies

Öz

Amaç: Bu çalışmanın amacı, gerçek yaşam koşullarında romosozumab tedavisinin bir yıllık sürede kemik mineral yoğunluğu (KMY) ve T-skorları üzerindeki etkilerini Türk şiddetli osteoporoz kohortunda değerlendirmektir.

Gereç ve Yöntem: Bu tek merkezli retrospektif kesitsel çalışmada, Ekim 2023-Mart 2025 tarihleri arasında takip edilen 124 ardışık hasta tarandı, dışlama kriterlerini karşılayan 29 hasta çalışma dışı bırakıldı. Kalan 95 hasta, 12 ay boyunca aylık 210 mg romosozumab tedavisi almıştı. Lomber omurga (L1-L4 ve L2-L4), femur boynu ve total kalça bölgelerinde KMY ölçümleri dual enerjili X-ışını absorbsiyometri yöntemiyle başlangıçta, 6. ayda ve 12. ayda yapılmıştı. Grup içi değişimler Wilcoxon işaretli sıralar testi, bağımsız gruplar arası karşılaştırmalar Mann-Whitney U testi ile değerlendirildi.

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Bulgular: Katılımcıların %89,5'i kadındı ve medyan yaş 73 yıldı. Başlangıçta L1-L4 bölgesinde medyan KMY 0,671 g/cm² (T-skoru -3,50) iken, 12. ayda 0,762 g/cm²'ye yükseldi (+%13,6; p<0,001). L2-L4 bölgesinde KMY 0,750 g/cm²'ye (+%14,9; p<0,001), femur boynunda 0,548 g/cm²'ye (+%4,9; p<0,001) ve total kalçada 0,668 g/cm²'ye (+%3,7; p<0,001) yükseldi. T-skoru artışları sırasıyla +0,47, +0,52, +0,11 ve +0,08 standart sapma birimi oldu. Artışlar cinsiyete veya önceki tedavi durumuna göre farklılık göstermedi (tüm p>0,05). Bir hastada çarpıntı nedeniyle tedavi sonlandırılmıştı; dokuz hastada (%9,5) nazofarenjit, enjeksiyon bölgesi reaksiyonu ve bel ağrısı gibi hafif advers olaylar bildirilmişti.

Sonuç: Gerçek yaşam verilerine dayalı bu 95 hastalık kohortta romosozumab, omurga ve kalça KMY'sinde hızlı ve klinik olarak anlamlı artışlar sağlamış, bu kazanımlar 12 ay boyunca korunmuş ve cinsiyet ya da önceki farmakoterapiden bağımsız olmuştur. Olumlu güvenlilik profili, şiddetli osteoporozu olan hastalarda romosozumab kullanımını desteklemektedir.

Anahtar kelimeler: Osteoporoz, romosozumab, kemik mineral yoğunluğu, retrospektif çalışmalar

Introduction

Osteoporosis is a systemic skeletal disease characterized by reduced bone mass and microarchitectural deterioration, leading to increased bone fragility and fracture risk (1). It is a major public health concern, particularly in aging populations, with a significant socioeconomic and healthcare burden due to the morbidity and mortality associated with osteoporotic fractures (2). Despite advancements in early diagnosis, osteoporosis remains largely underdiagnosed and undertreated, with many patients only identified after a fragility fracture has occurred (3). The treatment landscape for osteoporosis includes antiresorptive agents such as bisphosphonates and denosumab, as well as anabolic agents like teriparatide, which aim to improve bone strength and reduce fracture risk (4). However, long-term adherence to these treatments remains suboptimal due to side effects, limited efficacy in severely osteoporotic patients, and concerns over rare adverse effects like atypical fractures and osteonecrosis of the jaw (5). Moreover, many current therapies predominantly act by either inhibiting bone resorption or stimulating bone formation, rather than simultaneously addressing both processes, creating a need for innovative therapies that provide more comprehensive skeletal benefits (6). Romosozumab, a monoclonal antibody that inhibits sclerostin, is a paradigm shift in osteoporosis therapy by providing novel synergy of anabolic and antiresorptive activity (7). Phase III trials have demonstrated that 12-month romosozumab therapy is followed by striking increases in hip and lumbar spine bone mineral density, outcompeting teriparatide and bisphosphonates on reduction of fracture risk (8). Exciting though these findings are, there have been cardiovascular safety issues that have led to regulatory restrictions, where there is requirement of post-marketing surveillance together with real-world efficacy studies (9).

While randomized controlled trials provide valuable evidence of efficacy, outcomes of treatments of osteoporosis can also vary by demographic, gene, lifestyle, and health system differences within populations (10). Real-world evidence produced within targeted countries is what confirms how these therapies operate within real-world practice, where compliance of patients, comorbidities, and habits of prescriptions can also vary compared to that of trial settings (11). The use of FRAX or other fracture risk assessments is also population-adjusted, hence population-based research is critical to personalize treatments and enhance outcomes of patients (12).

In light of the current evidence and the clinical need for real-world data, the aim of this single-center retrospective cross-sectional study was to assess the effectiveness and safety of 12-month romosozumab therapy in a Turkish cohort with severe osteoporosis. The primary outcomes were changes in bone mineral density (BMD) and T-scores at the lumbar spine, femoral neck, and total hip after 12 months of treatment.

Materials and Methods

Study Design and Ethical Considerations

This retrospective cross-sectional study was conducted at the University of Health Sciences Türkiye, Sultan 2. Abdülhamid Han Training and Research Hospital, Physical Medicine and Rehabilitation Clinic, between January 10, 2025, and February 20, 2025. Ethical approval was obtained from the University of Health Sciences Türkiye Hamidiye Clinical Trials Ethics Committee (approval number: 1/23, date: January 1, 2025). The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Study Population

Patient records were retrospectively reviewed for individuals diagnosed with osteoporosis who presented to the physical medicine and rehabilitation outpatient clinic at our institution between August 25, 2023, and January 8, 2025. The study population consisted of patients classified as high fracture risk according to the Türkiye Osteoporosis Clinical Guidelines (13) and who were initiated on romosozumab therapy. Patients with secondary osteoporosis were excluded. Only patients with a diagnosis of primary osteoporosis were included in the analysis, in accordance with the Türkiye Osteoporosis Clinical Guidelines. All female participants were postmenopausal. No patients were receiving hormone replacement therapy or estrogen treatment during the study period.

Per the Türkiye Osteoporosis Clinical Guidelines, high-risk osteoporosis is defined as:

- Severe osteoporosis (T-score ≤-3.0) with one or more fragility fractures
- Multiple vertebral fractures
- Imminent fracture risk due to a combination of clinical and densitometric risk factors

Treatment Administration

Romosozumab therapy was administered by monthly subcutaneous administration of 12 doses of 12 months utilizing the same dosing regimen that had been created by conducting clinical trials (14). The monthly dose of romosozumab totaled 210 mg that had been administered by two consecutive injections of 105 mg each taken separately by anatomically distinct locations (e.g., abdominal region, thigh, or upper extremity) (15).

All patients received concurrent calcium and vitamin D supplementation during romosozumab treatment. A daily fixed-dose supplement containing 600 mg calcium and 400 IU vitamin D3 was prescribed. For patients with baseline 25(OH) D levels below 30 ng/mL, vitamin D deficiency was corrected using 20,000 IU cholecalciferol twice weekly for 7 weeks, followed by a maintenance dose of 20,000 IU once weekly. Prior to treatment initiation, serum calcium levels were assessed in all patients. Those with suboptimal levels received calcium replacement therapy before romosozumab was initiated.

Adherence to supplementation was monitored during routine outpatient follow-up visits at 3-month intervals. Electronic prescription refill records were reviewed through the national e-prescription system to verify continuous use. Any deficiencies identified during follow-up were corrected in accordance with standard clinical practice. All romosozumab administrations were scheduled as monthly outpatient visits at the study center. During each visit, calcium and vitamin D supplementation status was also checked, and serum levels were monitored in accordance with standard clinical practice guidelines (13). Adherence was reinforced at each visit.

Data Collection and Assessments

Patient records were systematically evaluated to gather demographic and anthropometric data, that is, age, gender, weight, and height. Femoral neck, total femur, L2-L4, and L1-L4 BMD with corresponding T-scores were obtained by means of dual-energy X-ray absorptiometry (DXA) Since a site-specific precision assessment has not yet been performed in our facility, we referenced the International Society for Clinical Densitometry (ISCD) guidelines for acceptable least significant change (LSC) values. According to ISCD best practices, the maximum recommended LSC is 5.3% for the lumbar spine, 5.0% for the total hip, and 6.9% for the femoral neck (16). These thresholds were used to interpret changes in BMD over time in our study. DXA results were recorded from the following time intervals: At the beginning of treatment, at the 6th month of treatment, and at the 12th month of the follow-up time frame. Besides this information, the medical record of the prior treatment of osteoporosis was also documented with reference to the administration of pharmacological therapy with a description of the specific medications that were administered to the patient. The presence of fragility fractures was confirmed through review of existing medical records and radiology reports or newly obtained spinal and skeletal radiographs where necessary during screening.

BMD and T-score Measurement

Bone mineral content and T-score values were measured by using the Hologic DXA scanner (Hologic Inc., Marlborough, MA, USA). For DXA scans, there were standardized positioning protocols followed to ensure maximum reproducibility and accuracy. For lumbar spine DXA, patients were seated supine with hip and knee flexion over a cushion to flatten out lordosis of the lumbar region, ensuring clear visualization of the scan of the T12 to L5 vertebral bodies within the scan region. For hip DXA, patients were seated supine with internally rotated femur (15-20°) using a positioning apparatus to ensure maximum accuracy of measurement and to ensure visualization of the lesser trochanter is minimized. Appropriate patient positioning was carefully adhered to within both tests to ensure maximum precision and reduction of artifacts, ensuring valid BMD measures (17).

Patient Monitoring, Treatment Adherence and Adverse Event Surveillance

All injections were administered by the same physician. Following the injections, patients were scheduled for their subsequent romosozumab administration. Those who missed their appointments or were unable to attend were contacted by phone and invited to continue their treatment.

The immediate hypersensitivity or acute adverse effects were assessed within patients within 30 minutes of administration of injections (18). Patients were screened out of possible contraindications, including history of cardiovascular complications and hypocalcemia, prior to each administration session, adhering to predetermined safety protocols (19).

Adverse events were defined as minor adverse events and major adverse events, utilizing earlier operational definitions of adverse events within clinical research. Minor adverse events were operationalized as non-serious, transient signs that were not medically intervened upon, e.g., mild nausea, transient headache, fatigue, or focal discomfort on administration site (20). Major adverse events were operationalized as severe complications that hospitalized, permanently disabled, threatened life, or led to death, utilizing guidelines by regulators (21).

To ensure systematic AE monitoring, patients were questioned before each treatment session regarding the occurrence of any adverse events since their last visit. Standardized questionnaires and structured interviews were used to document and categorize reported AEs. In cases where patients reported symptoms, clinical assessments were performed to determine the severity and potential causality of the event (22).

Statistical Analysis

Statistical analyses were performed using IBM SPSS (Statistical Package for the Social Sciences, Version 27.0, Armonk, NY, IBM Corp.) and Python (version 3.11.10). The distributional properties of continuous variables were assessed with the Shapiro-Wilk test. Descriptive data are summarized as mean ± standard deviation or as median and interquartile range, according to distributional characteristics. Within-group changes over time

were evaluated using the Wilcoxon signed-rank test. Between-group comparisons of continuous outcomes were performed with the Wilcoxon Rank-Sum test. Adjustment for multiple hypothesis testing was carried out using the Holm-Bonferroni method for the primary subgroup analyses. A two-tailed p-value <0.05 was considered statistically significant. "Plotly" library was used for visualizations.

Results

The cohort was predominantly female (89.5%) with a median age of 73 years (68-77.5). At baseline, lumbar spine (L1-L4) BMD was 0.671 g/cm² (0.592-0.764), and the corresponding T-score was -3.50 (-4.10 to -2.60). Among the 95 patients, 71 (74.7%) had received at least one osteoporosis treatment before enrollment. The median total prior treatment duration was 4.0 years. Prior use by agent was as follows: alendronate 23 patients (24.2%), 2.0 years; zoledronic acid 37 (38.9%), 2.0 years; ibandronate 29 (30.5%), 2.0 years; risedronate 13 (13.7%), 2.0 years; denosumab 20 (21.1%), 2.0 years; and teriparatide 10 (10.5%), 2.0 years. No significant differences in demographic, biochemical, or densitometric characteristics were observed by sex or treatment history (p>0.05). Laboratory parameters—including serum albumin, calcium, and 25-hydroxyvitamin D—as well as all additional baseline characteristics are summarized in Table 1.

Table 1. Baseline characteristics of the study cohort

Characteristic	Value
Age, yr	73.0 (68.0-77.5)
Sex, n (%)	85 female/10 male (89.5% F)
BMI, kg m^{-2}	26.8±5.5
eGFR, mL min^{-1} 1.73 m^{-2}	70.6±26.9
Albumin, g L^{-1}	43.2±2.3
Serum calcium, mg dL^{-1}	9.45±0.33
25-OH-vitamin D, µg L^{-1}	45.5±12.3
Lumbar spine (L1-L4) BMD, g cm^{-2}	0.671 (0.592-0.764)
Lumbar spine (L1-L4) T-score	-3.50 (-4.10- -2.60)
Lumbar spine (L2-L4) BMD, g cm^{-2}	0.653 (0.592-0.774)
Lumbar spine (L2-L4) T-score	-3.90 (-4.45- -2.80)
Femoral neck BMD, g cm^{-2}	0.522 (0.453-0.605)
Femoral neck T-score	-2.90 (-3.60- -2.20)
Total hip BMD, g cm^{-2}	0.648 (0.606-0.713)
Total hip T-score	-2.40 (-2.80- -1.90)
Treatment-naïve, n (%)	24 (25.3)
Any prior osteoporosis therapy, n (%)	71 (74.7)
Bisphosphonate only	47 (49.5)
Denosumab only	4 (4.2)
Denosumab following bisphosphonate	10 (10.5)
Teriparatide following bisphosphonate	4 (4.2)
Teriparatide following denosumab and bisphosphonate	6 (6.3)

BMD: Bone mineral density, BMI: Body mass index, eGFR: Estimated glomerular filtration rate, SD: Standard deviation, IQR: Interquartile range. Continuous variables with normal distribution (BMI, eGFR, albumin, calcium, 25-hydroxyvitamin D) are presented as mean ± SD; all other variables are reported as median (IQR)

Overall Treatment Response

During 12 months of romosozumab therapy, significant improvements were observed in both (BMD and T-scores across all measured skeletal sites (Table 2).

At the lumbar spine (L1-L4), median BMD increased from 0.671 g/cm² (0.592-0.764) at baseline to 0.727 g/cm² (0.601-0.872) at 6 months [+8.6% (1.7-14.2%)] and to 0.762 g/cm² (0.641-0.903) at 12 months [+13.6% (8.4-17.9%)] (p<0.001 for both intervals). The corresponding median T-score improved from -3.50 (-4.10 to -2.60) at baseline to -3.17 (-3.71 to -2.35) at 6 months and -3.03 (-3.55 to -2.25) at 12 months (p<0.001 for both comparisons).

For the lumbar spine (L2-L4), BMD increased from 0.653 g/cm² (0.593-0.774) at baseline to 0.711 g/cm² (0.623-0.870) at 6 months [+8.6% (5.0-13.1%)] and to 0.750 g/cm² (0.679-0.878) at 12 months [+14.7% (14.2-15.1%)] (p<0.001). The T-score for this region improved from -3.90 (-4.45 to -2.80) at baseline to -3.53 (-4.04 to -2.54) at 6 months and -3.36 (-3.85 to -2.42) at 12 months (p<0.001).

At the femoral neck, BMD rose from 0.522 g/cm² (0.453-0.605) at baseline to 0.539 g/cm² (0.470-0.626) at 6 months [+3.6% (3.3-3.9%)] and 0.548 g/cm² (0.475-0.634) at 12 months [+4.5% (4.1-5.0%)] (p<0.001). The corresponding T-score increased from -2.90 (-3.60 to -2.20) to -2.84 (-3.52 to -2.15) at 6 months and -2.79 (-3.47 to -2.12) at 12 months (p<0.001).

For the total hip, median BMD improved from 0.648 g/cm² (0.606-0.713) at baseline to 0.668 g/cm² (0.619-0.731) at 6 months [+2.3% (2.0-2.6%)] and 0.668 g/cm² (0.623-0.733) at 12 months [+2.9% (2.6-3.2%)] (p<0.001). The corresponding T-score increased from -2.40 (-2.80 to -1.90) at baseline to –2.34 (-2.73 to -1.86) at 6 months and -2.32 (-2.70 to -1.84) at 12 months (p<0.001).

Sex-specific Treatment Response

The median percentage increase in BMD from baseline to 12 months was comparable between sexes at the lumbar spine L1-L4 (13.6% in women vs. 14.0% in men; p=0.68), lumbar spine L2-L4 (14.7% vs. 14.4%; p=0.41), femoral neck (4.48% vs. 4.85%; p=0.13), and total hip (2.82% vs. 3.08%; p=0.040). Similarly, absolute changes in T-score were nearly identical in women and men for each region (L1-L4: +0.47 vs. +0.48 SD units, p=0.13; L2-L4: +0.52 vs. +0.53, p=0.17; femoral neck: +0.11 vs. +0.09, p=0.23; total hip: +0.08 vs. +0.08, p=0.72) (Figure 1). No significant differences in densitometric response to romosozumab were identified between women and men at any of the evaluated skeletal sites.

Table 2. Changes in bone mineral density and T-score at 6 and 12 months of romosozumab therapy

Region/outcome	T0 median (IQR)	T6 median (IQR)	T12 median (IQR)	%Δ T0→T6	%Δ T6→T12	%Δ T0→T12	p T0→T6	P T6→T12	p T0→T12
Lumbar spine (L1-L4) BMD (g cm^2)	0.671 (0.592-0.764)	0.727 (0.601-0.872)	0.762 (0.641-0.903)	8.32%	4.86%	13.58%	<0.001	<0.001	<0.001
Lumbar spine (L1-L4) T-score (SD)	-3.50 (-4.10 to -2.60)	-3.17 (-3.71 to -2.35)	-3.03 (-3.55 to -2.25)	9.50%	4.34%	13.43%	<0.001	<0.001	<0.001
Lumbar spine (L2-L4) BMD (g cm^2)	0.653 (0.593-0.774)	0.711 (0.623-0.870)	0.750 (0.679-0.878)	8.81%	5.56%	14.86%	<0.001	<0.001	<0.001
Lumbar spine (L2-L4) T-score (SD)	-3.90 (-4.45 to -2.80)	-3.53 (-4.04 to -2.54)	-3.36 (-3.85 to -2.42)	9.39%	4.78%	13.72%	<0.001	<0.001	<0.001
Femoral neck BMD (g cm^2)	0.522 (0.453-0.605)	0.539 (0.470-0.626)	0.548 (0.475-0.634)	3.33%	1.55%	4.94%	<0.001	<0.001	<0.001
Femoral neck T-score (SD)	-2.90 (-3.60 to -2.20)	-2.84 (-3.52 to -2.15)	-2.79 (-3.47 to -2.12)	2.14%	1.39%	3.67%	<0.001	<0.001	<0.001
Total hip BMD (g cm^2)	0.648 (0.606-0.713)	0.668 (0.619-0.731)	0.668 (0.623-0.733)	3.08%	0.63%	3.72%	<0.001	<0.001	<0.001
Total hip T-score (SD)	-2.40 (-2.80 to -1.90)	-2.34 (-2.73 to -1.86)	-2.32 (-2.70 to -1.84)	2.50%	0.85%	3.27%	<0.001	<0.001	<0.001

BMD: Bone mineral density, IQR: Interquartile range, SD: Standard deviation, %Δ: Percent change; T0, baseline; T6, 6 months; T12, 12 months. P-values from paired Wilcoxon signed-rank tests. Bonferroni-corrected significance threshold =0.0021 (0.05/24 comparisons)

Effect of Any Prior Osteoporosis Therapy on Romosozumab Response

Treatment-naïve patients (n=24) showed numerically larger densitometric gains than those with any prior anti-osteoporotic therapy (n=71), yet the differences were not statistically significant. Over 12 months, median BMD increased by 16.3% (IQR, 10.6-18.3) at the lumbar spine L1-L4, 14.6% (14.0-15.2) at L2-L4, 4.5% (4.2-4.9) at the femoral neck, and 2.95% (2.66-3.22) at the total hip; the corresponding gains among previously treated patients were 13.3% (8.0-17.8), 14.7% (14.3-15.1), 4.48% (4.12-4.97), and 2.89% (2.58-3.22), respectively (p=0.14, 0.67, 0.86, and 0.86, respectively).

T-score improvements paralleled these findings. In treatment-naïve individuals, median T-score rose by 0.54 SD units (0.42-0.66) at L1-L4, 0.57 (0.45-0.69) at L2-L4, 0.12 (0.09-0.15) at the femoral neck, and 0.09 (0.07-0.11) at the total hip. Previously treated patients exhibited median increases of 0.45 (0.33-0.57), 0.52 (0.40-0.63), 0.11 (0.08-0.14), and 0.08 (0.06-0.10) SD units, respectively, with no significant between-group differences (p=0.18, 0.39, 0.81, and 0.90, respectively) (Figure 2).

Between-group analyses of percentage BMD change and T-scores at 12 months were performed across prior osteoporosis therapy categories. Kruskal-Wallis tests showed no significant differences among groups at the lumbar spine L1-L4, L2-L4, femoral neck, or total hip (all $p \geq 0.05$).

Adverse Events

No major AEs were reported. At least one AE occurred in 9 patients. Specifically, 1 had experienced palpitations and breathing difficulty, 2 had experienced injection site reactions, 3 had experienced backache, and 3 had experienced nasopharyngitis diagnosed. In addition, 38 patients demonstrated non-treatment compliance and had also defaulted on follow-up. By month 12, incident vertebral fractures were observed in two patients (2.1%; 1 vertebra each), although both had shown gains in BMD and T-scores.

Discussion

This study demonstrates real-world outcomes of romosozumab's activity on a population of individuals with osteoporosis within Türkiye, closing a key literature gap. While randomized controlled trials have validated its efficacy, real-world evidence is important to establish outcomes of therapy, compliance, and efficacy within real-world populations. Our findings reinforce significant increases within diverse skeletal locations, particularly of the lumbar spine, confirming romosozumab's dual function of inducing anabolism and inhibiting resorption.

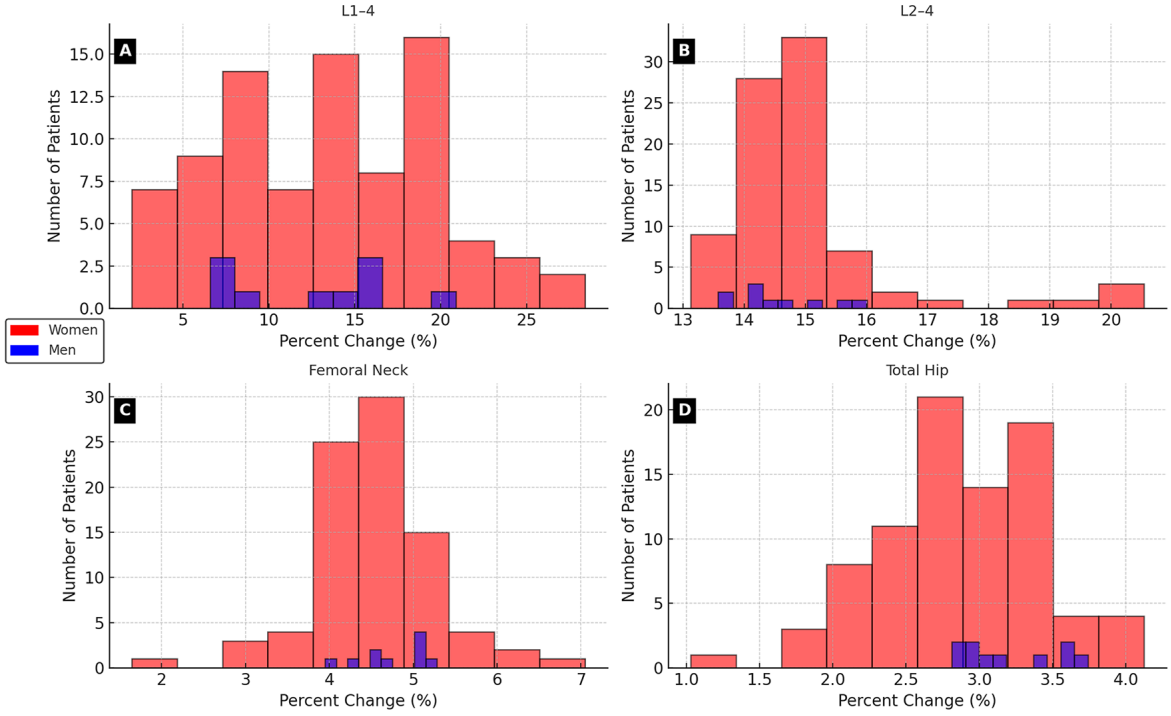

Figure 1. Distribution of 12-month percent BMD an T-score change by sex. Panels A through D show histograms for the lumbar spine (L1-4), lumbar spine (L2-4), femoral neck, and total hip, respectively. Red bars represent women (n=85) and blue bars represent men (n=10). Bin widths are identical across panels (10 bins) to permit direct visual comparison. The overlapping distributions for each skeletal site corroborate the non-significat sex differences
BMD: Bone mineral density

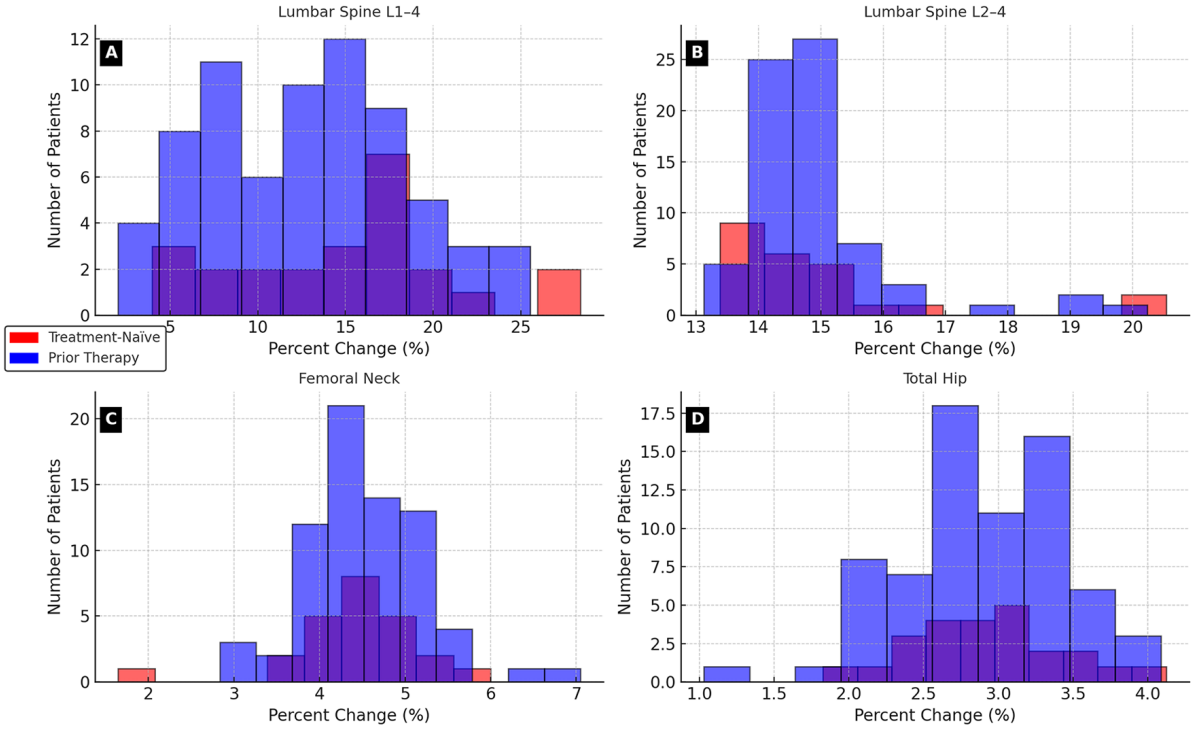

Figure 2. Distribution of 12-month percent BMD and T-score change by prior osteoporosis therapy. Panels A through D depict histograms of 12-month percentage change in BMD at the lumbar spine (L1-4), lumbar spine (L2-4), femoral neck, and total hip, respectively. Red bars represent treatment-naïve patients (n=24); blue bars represent patients who had received any previous anti-osteoporotic therapy (n=71)
BMD: Bone mineral density

With issues of non-adherence to therapy of osteoporosis and maintaining long-term skeletal health, these findings reinforce romosozumab's use within practice and provide region-specific evidence helpful within Türkiye's management of osteoporosis.

The observed significant increases in femoral neck and total femur BMD and T-scores align well with previous studies although there are variations in amount of increase in those scores in literature. For example, Ishibashi et al. (23) reported a 3.8% increase in femoral neck BMD at 12 months, which is slightly lower to the 4.94% increase observed in our study. Similarly, Dilshani et al. (24) found a 4.8% increase in total femoral BMD, which is lower than our findings. They also reported a 4.1% increase in femur neck BMD, which is slightly lower than our results. A multicenter real-world study found a 6.0% increase in femoral neck BMD over 12 months (25), which is higher than our findings. A meta-analysis confirmed that romosozumab significantly increases femoral neck BMD by approximately 5.18% at 12 months (26).

Similarly, romosozumab's impact on the lumbar spine observed in this study had parallel results compared to literature. A 16.9% BMD of the lumbar spine after 12 months has been reported by Ishibashi et al. (23), compared to our 13.58% BMD of L1-4 and 14.86% of BMD of L2-4. Similarly, Anno et al. (27) also reported that BMD of the lumbar spine is elevated by 10.8% after 12 months, which is above our findings. Our findings also exceed the 10.8% lumbar spine BMD increase observed in rheumatoid arthritis patients receiving romosozumab (28), and a parallel results yielding a 15.3% gain in osteoporotic patients undergoing hemodialysis (29). Additionally, a study comparing romosozumab and teriparatide found a 10.2% increase in lumbar spine BMD after 12 months, also lower than our results (30).

The differences in the magnitude of BMD and T-score increases at the lumbar spine, femoral neck, and total hip observed in our study compared with previous reports may be attributed to multiple factors. These include the severity of baseline osteoporosis, the specific characteristics of the patient population, and adherence patterns in real-world clinical settings. For example, previous reports indicate that variations in femoral neck and total femur outcomes could reflect regional and ethnic differences, as well as potential influences from prior osteoporosis treatments, both of which have been shown to affect treatment response (31,32). Collectively, these factors likely account for the observed variations in femur neck and femur total BMD and T-scores relative to earlier literature.

The observed greater increases in lumbar spine BMD and T-scores compared to femoral neck and total femur align with prior findings. A study comparing romosozumab with denosumab in rheumatoid arthritis patients found lumbar spine BMD increase by 10.2% with romosozumab, while femoral neck and total hip BMD increased by 3.6% (30). Similarly, a multicenter real-world study found a 14.1% increase in lumbar spine BMD after 12 months of romosozumab, while total hip BMD increased by 5.7% (33). Another phase 2 study reported that romosozumab led to a 15.1% gain in lumbar spine BMD and a 5.4% gain in total hip BMD over 24 months (7). This discrepancy could be attributed to differences in bone composition and remodeling dynamics, as trabecular-rich sites such as the vertebral column exhibit higher metabolic activity and faster turnover than cortical-dominant regions like the femur which results to a greater response to anabolic stimuli (23).

The observation that prior osteoporosis therapy did not have a statistically significant effect on changes in BMD or T-score following romosozumab treatment in our cohort contrasts with several previous reports, though real-world variability in patient response may account for this discrepancy. Notably, while statistical significance was not reached, our treatment-naïve subgroup demonstrated a trend toward greater improvements in BMD and T-score compared to those with prior anti-osteoporotic therapy, and the relatively small sample size may have limited our ability to detect significant differences. Ebina et al. (34) reported that increases of BMD of the lumbar spine after 6-12 months were greater in individuals without previous therapy compared to individuals on previous therapy of bisphosphonates, denosumab, or teriparatide. Ebina et al. (32) also reported that early increases of BMD of the lumbar spine after 6 months were also significantly affected by previous therapy but that most increases occurred in individuals without previous therapy. In contrast, Anno et al. (27) reported that romosozumab increased BMD of the lumbar and femoral sites regardless of previous therapy of osteoporosis, agreeing with our findings.

The absence of major AEs and the low incidence of minor AEs in our study is consistent with previous clinical trials and pharmacovigilance analyses, which have generally reported a favorable safety profile for romosozumab. A meta-analysis by Mariscal et al. (35) found that romosozumab had a similar overall safety profile to bisphosphonates, except for an increased risk of mild injection site reactions. Similarly, Chen et al. (36) identified injection site pain, back pain, and nasopharyngitis as the most reported non-serious AEs, aligning with our findings. The lack of severe AEs, particularly cardiovascular events, may be attributed to careful patient selection and exclusion of high-risk individuals, as major cardiovascular events have been primarily reported in high-risk populations (37). The high rate of non-compliance and follow-up was notable, as adherence challenges have been reported in real-world romosozumab use and may impact treatment outcomes (38).

Study Limitations

This study has several limitations that must be acknowledged. Its retrospective design introduces potential sources of bias, including selection bias and incomplete data, which may affect the reliability of the findings. The absence of a control group limits the ability to directly compare romosozumab with other osteoporosis treatments. Adherence to therapy and lifestyle factors, such as physical activity and nutrition, were not systematically assessed and may have influenced BMD outcomes. Although significant improvements in BMD were observed,

fracture incidence was not recorded, making it unclear whether these gains translated into reduced fracture risk. The 12-month follow-up period does not allow for assessment of long-term bone mass retention following cessation of therapy. Furthermore, the single-center design and inclusion of only patients from Türkiye may limit the generalizability of the results to populations with differing genetic, dietary, and healthcare profiles. Another limitation is the absence of a site-specific precision study in our facility to determine LSC values for BMD. Instead, we relied on published LSC thresholds for Hologic DXA systems. In addition, bone turnover markers such as procollagen type 1 N-terminal propeptide and C-terminal telopeptide of type 1 collagen were not measured, as they are not included in routine clinical testing for osteoporosis. Future prospective, randomized, multi-center studies with extended follow-up durations and comprehensive biochemical and fracture outcome assessments are needed to validate and expand upon these findings.

Conclusion

In conclusion, our real-world findings underscore romosozumab's therapeutic effects, as evidenced by marked increases in BMD and T-scores at multiple skeletal sites among high-risk Turkish patients with osteoporosis. Notably, we observed particularly pronounced improvements at the lumbar spine, reflecting the therapy's greater impact in trabecular-rich regions, along with significant gains at the femoral neck and total femur. Romosozumab also exhibited a favorable safety profile; no major adverse events occurred, and minor adverse events were uncommon. Contrary to some prior reports, previous osteoporosis therapies did not substantially alter romosozumab's effectiveness in our cohort, pointing to consistent benefits across varied treatment histories. While limitations such as a single-center design and relatively small sample size warrant caution, these findings add valuable real-world evidence to support romosozumab's promise in managing osteoporosis in the Turkish context, reinforcing the need for more extensive, multi-center studies to confirm these positive outcomes.

Ethics

Ethics Committee Approval: Ethical approval was obtained from the University of Health Sciences Türkiye Hamidiye Clinical Trials Ethics Committee (approval number: 1/23, date: January 1, 2025). The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.A., Concept: E.A., M.A.G., Design: E.A., F.N.Y., Data Collection or Processing: E.A., A.G.G., M.H.T., Analysis or Interpretation: M.H.T., Literature Search: M.H.T., F.N.Y., M.A.G., Writing: M.H.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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Comparison of the Effectiveness of Short-wave Diathermy and Extracorporeal Shock Wave Therapy in Knee Osteoarthritis: A Quasi-experimental Clinical Study

Diz Osteoartritinde Kısa Dalga Diatermi ve Ekstrakorporeal Şok Dalga Tedavisinin Etkinliğinin Karşılaştırılması: Yarı Deneysel Klinik Çalışma

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Abstract

Objective: Physical therapy agents are widely used in knee osteoarthritis (OA) to relieve symptoms and improve function. This study aimed to compare the effectiveness of combined physical therapy protocols including short-wave diathermy (SWD) or extracorporeal shock wave therapy (ESWT) on pain and functional status in patients with knee OA.

Materials and Methods: A prospective, quasi-experimental trial was conducted with 49 patients with stage 2-3 knee OA. Group 1 received hot pack (HP) + transcutaneous electrical nerve stimulation (TENS) + SWD, while Group 2 received HP + TENS + ESWT. ESWT was administered once weekly for four sessions. Patients were evaluated at baseline, post-treatment, and at 3 and 6 months using the visual analogue scale (VAS), the Western Ontario and McMaster Universities osteoarthritis index (WOMAC), and the Lequesne OA severity index.

Results: Mean ages were 58.3±5.2 years (Group 1) and 54.9±6.5 years (Group 2) ($p>0.05$). Both groups showed significant improvements at all follow-ups compared to baseline ($p<0.05$). Group 1 demonstrated greater short-term improvements, particularly in rest VAS, Lequesne index scores and WOMAC scores ($p<0.05$). By 6 months, no significant differences were found between the groups ($p>0.05$).

Conclusion: Both combined protocols were effective in knee OA. SWD showed superior short-term effects, while mid-term outcomes were comparable.

Keywords: Knee osteoarthritis, short-wave diathermy, extracorporeal shock wave therapy

Öz

Amaç: Fizik tedavi ajanları, diz osteoartritinde (OA) semptomların hafifletilmesi ve fonksiyonların iyileştirilmesi amacıyla yaygın olarak kullanılmaktadır. Bu çalışmanın amacı, kısa dalga diatermi (KDD) veya ekstrakorporeal şok dalga tedavisini (ESWT) içeren kombine fizik tedavi protokollerinin diz OA'lı hastalarda ağrı ve fonksiyonel durum üzerine etkinliğini karşılaştırmaktır.

Gereç ve Yöntem: Evre 2-3 diz OA'sı olan 49 hasta ile prospektif, yarı deneysel bir çalışma yürütüldü. Grup 1'e sıcak paket (HP) + transkutanöz elektriksel sinir stimülasyonu (TENS) + KDD, Grup 2'ye ise HP + TENS + ESWT uygulandı. ESWT haftada bir olmak üzere toplam dört seans yapıldı. Hastalar başlangıçta, tedavi bitiminde, 3. ve 6. aylarda görsel analog skala (VAS), Western Ontario and McMaster Universities osteoartrit indeksi (WOMAC) ve Lequesne OA şiddet indeksi ile değerlendirildi.

Bulgular: Ortalama yaş Grup 1'de 58,3±5,2, Grup 2'de 54,9±6,5 yıl idi ($p>0,05$). Her iki grupta da tüm takiplerde başlangıca göre anlamlı iyileşme görüldü ($p<0,05$). Grup 1, kısa dönemde özellikle istirahat VAS, Lequesne indeksi skorları ve WOMAC skorlarında daha belirgin düzelme gösterdi ($p<0,05$). Altıncı ayda ise gruplar arasında anlamlı fark bulunmadı ($p>0,05$).

Sonuç: Her iki kombine protokol de diz OA tedavisinde etkilidir. KDD kısa dönemde daha üstün görünse de orta vadede sonuçlar benzerdir.

Anahtar kelimeler: Diz osteoartriti, kısa dalga diatermi, ekstrakorporeal şok dalga tedavisi

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Introduction

Osteoarthritis (OA) is the most prevalent chronic rheumatic disease and is one of the leading causes of pain and disability worldwide. Its prevalence is strongly associated with aging and is more common in women than in men (1). Although OA can affect many joints, weight-bearing joints such as the knee are particularly at risk, with the knee joint being the most commonly affected site. Radiographic signs of knee OA (KOA) are observed in approximately 30% of individuals over the age of 45, and about half of these individuals experience clinical symptoms (2). The etiology and progression mechanisms of OA are not yet fully understood, and therefore, current treatments cannot provide complete recovery (3). The primary aims of treatment are to alleviate pain, reduce functional limitations, and improve quality of life (4). Treatment options for KOA are diverse and include biomechanical interventions, intra-articular corticosteroids, exercise, self-management and education, weight management, paracetamol, balneotherapy, capsaicin, mobility aids, duloxetine, oral and topical non-steroidal anti-inflammatory drugs (NSAIDs), and physical therapy modalities (5).

Physical therapy agents are modalities that use physical modalities to achieve therapeutic effects. Heat, cold, and electricity have been used since ancient times to relieve and manage pain (3). Shortwave diathermy (SWD) is an electrotherapy modality used in the treatment of KOA. The application of continuous electromagnetic radiation in SWD increases tissue temperature, which leads to vasodilation, reduction in muscle spasms, acceleration of cellular activity, and elevation of the pain threshold (6).

In recent years, extracorporeal shock wave therapy (ESWT) has been widely used in the treatment of musculoskeletal disorders such as epicondylitis, plantar fasciitis, and calcific tendinitis (5). ESWT is increasingly being utilized in patients with KOA (7,8). Its advantages include being non-invasive, having a low complication rate, not requiring hospitalization, and being relatively cost-effective compared to other modalities (8). While most studies have reported superior analgesic effects of ESWT compared to placebo (5,8), some have reported comparable efficacy between ESWT and placebo in pain control (9).

When we reviewed the literature, we found no studies directly comparing SWD and ESWT within combined physical therapy applications for KOA. SWD has been used for decades as a conventional physical therapy modality, whereas ESWT has emerged more recently and gained popularity due to its non-invasive nature and promising results in musculoskeletal disorders. Since both methods are commonly applied in clinical practice but differ in mechanisms of action and application, it is important to investigate whether one offers superior clinical outcomes. Therefore, the aim of the present study was to compare the effectiveness of combined physical therapy protocols including SWD or ESWT in patients with KOA.

Materials and Methods

The study was conducted between November 2020 and June 2021 at the Physical Medicine and Rehabilitation Outpatient Clinics of Hitit University Faculty of Medicine and Tokat Gaziosmanpaşa University Faculty of Medicine, involving patients who presented with complaints of knee pain. The study was approved by the Institutional Ethics Committee (337/2020). The study was conducted in accordance with the principles set forth in the Declaration of Helsinki. Written informed consent was obtained from all patients before the study.

Inclusion criteria were; age between 40 and 65 years, diagnosis of KOA according to the American College of Rheumatology criteria (10), presence of unilateral knee joint pain persisting for at least 6 months and unresponsive to medical treatments, Kellgren-Lawrence (KL) radiographic stage II or III (11), agree to participate in the study. Exclusion criteria included; bilateral knee symptoms, history of surgery or intra-articular injection/physical therapy within the past 6 months in the affected knee, secondary OA of the knee joint (inflammatory or metabolic origin), contraindications to ESWT or SWD (e.g., metallic implants, infection or tumor near the treatment site, coagulation disorders, or pregnancy).

Outcome measures for assessing treatment efficacy included; pain scores using the visual analogue scale (VAS) at rest and during activity, Western Ontario and McMaster Universities osteoarthritis index (WOMAC, Turkish version), Lequesne OA severity index.

VAS: Developed by Price et al. (12), the VAS is used to evaluate pain severity. It consists of a 10-cm horizontal or vertical line with two anchors (0= no pain, 1= worst imaginable pain). Patients are instructed to mark the point that corresponds to the intensity of pain they feel. The distance (in cm) from the "no pain" anchor to the marked point is recorded as the pain score (12).

The Turkish version of the WOMAC scale was validated by Tüzün et al. (13). The WOMAC OA scale consists of three sections and 24 questions that assess pain, stiffness, and physical function. Higher WOMAC scores indicate increased pain and stiffness and greater impairment in physical function (13,14).

The Lequesne OA severity index was used to assess OA severity. This disease-specific tool evaluates pain, maximum walking distance, and daily living activities. The total score ranges from 0 to 24: 1-4: Mild, 5-7: Moderate, 8-10: Severe, 11-13: Very severe, ≥14: Extremely severe functional impairment (15).

Patients were quasi-experimental into two groups according to the order of their arrival at the outpatient clinic.

Group 1: Hot pack (HP) + TENS + SWD

Group 2: HP + TENS + ESWT.

The physical therapy modalities were applied five days per week for four weeks. In the ESWT group, ESWT was administered once weekly for a total of four sessions.

The full physical therapy program consisted of 20 sessions (1 session/day, 5 sessions/week) for both groups, with 4 additional sessions of ESWT. HPs were applied around the knee for 20

minutes. TENS was applied bilaterally for analgesic purposes using a Danmeter device in burst mode, with 20-minute sessions per knee.

Shortwave Diathermy: SWD was applied with the patient seated on a wooden chair, knees in 90° flexion. Electrodes (12 cm in diameter) were placed parallel to the knees, and treatment was administered in continuous mode (frequency =27.12 MHz), thermal dose, for 20 minutes per session across 10 sessions. The device used was Curapulse 970 (Enraf-Nonius, Rotterdam, Netherlands).

Both the ultrasound and SWD machines were calibrated annually in accordance with the IEC 60601-1 international standard.

Extracorporeal Shock Wave Therapy: ESWT was administered once weekly for a total of four sessions on the same day of the week. The ESWT was applied by a physiotherapist who had received specific training in this area. During each session, patients lay in the supine position with the target knee flexed at 90°. The physiotherapist identified the pain points of the target knee via palpation and marked the painful areas along with the patellofemoral and tibiofemoral borders. Ultrasound gel was applied to the skin surface in contact with the ESWT probe. Therapy parameters included 2000 shocks delivered at a frequency of 8 Hz and pneumatic pressure of 2.5 bar (5). The first 1000 shocks were distributed equally across the identified pain points (maximum of four points). The remaining shocks were applied by moving the probe back and forth along the patellofemoral and tibiofemoral borders. No local anesthesia or other injections were used.

Both groups were given the same home exercise program, which consisted of isometric strengthening exercises for the quadriceps muscle. The exercise was planned as three sets of ten repetitions.

Evaluations were performed both before and after treatment. The researchers performing the evaluations were blinded to treatment allocation.

Sample size: To determine the number of participants in the intervention and control groups, a power analysis was performed using the G*Power (version 3.1.9.4; Düsseldorf University) software package, referencing the study by Lizis at al. (16). The analysis resulted in a sample size of 22 participants per group, based on an effect size of 0.7, 80% power, and α=0.05 type I error.

Statistical Analysis

Continuous quantitative variables were expressed as mean ± standard deviation, while categorical variables were expressed as counts, median (Q2), 25th (Q1), and 75th (Q3) percentiles. Normality of distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For normally distributed independent variables, the Independent Samples t-test was used. For non-normally distributed independent variables, the Mann-Whitney U test was used. For dependent variables from repeated measures, the Friedman Repeated Measures Analysis of Variance on Ranks test was applied. Categorical variables were analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant. All data analyses were performed using IBM SPSS Statistics version 21.

Results

The mean age was 58.3±5.2 years in the SWD group and 54.9±6.4 years in the ESWT group, with no statistically significant difference between them (p>0.05). The mean BMI was 31.4±5.0 kg/m² in Group 1 and 33.3±8.0 kg/m² in Group 2, also with no significant difference (p>0.05). Groups were similar in terms of sex and occupation distribution (p>0.05), with the majority being housewives in both groups. The most common comorbidities were diabetes and hypertension. The demographic data of the groups are presented in Table 1.

In the comparison between Group 1 and Group 2, all baseline parameters were similar (p>0.05). At the 1st month post-treatment, Group 1 (SWD) had significantly lower scores in resting VAS, WOMAC pain, stiffness, physical function, and total scores, as well as Lequesne index scores for pain, quality of life, and total (p<0.05). At the 3rd month post-treatment, WOMAC pain, stiffness, physical function, and total scores remained significantly lower in Group 1 (p<0.05). By the 6th month post-treatment, there were no significant differences between the two groups for any of the parameters (p>0.05) (Tables 2-4).

In the SWD group, resting and activity VAS, WOMAC pain, stiffness, physical function, and total scores, as well as Lequesne index scores for pain, walking distance, quality of life, and total, significantly improved at the 1st, 3rd, and 6th months compared to baseline (p<0.05). However, no statistically significant

Table 1. Demographic data

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Age	SWD	25	57.5	5.7	58.0	55.0	62.5	0.137
	ESWT	24	54.9	6.4	55.5	50.0	60.0	
BMI	SWD	25	31.4	5.0	31.9	27.3	34.2	0.154
	ESWT	24	33.3	4.0	33.9	30.1	36.1	
Kellgren-Lawrence	SWD	25	2.4	0.50	2.0	2.0	3.0	0.064
	ESWT	24	2.6	0.48	3.0	2.0	3.0	

SD: Standard deviation, BMI: Body mass index, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy

Table 2. Comparison of pain by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Rest VAS pretreatment	SWD	25	4.6	1.6	5.0	3.5	6.0	0.082
	ESWT	24	5.6	1.8	5.5	4.0	7.7	
Rest VAS 1st month	SWD	25	1.2	1.8	0.0	0.0	2.5	**0.033**
	ESWT	24	2.0	1.6	2.0	1.0	3.0	
Rest VAS 3rd month	SWD	25	1.4	2.4	0.0	0.0	2.5	0.258
	ESWT	24	1.7	2.3	1.0	0.0	2.7	
Rest VAS 6th month	SWD	25	1.7	2.2	0.0	0.0	3.0	0.213
	ESWT	24	0.8	1.6	0.0	0.0	1.0	
Activity VAS pretreatment	SWD	25	7.7	1.3	8.0	6.5	9.0	0.196
	ESWT	24	8.2	0.7	8.0	8.0	9.0	
Activity VAS 1st month	SWD	25	3.0	2.5	3.0	0.5	5.0	0.051
	ESWT	24	4.1	1.5	4.0	3.0	5.0	
Activity VAS 3rd month	SWD	25	2.7	3.0	2.0	0.0	4.5	0.516
	ESWT	24	2.8	2.4	2.0	1.0	4.7	
Activity VAS 6th month	SWD	25	3.1	3.4	2.0	0.0	6.5	0.597
	ESWT	24	1.6	2.0	1.0	0.0	2.0	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy, VAS: Visual analogue scale

differences were observed between the 1st, 3rd, and 6th month measurements for all parameters (p>0.05).

In the ESWT group, resting and activity VAS, WOMAC pain, stiffness, physical function, and total scores, along with Lequesne index scores for pain, walking distance, quality of life, and total, also showed significant improvement at the 1st, 3rd, and 6th months compared to baseline (p<0.05). When comparing the 1st and 6th months, significant improvements were observed in activity VAS, WOMAC stiffness, WOMAC physical function, WOMAC total, and Lequesne index for pain, quality of life, and total scores (p<0.05). In the comparison between month 3 and month 6, only the Lequesne quality of life and total scores showed further improvement (p<0.05).

Discussion

In our study comparing the effect of the treatment package including SWD and ESWT in the treatment of KOA, we found that both modalities were effective. However, treatment package including SWD demonstrated a superior effect compared to treatment package including ESWT in terms of pain, physical function, and disability in patients with chronic KOA.

There are various opinions regarding the effectiveness of physical therapy agents in the treatment of KOA (9,17). Most studies conducted with ESWT are placebo-controlled, and no prior studies comparing SWD and ESWT were found in the literature (1,5). The exact mechanism of action of ESWT is not fully understood. However, it is believed that ESWT induces neovascularization by disrupting microvascular structures in the treated area, followed by the release of local growth factors that promote tissue regeneration from stem cells, thereby accelerating healing and reducing pain (18). ESWT has been shown to inhibit nitric oxide production in knee synovium, reduce chondrocyte apoptosis, and cause selective dysfunction of sensory unmyelinated nerve fibers (5).

In studies evaluating the use of ESWT in the treatment of KOA, the results have been variable while some have reported its effectiveness, others have found its outcomes to be comparable to placebo (5,9,18). These discrepancies may be attributed to differences in total energy flux density and variations in patient positioning during treatment (5). In a study by Zhao et al. (1), 4000 shock waves at 0.25 mJ/mm² and 6 Hz were applied to the intervention group, and assessments at 1 and 3 months using pain, WOMAC, and Lequesne indices revealed significant pain reduction and improved function. Zhong et al. (4) applied 2000 shocks at 2.5 bar pneumatic pressure and 8 Hz in patients with KL grade II or III KOA and concluded that a 4-week low-dose ESWT course was superior to placebo in pain relief, with effects lasting up to 12 weeks in most patients (5). Another study divided 60 patients with KOA into low- and medium-energy ESWT groups and applied weekly sessions for 3 weeks. Significant improvements were observed in VAS, WOMAC, and Lequesne index scores at weeks 1, 4, and 12 in both groups, with greater improvement in the medium-energy group (5). In a study involving patients with mild KOA, ESWT was compared with sham therapy. Both groups showed improvements in VAS, WOMAC, and Lequesne scores, but ultrasonographic evaluation revealed a reduction in suprapatellar effusion only in the ESWT group, which persisted through the

Table 3. Western Ontario and McMaster Universities osteoarthritis index (WOMAC) comparison by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
WOMAC pain pretreatment	SWD	25	5.0	1.2	5.0	4.0	5.7	0.057
	ESWT	24	5.7	1.6	5.7	5.0	7.0	
WOMAC pain 1st month	SWD	25	1.1	1.6	0.0	0.0	2.0	**0.009**
	ESWT	24	1.8	1.2	1.7	0.6	2.5	
WOMAC pain 3rd month	SWD	25	1.0	1.8	0.5	0.0	1.2	**0.047**
	ESWT	24	1.5	1.7	1.0	0.5	2.3	
WOMAC pain 6th month	SWD	25	1.4	2.1	0.0	0.0	3.2	0.672
	ESWT	24	1.1	1.4	0.7	0.0	1.3	
WOMAC Stiffness pretreatment	SWD	25	5.3	1.4	6.0	5.0	6.2	0.064
	ESWT	24	5.9	2.3	6.2	5.0	7.5	
WOMAC Stiffness 1st month	SWD	25	0.7	1.8	0.0	0.0	0.0	**0.001**
	ESWT	24	2.3	1.7	2.5	1.2	3.7	
WOMAC Stiffness 3rd month	SWD	25	0.5	1.2	0.0	0.0	0.0	**0.002**
	ESWT	24	1.7	1.8	1.2	0.0	3.4	
WOMAC Stiffness 6th month	SWD	25	0.7	1.3	0.0	0.0	1.8	0.796
	ESWT	24	0.8	1.5	0.0	0.0	1.2	
WOMAC physical function pretreatment	SWD	25	5.2	1.5	5.0	4.0	6.6	0.052
	ESWT	24	6.0	1.9	6.4	4.9	7.3	
WOMAC physical function 1st month	SWD	25	1.1	1.6	0.5	0.0	1.6	**0.001**
	ESWT	24	2.5	1.4	2.6	1.5	3.6	
WOMAC physical function 3rd month	SWD	25	1.1	1.7	0.2	0.0	1.6	**0.037**
	ESWT	24	1.7	1.5	1.6	0.5	2.5	
WOMAC physical function 6th month	SWD	25	1.6	2.0	0.4	0.0	3.9	0.910
	ESWT	24	1.0	1.1	0.5	0.1	1.3	
WOMAC total pretreatment	SWD	25	17.0	1.3	17.4	16.2	18.0	0.063
	ESWT	24	17.9	4.5	18.6	14.7	21.5	
WOMAC total 1st month	SWD	25	2.7	4.5	0.5	0.0	3.4	**0.001**
	ESWT	24	7.0	3.4	6.5	4.3	9.4	
WOMAC total 3rd month	SWD	25	2.8	4.7	0.6	0.0	3.3	**0.010**
	ESWT	24	4.9	4.8	3.0	1.2	7.4	
WOMAC total 6th month	SWD	25	3.7	5.1	0.5	0.0	8.1	0.521
	ESWT	24	2.9	3.6	1.5	0.4	5.1	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy

1-month follow-up (19). In our study, ESWT led to significant improvements in pain, functional outcomes, and quality of life at follow-up, demonstrating sustained benefits over time. Compared with other treatment options, ESWT offers several advantages, including its non-invasive nature, low complication rate, avoidance of hospitalization, and cost-effectiveness (19).

In another study, Mostafa et al. (20) compared the effectiveness of ESWT and high-intensity laser therapy (HILT) in 40 patients with KL grade II KOA. The ESWT group received 0.05 mJ/mm² once weekly for 4 weeks, while the HILT group received three weekly sessions over the same period. Both groups received standard physiotherapy programs. Statistically significant improvements were reported in both groups, with HILT demonstrating superior effects in pain and physical function (20). In a study by Zhao et al. (21), one group received ESWT, the second group electroacupuncture, and the third topical NSAIDs (control). Comparisons were made at weeks 0, 2, and 4 in terms of pain, WOMAC, and quality of life. The authors reported that electroacupuncture and the combination of ESWT with pharmacotherapy were more effective than conventional drug therapy, and that ESWT and electroacupuncture had comparable efficacy (21). Our results indicate that SWD may provide superior

Table 4. Lequesne OA severity index comparison by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Lequesne pain pretreatment	SWD	25	5.3	1.3	5.0	4.0	7.0	0.073
	ESWT	24	6.0	1.3	6.0	6.0	7.0	
Lequesne pain 1st month	SWD	25	1.2	1.8	1.0	0.0	2.0	**0.001**
	ESWT	24	2.6	1.5	2.0	2.0	4.0	
Lequesne pain 3rd month	SWD	25	1.1	1.9	0.0	0.0	2.0	0.056
	ESWT	24	1.6	1.5	1.0	0.2	3.0	
Lequesne pain 6th month	SWD	25	1.3	1.7	0.0	0.0	3.0	0.744
	ESWT	24	0.9	1.1	0.5	0.0	1.7	
Lequesne distance pretreatment	SWD	25	2.2	1.3	2.0	1.0	3.0	0.296
	ESWT	24	2.7	1.8	2.0	1.2	4.0	
Lequesne distance 1st month	SWD	25	0.8	0.6	1.0	0.0	1.0	0.383
	ESWT	24	1.0	0.8	1.0	0.2	1.7	
Lequesne distance 3rd month	SWD	25	0.8	0.8	1.0	0.0	1.5	0.395
	ESWT	24	0.7	1.0	0.0	0.0	1.0	
Lequesne distance 6th month	SWD	25	0.8	0.9	1.0	0.0	2.0	0.117
	ESWT	24	0.4	0.7	0.0	0.0	1.0	
Lequesne daily living activities pretreatment	SWD	25	4.4	1.0	4.0	4.0	5.0	0.229
	ESWT	24	4.7	1.2	4.5	4.0	5.7	
Lequesne daily living activities 1st month	SWD	25	1.4	1.7	1.0	0.0	3.0	**0.001**
	ESWT	24	3.0	1.1	3.0	2.0	4.0	
Lequesne daily living activities 3rd month	SWD	25	1.5	1.7	1.0	0.0	3.0	0.058
	ESWT	24	2.2	1.5	2.0	1.0	4.0	
Lequesne daily living activities 6th month	SWD	25	1.6	1.8	1.0	0.0	4.0	0.967
	ESWT	24	1.2	1.1	1.0	0.2	2.0	
Lequesne total pretreatment	SWD	25	12.2	2.1	13.0	11.0	14.0	0.054
	ESWT	24	13.5	3.1	14.0	12.0	15.7	
Lequesne total 1st month	SWD	25	3.5	3.8	3.0	0.0	5.5	**0.001**
	ESWT	24	6.7	2.5	7.0	5.0	8.0	
Lequesne total 3rd month	SWD	25	3.4	4.1	2.0	0.0	6.5	0.130
	ESWT	24	4.5	3.5	4.0	2.0	6.7	
Lequesne total 6th month	SWD	25	3.8	4.4	2.0	0.0	8.5	1.000
	ESWT	24	2.7	2.9	2.0	1.0	4.0	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy, OA: Osteoarthritis

pain relief and functional improvement compared to ESWT in patients with grade 2-3 KOA, emphasizing the need to consider clinical effectiveness when choosing adjunctive therapies.

The efficacy of SWD, a common physiotherapy modality in KOA, remains a topic of debate (6,17,22-26). In the study by Berktaş et al. (23), the effectiveness of pulsed SWD and therapeutic ultrasound was compared. Both modalities were found to be effective for pain, ROM, and functional parameters, with no superiority over one another (23). Similarly, Sarıfakıoğlu et al. (17) evaluated 132 patients with KOA, dividing them into ultrasound and SWD groups. Significant improvements in VAS and WOMAC scores were observed in both groups after 15 sessions, but no superiority between treatment agents was reported (17). Another study demonstrated that SWD reduced synovial tissue thickness on ultrasound, suggesting reduced synovitis, which was accompanied by a significant decrease in pain scores (24). In contrast, Akyol et al. (25) compared a group receiving SWD and exercise with an exercise-only group in 40 patients and found no significant difference between the groups. Likewise, Rattanachaiyanont and Kuptniratsaikul (26) evaluated 113

patients and concluded that SWD had no significant effect on pain and function. Cetin et al. (27) reported that SWD improved adherence to exercise therapy in women with KOA. In our study, SWD appeared to provide notable improvements in both pain and functional outcomes, supporting its potential clinical benefit in patients with KOA.

Ultrasound, pulsed SWD combined with TENS and superficial heating agents have been shown to be effective treatment options for pain, physical function and quality of life in knee (23). Başar and Erhan (6) evaluated the efficacy of continuous SWD, US, and TENS in patients with KL stage 2-3 KOA, and reported that TENS was more effective than the other agents in terms of pain relief both immediately after treatment and at the 1-month follow-up, whereas SWD was found to be more effective in improving physical functions based on the repeated sit-to-stand and 20-meter walking tests. In our study, both groups received HP and TENS treatments. Both HP and TENS are modalities known to be effective in the treatment of KOA (17). However, since they were applied to both groups with identical protocols and durations, they were assumed to have no influence on between-group comparisons.

Study Limitations

Our study has several limitations. Patients were included consecutively based on their attendance at the outpatient clinic, and the study was not randomized, which may introduce selection bias and limit the generalizability of the findings. Additionally, no sham treatment was administered to create a control group, which restricts the ability to fully account for placebo effects. Future studies with larger sample sizes, randomization, and control groups are needed to confirm and strengthen the validity of these results. Despite these limitations, our study's strengths include being the first to compare SWD and ESWT within a combined treatment regimen and incorporating a 6-month mid-term follow-up, providing valuable insight into the sustained effects of these therapies.

Conclusion

This study demonstrated that both SWD and ESWT are effective modalities in the treatment of KOA. These agents are significant due to their ease of application, low cost, non-invasive nature, positive impact on quality of life, and rapid therapeutic response. In patients with appropriate indications, factors such as the clinical condition's impact on the choice of physical agent, patient compliance, available technical infrastructure, and physician preferences play crucial roles in treatment selection.

Ethics

Ethics Committee Approval: The study was conducted between November 2020 and June 2021 at the Physical Medicine and Rehabilitation Outpatient Clinics of Tokat Gaziosmanpaşa University and Hitit University Faculty of Medicine, involving patients who presented with complaints of knee pain. The study was approved by the Institutional Ethics Committee (337/2020).

Informed Consent: Written informed consent was obtained from all patients before the study.

Footnotes

It was uploaded for presentation as an oral presentation at the OSTEOAKADEMI 2025 symposium organized by the Turkish Osteoporosis Association.

Authorship Contributions

Concept: A.Ç.T., S.O., Design: A.Ç.T., S.O., Data Collection or Processing: A.Ç.T., S.O., Analysis or Interpretation: A.Ç.T., S.O., Literature Search: A.Ç.T., S.O., Writing: A.Ç.T., S.O.

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The Relationship Between Musculoskeletal Pain and Chronobiology in Musicians

Müzisyenlerde Kas-iskelet Sistemi Ağrısı ile Kronobiyoloji Arasındaki İlişki

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Abstract

Objective: This study aimed to investigate chronotype as one of the risk factors for musculoskeletal pain in musicians.

Materials and Methods: A total of 135 musicians were included in the study. The musculoskeletal pain questioning of the participants was evaluated with the Cornell musculoskeletal discomfort questionairre (CMDQ). The chronotype preferences of the participants were evaluated with the morningness-eveningness questionnaire. In addition, participants' depression symptoms evaluated with Beck depression inventory, anxiety symptoms evaluated with Beck anxiety inventory.

Results: The mean CMDQ value of the participants was found to be 47.80±55.88. The region with the highest pain score of the participants was the upper extremity. In the Pearson correlation analysis, a weak negative correlation was found between morningness-eveningness questionnaire and mean CMDQ. A moderate positive correlation was found between weekly performance time and Beck anxiety index and CMDQ.

Conclusion: Eveningness, long working hours and anxiety are the determining factors on the risk of pain in musicians. The potential effect of chronobiology on pain in musicians should be taken into consideration.

Keywords: Musician, musculoskeletal pain, chronotype, CMDQ, anxiety

Öz

Amaç: Bu çalışmada, müzisyenlerde kas-iskelet sistemi ağrısı için risk faktörlerinden biri olarak kronotipin araştırılması amaçlanmıştır.

Gereç ve Yöntem: Çalışmaya toplam 135 müzisyen dahil edilmiştir. Katılımcıların kas-iskelet sistemi ağrısı sorgulamaları Cornell kas-iskelet sistemi rahatsızlık anketi (CMDQ) ile değerlendirilmiştir. Katılımcıların kronotip tercihleri sabahçılık-akşamcılık anketi ile değerlendirilmiştir. Ayrıca, katılımcıların depresyon belirtileri Beck depresyon envanteri, anksiyete belirtileri ise Beck anksiyete envanteri ile değerlendirilmiştir.

Bulgular: Katılımcıların ortalama CMDQ değeri 47,80±55,88 olarak bulunmuştur. Katılımcıların en yüksek ağrı skoruna sahip bölgesi üst ekstremitedir. Pearson korelasyon analizinde, sabahçılık-akşamcılık anketi ile CMDQ ortalamaları arasında zayıf negatif korelasyon bulunmuştur. Haftalık performans süresi ile Beck anksiyete indeksi ve CMDQ arasında orta düzeyde pozitif bir korelasyon bulunmuştur.

Sonuç: Akşamcıllık, uzun çalışma saatleri ve anksiyete, müzisyenlerde ağrı riskini belirleyen faktörlerdir. Kronobiyolojinin müzisyenlerde ağrı üzerindeki potansiyel etkisi dikkate alınmalıdır.

Anahtar kelimeler: Müzisyen, kas-iskelet ağrısı, kronotip, CMDQ, anksiyete

Introduction

Musicians frequently experience physical discomfort and pain due to the demanding nature of musical performance, which involves repetitive, fast, and complex motor activities (1). Across all categories of musicians, the prevalence of pain has been reported to range from 29.0% to 90.0% (2). Previous studies have identified several risk factors for playing-related musculoskeletal pain, including female gender, body weight, posture, years of practice, and weekly instrument playing time (3-5). Additionally,

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psychological factors such as anxiety and depression have been documented to affect pain among musicians (6,7), and these conditions frequently contribute to musculoskeletal pain in the broader literature.

In recent years, chronotype has emerged as another factor associated with pain, particularly in conditions such as fibromyalgia and other rheumatic disorders (8-11). Chronotype, also referred to as circadian preference, represents individual differences in the timing of sleep-wake cycles throughout the day. The circadian rhythm is regulated by an endogenous biological clock with genetic foundations and is influenced by environmental factors. These individual variations lead to substantial fluctuations in energy and alertness across the day: Morning types tend to be more active and focused in the early hours, evening types exhibit higher alertness later in the day, and intermediate types fall between these two extremes (12). Circadian rhythms regulate and mediate hormone secretion, receptor activity, signal transduction pathways, enzyme kinetics, and gene expression at the molecular level (13).

The association between chronotype and musculoskeletal pain can also be explained through several biological mechanisms. Pain perception is subject to circadian modulation, with evidence demonstrating rhythmic changes in nociceptive sensitivity across the day (14). Cortisol, a hormone with a robust circadian secretion pattern, peaks in the early morning and contributes to the suppression of inflammatory processes; disruptions to this rhythm—more frequently observed in individuals with eveningness—may lead to heightened inflammation and increased pain sensitivity (15,16). Furthermore, inflammatory biomarkers such as tumor necrosis factor-alpha and interleukin-6 exhibit circadian oscillations, and disturbances in these rhythms have been associated with heightened pain perception and musculoskeletal tenderness (17). These mechanisms provide a strong biological rationale for considering chronotype as a factor influencing pain perception and musculoskeletal health.

Eveningness has already been identified as a risk factor for musculoskeletal pain in certain occupational groups (18,19). For instance, a study conducted among male workers in a large automobile manufacturing facility reported lower rates of musculoskeletal pain in morning-type individuals compared with individuals of other chronotypes (20).

Despite these findings, the relationship between chronotype and musculoskeletal pain among musicians has not been previously investigated. Therefore, the objective of the present study was to examine chronotype as a potential risk factor for musculoskeletal pain in musicians.

Materials and Methods

Ethical Approval

The Ethics Committee for Clinical Research at Afyonkarahisar Health Sciences University granted approval for the study (approval date: 02.12.2022; approval number: 2022/595). The research was carried out in accordance with the principles outlined in the Declaration of Helsinki. The STROBE reporting criteria were followed in the study.

Sample Size Calculation

There are 201 musicians at Afyon Kocatepe University State Conservatory. It is necessary to interview at least 133 of the 201 people to achieve a 5% margin of error at the 95% confidence level.

$$n = \frac{Nt^2pq}{d^2(N-1) + t^2pq}$$

N= Number of individuals in the universe
n= Number of individuals to be sampled
p= The incidence (probability) of the event to be examined was 0.5 in the study.
q= Frequency of absence of the event to be examined (1-p)
t= The theoretical value found in the t table at a certain degree of freedom and the detected error level. In the study, 1.96 was taken.
d= It is symbolized as ± deviation according to the incidence of the event.

Participants

A total of 201 musicians were invited to participate in the study. Participants were contacted through visits to the conservatory. After being briefed on the study hypotheses, participants were asked to complete surveys lasting approximately 30 minutes. A total of 56 individuals declined to participate, citing lack of time or unwillingness to share information after reading the surveys. Participants with inflammatory rheumatic disease, malignancy, pregnancy, or major musculoskeletal trauma or surgery in the last 6 months were excluded from the study. A total of 135 musicians from the Afyon Kocatepe University State Conservatory were included in the study (Figure 1). Each participant provided written consent after being fully informed about the study.

Questionnaires

Demographic information of the participants, smoking and alcohol history, dominant extremity, body mass indexes, musicianship duration (years), weekly performance time (WPT) (hours), whether they exercised before performance, performance posture (sitting/standing), and type of instrument recorded. WPT was defined as the total number of hours, including rehearsals, lessons, and private study, and was self-reported by participants. Participants' musculoskeletal pain was evaluated with the Cornell musculoskeletal discomfort questionnaire (CMDQ). Participants' chronotypes were assessed using morningness-eveningness questionnaire (MEQ). In addition, participants' depressive and anxiety symptoms were evaluated with the Beck depression inventory (BDI) and the Beck anxiety inventory (BAI), respectively. Turkish versions of these questionnaires were used in this study.

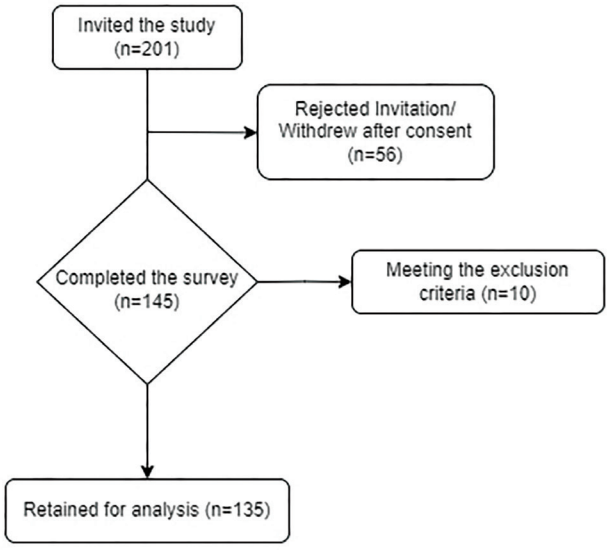

Figure 1. Flowchart of participant selection for the analysis

Cornell Musculoskeletal Discomfort Questionairre

CMDQ measures the frequency and severity of pain in 12 body regions (neck, shoulder, back, upper arm, waist, forearm, wrist, hip, upper leg, knee, lower leg, and foot) during the last 7 days and whether this pain hinders the ability to perform work. The score for each region is calculated as the product of th scores for pain frequency, pain severity, and work disability. According to the scoring system, each region's score ranges from 0 to 90. To interpret the results of the questionnaire applied in our study more clearly, CMDQ can be defined as three grouped regions: Spine (neck, back, waist), lower extremity (hip, upper leg, knee, lower leg, foot), and upper extremity (shoulder, upper arm, forearm, wrist). It was evaluated in three parts and by a total score. The validity and reliability of the Turkish version have been established (18).

Morningness-eveningness Questionnaire

This 19-item screening questionnaire has a rating range between 16 and 86. High scores indicate morningness, whereas low scores indicate eveningness. Scoring results were categorized as follows: Evening type: Scores between 16 and 41; morning type: Scores between 59 and 86; and none: Scores between 42 and 58. The MEQ's Cronbach's alpha value in the current study was 0.765 (19). The Turkish version has been shown to have good validity and reliability (21).

BDI, BAI

BDI and BAI are self-assessment tools comprising 21 items. The highest score that could be obtained from the scales was 63, and the lowest score was 0. Higher scores on the scales indicate greater severity of depression and anxiety. The Turkish versions of the BDI (22,23) and BAI (24) were shown to have good validity and reliability.

Statistical Analysis

Descriptive statistics used in the study included frequency, percent, mean, and standard deviation. Categorical data were analyzed using Pearson's chi-square test. Normality of the data was assessed using the Kolmogorov-Smirnov test. Pearson correlation analysis was used to evaluate relationships among CMDQ, MEQ, BAI, BDI, and WPT scores. A multiple linear regression was calculated to predict CMDQ. A p-value <0.05 was considered statistically significant. The obtained data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY).

Results

Descriptive statistics for the variables are presented in Table 1. Eighteen (13.3%) participants were in the morningness group, 34 (25.2%) in the eveningness group, and 83 (61.5%) were in neither group. The MEQ, BAI, BDI, and CMDQ characteristics of the participants are summarized in Table 2. The mean CMDQ (total) value was found to be 60.96±60.59 in females and 36.95±49.50 in males (p=0.045). The region of the musculoskeletal system in which participants had the highest pain score was the upper extremity. Mean CMDQ scores by painful body area are shown in Figure 2, and CMDQ groups are shown in Figure 3.

In the Pearson correlation analysis, a weak negative correlation was found between MEQ and CMDQ (r1=-0.174; p<0.001). A moderate positive correlation was found between WPT and BAI (r1=0.485, p<0.001) and between WPT and CMDQ (total) (r1=0.413, p<0.001). Table 3 shows the Pearson correlation coefficients between the variables. A multiple linear regression, adjusted for gender, was performed to predict CMDQ (total) from WPT, BAI, and MEQ (Table 4). A significant regression equation was found [F (3,132) =74.638, p<0.001], with an R^2 of 0.629. Participants' predicted CMDQ (total) =1.630*BAI-0.145*MEQ + 1.565*WPT.

Discussion

This study, conducted to examine musculoskeletal pain, chronotype, and other related factors in musicians, found that eveningness correlated with pain scores. Weekly practice hours and anxiety levels significantly affected musicians' pain.

Although the area where musculoskeletal pain is most commonly seen varies among different instruments, when all instrument families are considered, the most frequent pain is found in the neck and shoulders (20). Ioannou and Altenmüller (25) reported that the wrist, forearm, and fingers are three of the four most frequently impacted body parts. According to Berque et al. (26) the right and left hands and wrists were among the areas most impacted. We found the highest risk of pain in the upper extremities, followed by low back and other back pain.

Studies have shown that increased years of experience and higher perceived exertion rates after 45 minutes of continuous practice

Table 1. Descriptive statistics of variables			
		Mean ± SD	
Age (years)		25.81±9.19	
BMI		23.89±4.97	
Musicianship duration (years)		9.97±7.99	
Weekly performance time (hours)		21.68±16.14	
		n	**%**
Sex	Female	61	45.2
	Male	74	54.8
Dominant hand	Right handed	115	85.2
	Left handed	20	14.8
Smoking	Yes	50	37.0
	No	85	63.0
Alcohol	Yes	73	54.1
	No	62	45.9
Instrument	String	41	30.4
	Woodwind	14	10.4
	Plucked	46	34.1
	Keyboard	34	25.2
Warming up before the pratice	Yes	92	68.1
	No	43	31.9
Performance posture	Sitting	108	80.0
	Standing	27	20.0
SD: Standard deviation, BMI: Body mass index			

Table 2. Survey chracteristics	
	Mean ± SD
MEQ	47.11±10.29
BDI	14.68±9.95
BAI	12.13±12.15
CMDQ (total)	47.80±55.88
MEQ: Morningness-eveningness questionnaire, BDI: Beck depression inventory, BAI: Beck anxiety inventory, CMDQ: Cornell musculoskeletal discomfort questionairre, SD: Standard deviation	

are significantly associated with the musculoskeletal pain (3). It has been shown that musicians who play 15 hours or more per week are more likely to report experiencing musculoskeletal pain (4). The relationship between practice time and pain has also been demonstrated in other studies (25-27). Similarly, we found that weekly practice time was a factor predicting pain risk.

In a review conducted by Stanhope et al. (28) on musculoskeletal complaints in musicians, they compiled a comprehensive inventory of perceived risks or exacerbating factors that had previously been examined. Besides the aforementioned risk factors, they identified several other factors, some of which appear highly personal or not specific to music or to a particular instrument.

According to Jacukowicz (29) musculoskeletal disorders can be caused or worsened by psychological stress and burdens, a fact that has been well-documented by numerous studies conducted on different types of workers. According to Nedelcut et al. (30), musicians have higher anxiety scores than their matched controls. In the study conducted by Matei and Ginsborg (6), performance-related musculoskeletal disorders, anxiety, and reported frequency and severity of physical effort were positively associated. Similarly, we demonstrated that anxiety was correlated with pain scores. Furthermore, anxiety emerged as a determinant of pain risk in the multiple regression analysis.

Chronotypes have been associated with many mental health problems, including mood disorders (31). Studies also have indicated that sensitivity to pain may be influenced by chronotype, with evening types exhibiting a greater sensitivity to pain (32). Merikanto et al. (33) noted that evening types have a higher likelihood of joint diseases and back pain compared to morning types. Chronotype should be considered as an indicator of widespread pain, and therefore should be taken into account when assessing a patient's risk for chronic pain (34). There is strong evidence for the link between chronotype and the symptomatology of fibromyalgia syndrome, one of the common pain syndromes, with later chronotypes being more affected by fibromyalgia (9). Less eveningness has been linked with milder depressive symptoms and improved quality of life (35).

When considering exogenous factors and occupational settings, musicians may exhibit eveningness. Our study revealed that approximately 25.2% of individuals exhibited eveningness.

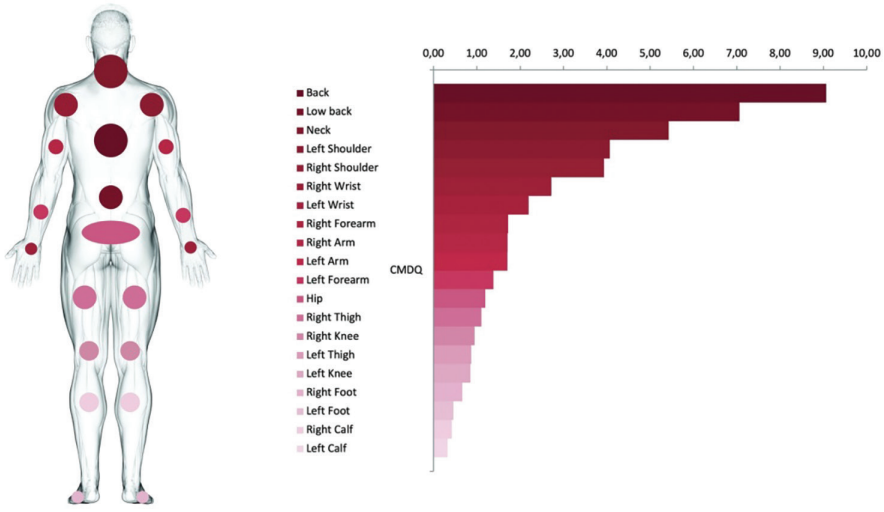

Figure 2. Mean CMDQ scores according to the painful areas of the body
CMDQ: Cornell musculoskeletal discomfort questionairre

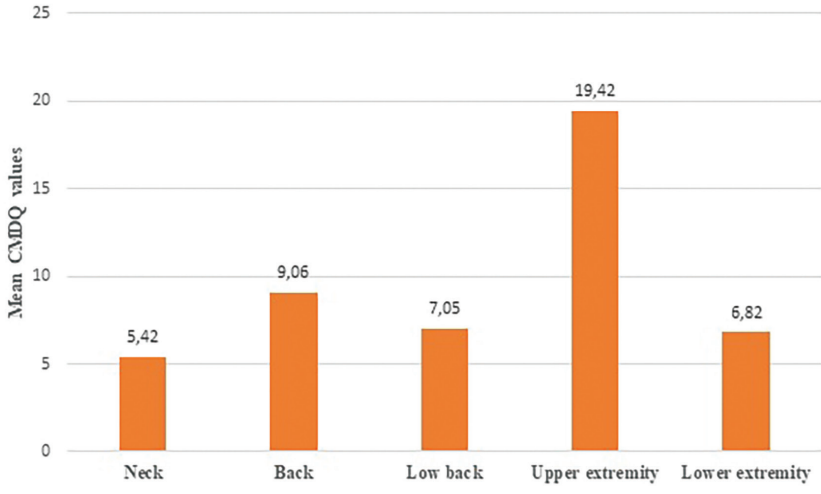

Figure 3. Mean CMDQ group scores
CMDQ: Cornell musculoskeletal discomfort questionairre

Table 3. Correlation analyses of variables

		WPT	MEQ	BDI	BAI	CMDQ
WPT	r	1				
MEQ	r	0.02	1			
BDI	r	0.06	**-0.336****	1		
BAI	r	0.15	-0.155	**0.529****	1	
CMDQ (total)	r	**0.485****	**-0.174***	**0.286****	**0.413****	1

**: p<0.001, p<0.05 p-value is the result of Pearson correlation, WPT: Weekly performance time, MEQ: Morningness-eveningness questionnaire, BDI: Beck depression inventory, BAI: Beck anxiety inventory, CMDQ: Cornell musculoskeletal discomfort questionairre

Paine et al. (36) reported that 49.8% of the total population was morning type and 5.6% had evening type. Compared with the general population, musicians have a greater preference for evening activities.It has been shown that evening chronotype is a risk factor for work-related musculoskeletal disorders in different occupational groups. For instance, in a study with 119 male production workers, the rate of musculoskeletal pain was significantly lower for morning-type workers (37). In nurses, evening chronotype was found to be linked with higher risk of work-related musculoskeletal disorders (38). Heikkala et al. (34) also noted that eveningand intermediate chronotypes are associated with musculoskeletal pain, but that mental distress, insomnia, and comorbidities may also play a role in these relationships. Our study is the first to examine chronotype in musicians, a population with a high prevalence of musculoskeletal problems, and to find that evening chronotype, along with performance duration and anxiety, was a significant factor in pain risk.

Table 4. Regression analyzes for CMDQ (total)

	β	R^2	Adj. R^2	F	p
WPT	1.63				
MEQ	-0.145	0.629	0.621	74.648	<0.001
BAI	0.346				

BAI: Beck anxiety inventory, CMDQ: Cornell musculoskeletal discomfort questionairre, MEQ: Morningness-eveningness questionnaire

Study Limitations

A strength of this study is that it is the first to examine chronobiology among musicians. Furthermore, the inclusion of depression and anxiety, which can be influenced by chronobiology, strengthens the study.

Musculoskeletal problems are closely related to sleep and sleep quality. One limitation of this study is that sleep quality was not assessed. The small sample size is a limitation.

In conclusion, musicians are at higher risk of developing musculoskeletal pain, particularly in the upper extremities and back. Eveningness, long working hours, and anxiety are determinants of pain risk.

Ethics

Ethics Committee Approval: The Ethics Committee for Clinical Research at Afyonkarahisar Health Sciences University granted approval for the study (approval date: 02.12.2022; approval number: 2022/595).

Informed Consent: Each participant provided written consent after being fully informed about the study.

Footnotes

Authorship Contributions

Design: S.A., C.K.T., Data Collection or Processing: S.A., Analysis or Interpretation: S.A., C.K.T., Literature Search: S.A., C.K.T., Writing: S.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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Investigating the Effects of Face-to-face Rehabilitation and Telerehabilitation on Muscle Strength, Balance, and Quality of Life in Postmenopausal Osteoporosis Patients: Randomized Controlled Trial

Postmenopozal Osteoporoz Hastalarında Yüz Yüze Rehabilitasyon ve Telerehabilitasyonun Kas Gücü, Denge ve Yaşam Kalitesi Üzerine Etkilerinin Araştırılması: Randomize Kontrollü Çalışma

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Abstract

Objective: Exercise is an important parameter in osteoporosis (OP). However, there are significant difficulties in patients following exercise programs in the long term. We aimed to compare the effectiveness of the exercise program applied with face-to-face and telerehabilitation methods in postmenopausal OP.

Materials and Methods: The study included 50 patients aged 55-75 years, diagnosed with postmenopausal OP and able to use technology. Patients were randomly divided into 2 groups (group 1: Face-to-face, group 2: Telerehabilitation). The exercise program was applied 3 days a week for 12 weeks. Assessments were made before treatment and at 6th and 12th weeks. Primary outcome measures, muscle strength, were assessed with a hand-held dynamometer, balance was assessed with the Tinetti balance-walking test. Kinesiophobia was assessed with the TAMPA kinesiophobia scale, quality of life with the short form-36 (SF-36), health anxiety with the health anxiety scale (HAS).

Results: In group 1, a significant change was found in knee extensor muscle strength after treatment (p=0.032, 0.004). No change was detected in kinesiophobia levels (p>0.05). There was a significant difference in balance before and after treatment in group 1 (p=0.001), but not in group 2 (p>0.05). In the HAS, a significant difference was seen in favor of group1 in anxiety and total scores (p=0.025; 0.023). A significant difference was seen between SF-36 general health (p=0.034) and emotional role limitation delta change values in favor of group 1 (p=0.011).

Conclusion: Although both face-to-face and telerehabilitation were found to be effective in postmenopausal OP, this effect was greater in face-to-face. We think that telerehabilitation would be a good option for those who have obstacles to participating in face-to-face rehabilitation.

Keywords: Postmenopausal osteoporosis, exercise therapy, telerehabilitation, muscle strength, postural balance

Öz

Amaç: Egzersiz, osteoporoz (OP) tedavisinin ana bileşenlerinden olmasına rağmen, hastaların uzun vadede egzersiz programlarını takip etmelerinde önemli zorluklar yaşanmaktadır. Bu çalışmada, postmenopozal OP'de yüz yüze ve telerehabilitasyon yöntemleriyle uygulanan egzersiz programının etkinliğini karşılaştırmayı amaçladık.

Gereç ve Yöntem: Çalışmaya, 55-75 yaşları arasında, postmenopozal OP tanısı almış ve teknolojiyi kullanabilen 50 hasta dahil edildi. Hastalar rastgele 2 gruba ayrıldı (grup 1: Yüz yüze, grup 2: Telerehabilitasyon). Egzersiz programı haftada 3 gün, 12 hafta boyunca uygulandı. Değerlendirmeler tedavi öncesi, 6. ve 12. haftalarda yapıldı. Birincil sonuç ölçütleri olan kas kuvveti elde taşınan bir dinamometre ile, denge Tinetti denge-yürüme testi ile, kinezyofobi TAMPA kinezyofobi ölçeği ile, yaşam kalitesi kısa form-36 (SF-36) ile, sağlık kaygısı ise sağlık kaygısı ölçeği (HAS) ile değerlendirildi.

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Bulgular: Grup 1'de tedavi sonrası diz ekstansör kas kuvvetinde anlamlı bir değişiklik bulundu (p=0,032, 0,004). Kinezyofobi düzeylerinde bir değişiklik saptanmadı (p>0,05). Grup 1'de tedavi öncesi ve sonrası dengede anlamlı bir fark vardı (p=0,001), ancak grup 2'de böyle bir fark yoktu (p>0,05). HAS'de kaygı ve toplam puanlarda grup 1 lehine anlamlı bir fark görüldü (p=0,025; 0,023). SF-36 genel sağlık (p=0,034) ve duygusal rol kısıtlaması delta değişim değerleri arasında grup 1 lehine anlamlı bir fark görüldü (p=0,011).

Sonuç: Hem yüz yüze hem de telerehabilitasyonun postmenopozal OP'de etkili olduğu bulunmuş olsa da, bu etki yüz yüze tedavide daha fazlaydı. Yüz yüze rehabilitasyona katılımda engeli olan kişiler için telerehabilitasyonun iyi bir seçenek olacağını düşünmekteyiz.

Anahtar kelimeler: Postmenopozal osteoporoz, egzersiz tedavisi, telerehabilitasyon, kas gücü, duruş dengesi

Introduction

Osteoporosis (OP) is an osteometabolic disorder marked by bone tissue deterioration that compromises bone quality and strength, raising fracture risk and potentially leading to chronic pain, functional capacity loss, and reduced quality of life (1). OP is increasingly prevalent due to population aging, leading to serious secondary health problems, including fractures that may result in mortality (2). Each year, OP-related fractures affect an estimated 9 million people worldwide, with women constituting the majority (3). For those who experience fractures, mortality risk increases by 2.7 times (4). Ranking as the fourth most severe chronic disease, OP-related fractures place a substantial burden on healthcare systems, largely due to associated issues such as depression, pain, and functional impairments (5).

Physical activity is recommended as a cost-effective strategy for slowing bone loss and improving bone mineral density (BMD) (6). Systematic reviews indicate that different types of exercise positively impact BMD in postmenopausal women (7,8). While walking has been recommended in a systematic review, progressive resistance exercise training has also been cited as an effective strategy for maintaining or increasing BMD (9). Studies on chronic painful musculoskeletal disorders, including OP, reveal that these conditions contribute to pain, kinesiophobia, physical dysfunction, dissatisfaction with daily life, and low quality of life (10). Due to OP's prevalence, an aging population, and limited access to treatment, few patients participate in structured, professional exercise programs.

Telerehabilitation is under study as a potentially innovative solution for patients with limited access to healthcare. A study evaluating telerehabilitation-based physical therapy reported that 94% of patients and 100% of treating physiotherapists were satisfied with the application and outcomes, highlighting the feasibility of delivering physical therapy via telehealth (11). Another randomized controlled study comparing telerehabilitation and face-to-face rehabilitation after total hip replacement surgery found comparable physical and functional outcomes between the two approaches (12).

The current study aimed to compare the effectiveness of a 12-week face-to-face rehabilitation and telerehabilitation on muscle strength, balance, and quality of life in postmenopausal OP patients. Since this is the first study on this topic in the literature, it holds unique value. The findings obtained will shed light on identifying a more accessible, cost-effective, and efficient treatment tool to reach a broader range of individuals for OP rehabilitation.

Materials and Methods

Desing and Setting

This randomized, controlled single blind study was conducted between January-September 2022 in the physical medicine and rehabilitation outpatient clinic. The study was conducted as a single-blind study with blinding of the physiotherapist performing the assessments. This research has been approved by the authors' affiliated institutions and all procedures were conducted according to the Declaration of Helsinki. Prior to the commencement of the study, approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision no: 459, date: December 22, 2021). The study was supported by the Scientific Research Projects Coordination Unit at İzmir Bakırçay University (KBP.2021.002). All participants provided written informed consent before the participation in the study.

Participants

The study included 50 postmenopausal OP patients and they were randomly divided into two groups using a web-based randomization tool (random.org). The inclusion criteria were: (1) being between 55-75 years of age, (2) those with a DEXA score of -2.5 and above and diagnosed with OP, (3) required to have the necessary skills and access to participate in telerehabilitation as well as possess and be proficient in using a smartphone or computer. Patients with severe cardiovascular or respiratory problems or those with neurological, metabolic, vestibular, or orthopedic issues that could impact gait, balance, or mobility (such as prior spinal surgery, or the presence of rheumatologic diseases or central or peripheral nervous system disorders), acute compression fractures, or spinal pain restricting exercise were excluded. The study flowchart is presented in Figure 1.

Procedure

Fifty adults with OP was randomized into two groups to either a control group (face-to-face rehabilitation) or an experimental group (telerehabilitation). Socio-demographic data (age, gender, occupation, medical history, etc.), height, body mass index, and DXA scores were recorded for all patients, followed by the assessment of their muscle strength, balance, fear of movement, quality of life, and health anxiety levels. All evaluations of the participants were performed face-to-face at the physical medicine and rehabilitation outpatient clinic by a physiotherapist who was blind to the study. Patients received exercise therapy three times weekly over a 12-week period, with the program updated every

three weeks to gradually increase intensity. Interim assessments were conducted at the end of the six week of exercise therapy, with final assessments following the full 12-week program.

Intervention

Patients received exercise therapy three times weekly over a 12-week period, with the program updated every three weeks to gradually increase intensity. The rehabilitation program content was consistent across groups, differing only in the delivery method (face-to-face versus telerehabilitation). The face-to-face group attended sessions at the treatment unit under a physiotherapist's supervision. For the telerehabilitation group, exercises were taught one-on-one by a physiotherapist during the initial assessment. Exercise videos were provided via telephone as a reference in case patients forgot the instructions. The telerehabilitation group was managed by a physiotherapist and sent reminders before each session and provided live session support.

The exercise program was structured across four levels, with progressions every three weeks. Warm-up and cool-down involved three to five minutes of marching in place, with stretching exercises performed as self-administered at each joint's end range of motion for 10-15 seconds, repeated 3-5 times. Strengthening exercises followed, maintaining a modified Borg scale intensity of 13-15, with repetitions per set varying from 8-12 based on individual capacity. Strengthening exercises were performed in lying, sitting and standing positions. Started from the easy and made more difficult according to the patient's tolerance. Although lower extremity and trunk exercises are predominant, exercises that include the whole body have been selected. All exercises were performed as calisthenic exercises. Balance exercises were performed in standing position, double-leg, tandem and single-leg positions. Starting with a wide support surface, the support surface was gradually narrowed.

The exercise session lasted 45 minutes in total, with a 5-minute warm-up and cool-down period. Patients were asked to walk for 30 minutes on days when they did not exercise.

Outcome Measures

For strength measurements, a handheld dynamometer was used. Patients were seated with hips and knees at 90° flexion, with the dynamometer positioned at the distal two-thirds of the calves, anteriorly for knee extension measurements and posteriorly for knee flexor assessments. An isometric "make

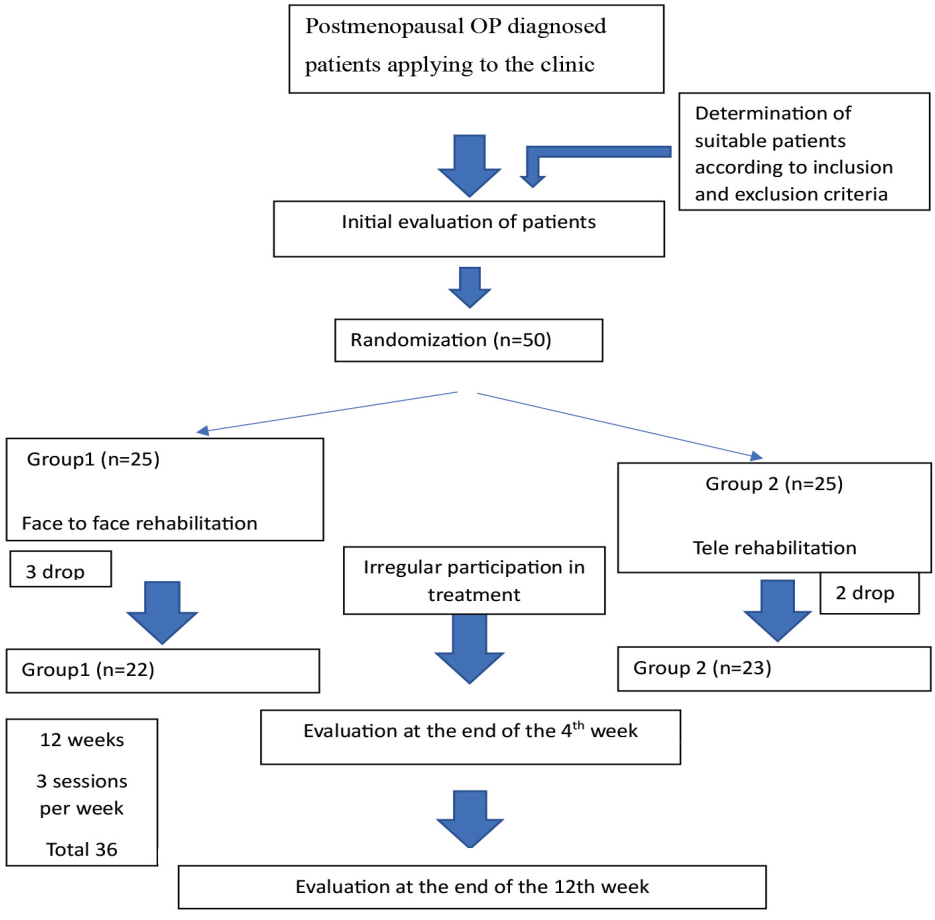

Figure 1. Study flow diagram
OP: Osteoporosis

test" was employed, with patients instructed to apply maximum force against the fixed device for three seconds. Each trial was followed by a 30-second rest period, and two measurements were averaged and recorded in kilograms (13).

The Tinetti test assesses balance through the first nine items and gait through the following seven, categorized into two sections. Scores below 18 indicate a high fall risk, scores of 19-23 suggest moderate risk, and scores of 24 or higher reflect a low fall risk (14).

Kinesiophobia was evaluated with the 17-item tampa scale of kinesiophobia. The scale uses a 4-point Likert scoring system (1: Strongly disagree, 4: Strongly agree), with total scores ranging from 17 to 68, where higher scores represent greater fear of movement (15).

Quality of life was assessed using the SF-36, evaluating eight domains of functional health (physical functioning, physical role, bodily pain, general health, vitality, social functioning, role-emotional, and mental health). Scores range from 0 (worst quality of life) to 100 (best quality of life) (16).

The short health anxiety inventory was used to measure health anxiety levels. Fourteen items assess patients' psychological states in relation to their health, while the remaining four evaluate concerns about possible serious illnesses. Each item is scored from 0-3, with higher scores indicating greater health anxiety (17).

Statistical Analysis

Sample size determination

The primary objective of this study was to compare the effects of face-to-face rehabilitation versus telerehabilitation on muscle strength, balance, and quality of life in postmenopausal OP patients at 12 weeks. Based on the study by Moffet et al. (18) on knee osteoarthritis patients and changes in knee extensor strength, a sample size calculation was performed using a t-test to compare the differences between the two groups. This calculation determined that a total of 40 patients (20 per group) would be needed, with an α of 0.05, power of 0.85, and effect size of 0.97. To account for an estimated 10% potential attrition rate during follow-up, 50 patients were included.

Statistical Methods

All data analyses were performed using IBM SPSS Statistics v.25. Normal distribution was assessed with the Kolmogorov-Smirnov test (for analyses involving all participants) and the Shapiro-Wilk test (for analyses within treatment groups), as well as by examining Skewness, Kurtosis, graphs, and histograms. Descriptive statistics were reported as medians and interquartile ranges for non-normally distributed variables. For repeated measures comparisons (baseline, week 4, and week 8), the Friedman test was applied for non-normally distributed data. Statistical significance was set at $p<0.05$ for all analyses. Post-hoc Wilcoxon tests identified specific differences in variables with significant Friedman test results, with statistical significance set at $p<0.17$. Intergroup comparisons involved calculating differences from baseline to second and third measurements, analyzed using the Mann-Whitney U test, with a significance level set at $p<0.17$.

Results

Our study included 50 females who presented at the Physical Medicine and Rehabilitation Clinic at İzmir Bakırçay University and were diagnosed with OP. The average ages of the randomly assigned face-to-face exercise and telerehabilitation groups were 60.5±4.47 and 61.0±7.1 years, respectively. The demographic characteristics of the participants and intergroup comparisons are presented in Table 1. Statistical analysis revealed no significant differences in demographic characteristics between the groups, indicating homogeneity ($p>0.05$).

Muscle Strength

Significant changes were observed within the face-to-face exercise group in both dominant and non-dominant knee extensor muscle strength post-treatment compared to pre-treatment ($p=0.032$ and $p=0.004$). In the telerehabilitation group, an increase was noted only in non-dominant flexor muscle strength ($p=0.008$). No significant differences were found in other parameters ($p>0.05$) (Table 2). When comparing the groups, a significant difference was observed only in the delta values for non-dominant knee flexion between mid-treatment and post-treatment, with no significant differences noted in the other parameters ($p>0.05$) (Table 3).

Kinesiophobia

Face-to-face exercise and telerehabilitation groups exhibited high pre-treatment kinesiophobia scores [47.00 (39.00-53.00) and 42.00 (36.00-46.00)]. However, there were no significant changes in kinesiophobia scores either within or between the groups ($p>0.05$) (Table 2, Table 3).

Balance/Gait

When evaluating the balance and gait scores, a significant improvement in gait was observed within the face-to-face exercise group from pre-treatment to post-treatment ($p=0.001$). In contrast, no significant changes were noted in the telerehabilitation group ($p>0.05$). Comparisons between the groups revealed significant differences in favor of the face-to-face exercise group regarding balance scores at both mid-treatment and post-treatment. However, no significant differences were found in gait within or between the groups ($p>0.05$) (Table 2, Table 3).

Anxiety Levels

In comparing intragroup anxiety levels before, during, and after treatment, the face-to-face exercise group exhibited significant differences across all parameters ($p=0.016$, $p=0.001$, and $p=0.005$, respectively), while no differences were noted in the telerehabilitation group ($p>0.05$) (Table 4). When comparing the

Table 1. Demographic and clinical characteristics of the study population			
	Face-to-face X±SD/n (%)*	**Telerehabilitation X±SD/n (%)***	**p**
Age (year)	60.5±4.47	61.0±7.1	0.76
Body mass index (kg/m²)	26.0±3.6	25.7±4.2	0.78
Lomber T-score	-2.6±0.6	-2.6±0.8	0.96
Femur neck T-score	-2.0±0.5	-2.0±0.7	0.98
Duration of symptoms (month)	71.3±53.4	88.0±63.9	0.34
Age of menopause (month)	46.5±3.9	45.6±5.4	0.53
Number of falls (year)	1.9±2.6	0.4±0.9	**0.02**
Education level*			
Not literate	1	1	
Primary-secondary education	11	9	
High school	3	6	0.75
University	7	7	
Marital status*			
Married	12	14	
Not married	6	4	0.72
Widow	4	5	
Occupation*			
Retired	8	13	0.17
Housewife	14	10	
Fracture history*			
Yes	8	11	0.43
No	14	12	

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test, SD: Standard deviation, *: Number of participants

Table 2. Comparison of muscle strength, TSK and TGBT values within the group before and after treatment						
	Face-to-face			**Telerehabilitation**		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Left knee flexion 1 **Left knee flexion 2** **Left knee flexion 3**	15.42 (13.46-19.02) 17.67 (15.92-19.86) 18.62 (16.63-19.90)	1.402	0.496	21.05 (18.90-21.90) 23.25 (19.95-26.45) 20.95 (18.15-22.65)	9.648	**0.008**
Right knee flexion 1 **Right knee flexion 2** **Right knee flexion 3**	16.32 (14.58-20.47) 16.35 (15.47-18.63) 16.95 (15.70-17.86)	0.023	0.989	20.00 (18.10-22.05) 20.65 (18.50-22.75) 20.95 (17.90-22.70)	3.130	0.209
Left knee extension 1 **Left knee extension 2** **Left knee extension 3**	20.85 (18.11-23.47) 21.72 (17.83-23.98) 23.07 (19.77-27.08)	11.000	**0.004**	24.50 (19.15-28.65) 24.20 (22.00-29.50) 23.95 (22.30-32.25)	2.696	0.260
Right knee extension 1 **Right knee extension 2** **Right knee extension 3**	19.70 (14.03-22.76) 22.22 (17.70-24.81) 22.92 (19.12-25.78)	6.909	**0.032**	23.45 (18.80-25.35) 23.25 (19.00-28.70) 25.60 (21.90-28.70)	3.739	0.154
TSK 1 **TSK 2** **TSK 3**	47.00 (39.00-53.00) 46.00 (38.50-49.25) 41.00 (38.00-44.50)	2.424	0.289	42.00 (36.00-46.00) 40.00 (36.00-44.00) 40.00 (38.00-45.00)	0.483	0.786
TGBT gait 1 **TGBT gait 2** **TGBT gait 3**	9.00 (9.00-9.00) 9.00 (9.00-9.00) 9.00 (9.00-9.00)	2.000	0.368	9.00 (9.00-9.00) 9.00 (9.00-9.00) 9.00 (9.00-9.00)	2.000	0.368
TGBT balance 1 **TGBT balance 2** **TGBT balance 3**	25.50 (23.75-26.00) 25.00 (26.00-26.00) 26.00 (26.00-26.00)	16.233	**0.001**	26.00 (25.00-26.00) 26.00 (26.00-26.00) 26.00 (26.00-26.00)	4.909	0.086

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test

groups, significant differences favoring the face-to-face exercise group were observed in the negative delta values for the HAI between pre-treatment and mid-treatment (p=0.021), as well as in the HAI anxiety and total HAI delta values between mid-treatment and post-treatment (p=0.025 and p=0.023). No significant differences were found among other data (p>0.05).

Quality of Life

In the intra-group comparisons of quality of life, significant differences were noted in the face-to-face exercise group for physical and emotional role limitations, energy/fatigue, emotional well-being, and pain subparameters (p=0.044, p=0.050, p=0.001, p=0.001, and p=0.0189, respectively). In contrast, the telerehabilitation group exhibited significant differences only in the energy/fatigue and pain subparameters (p=0.009 and p=0.050) (Table 5). Intergroup comparisons revealed a significant difference favoring the face-to-face exercise group in SF-36 energy/fatigue delta values between pre-treatment and mid-treatment (p=0.034) and in SF-36 emotional role limitation delta values between mid-treatment and post-treatment (p=0.011). No significant differences were found among other data (p>0.05).

Discussion

Exercise has been recommended as a low-cost and effective non-pharmacological strategy for improving bone strength. However, due to disparities in medical accessibility, many patients remain unidentified and have limited access to regular professional exercise programs. To enable more patients to receive professional rehabilitation guidance, numerous studies have begun exploring telerehabilitation, which is considered a potential innovative treatment approach and has demonstrated positive physical and functional outcomes. Nevertheless, there is insufficient literature and data on the effectiveness of telerehabilitation for patients with OP (19). Therefore, our study

Table 3. Comparison of changes in result scores in muscle strength, TSK and TGBT evaluations at baseline, 2nd and 3rd controls

	Face-to-face	Telerehabilitation	z	p
Δ Left knee flexion 1-2	1.35 (4.18-1.35)	2.05 (5.85-0.2)	0.772	0.440
Δ Left knee flexion 2-3	0.22 (2.37-1.42)	2.55 (0-4.95)	1.987	**0.047**
Δ Left knee extension 1-2	1.2 (4.62-1.56)	3.3 (4.6-6.05)	0.136	0.892
Δ Left knee extension 2-3	2.15 (4.18-0.73)	1.2 (2.75-4.3)	0.488	0.625
Δ Right knee flexion 1-2	0.05 (3.1-2.4)	0.55 (1.55-3.55)	0.749	0.454
Δ Right knee flexion 2-3	0.05 (1.23-1.42)	0.4 (1.15-3.3)	0.227	0.820
Δ Right knee extension 1-2	2.6 (4.87-1.53)	1.35 (3.15-4.4)	0.693	0.489
Δ Right knee extension 2-3	0.65 (5.18-2.2)	1.75 (3.5-6.2)	0.420	0.674
Δ TSK 1-2	0.5 (3.5-4.5)	0 (2-6)	0.057	0.955
Δ TSK 2-3	3.5 (3-8.25)	1 (2-3)	1.174	0.240
Δ TGBT gait 1-2	0 (0-0)	0 (0-0)	0.333	0.739
Δ TGBT gait 2-3	0 (0-0)	0 (0-0)	1.399	0.162
Δ TGBT balance 1-2	0.5 (2-0)	0 (0-0)	0.970	0.332
Δ TGBT balance 2-3	0 (0-1)	0 (0-1)	2.314	**0.019**

TSK: Tampa scale of kinesiophobia, TGBT: Tinetti gait and balance test

Table 4. Comparison of SHAI values within the group before and after treatment

	Face-to-face			Telerehabilitation		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Anxiety 1 **Anxiety 2** **Anxiety 3**	15.50 (9.75-20.00) 14.50 (10.00-17.50) 11.00 (10.00-15.75)	8.32	**0.016**	21.05 (18.90-21.90) 23.25 (19.95-26.45) 20.95 (18.15-22.65)	2.02	0.363
Negative result 1 **Negative result 2** **Negative result 3**	6.00 (2.75-9.00) 4.00 (2.00-6.00) 2.00 (1.00-4.00)	18.65	**0.001**	20.00 (18.10-22.05) 20.65 (18.50-22.75) 20.95 (17.90-22.70)	1.23	0.538
Total 1 **Total 2** **Total 3**	21.50 (14.00-27.25) 19.00 (14.00-21.50) 13.50 (11.00-19.25)	10.41	**0.005**	24.50 (19.15-28.65) 24.20 (22.00-29.50) 23.95 (22.30-32.25)	1.19	0.550

SHAI: Short health anxiety inventory

Table 5. Comparison of SF-36 values within the group before and after treatment

	Face-to-face			Telerehabilitation		
	Median (25-75%)	**Chi-square**	**p**	**Median (25-75%)**	**Chi-square**	**p**
Physical function 1 **Physical function 2** **Physical function 3**	70.00 (55.00-85.00) 70.00 (58.75-95.00) 75.00 (60.00-90.00)	3.675	0.159	75.00 (60.00-90.00) 80.00 (65.00-95.00) 75.00 (60.00-95.00)	0.538	0.764
Role physical 1 **Role physical 2** **Role physical 3**	50.00 (0.00-100.00) 62.50 (25.00-100.00) 87.50 (25.00-100.00)	6.241	**0.044**	75.00 (25.00-100.00) 100.00 (50.00-100.00) 100.00 (75.00-100.00)	4.633	0.099
Role emotion 1 **Role emotion 2** **Role emotion 2**	50.00 (0.00-100.00) 83.35 (58.35-100.00) 50.00 (0.00-100.00)	5.607	**0.050**	66.70 (0.00-100.00) 66.70 (33.30-100.00) 100.00 (33.30-100.00)	3.640	0.162
Vitality 1 **Vitality 2** **Vitality 3**	35.00 (15.00-71.25) 60.00 (33.75-75.00) 62.50 (45.00-81.25)	26.554	**0.001**	50.00 (40.00-65.00) 60.00 (45.00-70.00) 65.00 (50.00-80.00)	9.349	**0.009**
Mental health 1 **Mental health 2** **Mental health 3**	50.00 (31.00-80.00) 72.00 (52.00-80.00) 70.00 (59.00-81.00)	17.446	**0.001**	60.00 (52.00-76.00) 72.00 (52.00-80.00) 68.00 (60.00-84.00)	3.791	0.150
Social function 1 **Social function 2** **Social function 3**	62.50 (50.00-87.50) 68.75 (50.00-87.50) 75.00 (59.37-100.00)	1.365	0.505	87.50 (50.00-100.00) 87.50 (62.50-100.00) 75.00 (62.50-100.00)	0.427	0.808
Pain 1 **Pain 2** **Pain 3**	45.00 (35.00-77.50) 61.25 (45.00-78.12) 57.50 (45.00-90.00)	8.026	**0.018**	55.00 (35.00-67.50) 67.50 (45.00-77.50) 77.50 (45.00-90.00)	5.951	**0.050**
General health 1 **General health 2** **General health 3**	52.50 (35.00-70.00) 70.00 (38.75-75.00) 52.50 (42.50-70.00)	4.741	0.093	50.00 (50.00-70.00) 65.00 (45.00-80.00) 70.00 (50.00-80.00)	4.959	0.084

SF-36: Short form-36

aimed to investigate and compare the effectiveness of face-to-face rehabilitation and telerehabilitation on muscle strength, balance, and quality of life in postmenopausal patients with OP. We found significant changes in both the face-to-face exercise group and the telerehabilitation group after treatment compared to pre-treatment, with the changes being more pronounced in the face-to-face exercise group.

Individuals with OP often experience muscle strength reduction and muscle atrophy due to various reasons. Muscle strength is a critical parameter, as its reduction is associated with decreased physical function, loss of balance, and falls (20). Studies have shown that exercise interventions are effective in increasing muscle strength. Gibbs et al. (21) demonstrated that home exercise programs could lead to increased muscle strength in individuals with OP. Similarly, Zhang et al. (20) found that exercise programs resulted in improvements in muscle strength and function. While there are variations in the literature regarding the duration of exercises, it is generally suggested that a minimum of 12 weeks of exercise programs should be implemented for individuals with OP (22). The length of exercise programs poses challenges for patients in accessing facilities, prompting the consideration of telerehabilitation as a viable option. Chen et al. (23) compared the effectiveness of face-to-face rehabilitation and telerehabilitation in stroke patients, implementing interventions for 12 weeks and following up for an additional 12 weeks. The authors reported that telerehabilitation was as effective as face-to-face rehabilitation in terms of functional improvement and muscle strength. Nelson et al. (12) divided 69 patients who had undergone total hip arthroplasty into two groups, providing face-to-face rehabilitation and a technology-based home exercise program using an iPad. Their 6-week follow-up indicated no differences in muscle strength and balance between the two groups. Zou et al. (24) concluded in their meta-analysis that the use of telerehabilitation is beneficial, particularly in reducing pain intensity and improving disability in patients with non-specific neck pain. On the other hand, Xiang et al. (25) reported in their meta-analysis of patients with knee osteoarthritis that telerehabilitation programs may help alleviate pain but do not improve physical function; however, they are beneficial for facilitating the implementation of home-based rehabilitation exercises for patients. In our study, which examined the effectiveness of both face-to-face rehabilitation and telerehabilitation, we found changes in muscle strength and balance before and after treatment in both groups; however, there was no superiority in muscle strength between the groups, whereas the face-to-face exercise group had better outcomes in terms of balance. The necessity for the face-to-face exercise group to leave their homes and attend a facility on specific days of the week may

have contributed to an increase in their physical activity levels, leading to this observed difference. While the face-to-face exercise program was found to be more effective functionally than telerehabilitation, we believe that telerehabilitation could be a useful option for patients with barriers to participating in face-to-face exercise programs, particularly for those who have difficulty in transportation or who are at high risk of fractures, balance loss, and falls.

A decrease in bone density, an increase in fragility, and the possibility of falling and related fractures, especially during physical activity, can lead to kinesiophobia in individuals with OP, particularly those living a sedentary lifestyle (5). Osteoporotic fractures, recognized as the fourth most burdensome chronic disease, can lead to significant economic and social costs, increased disability, and a reduced quality of life (26,27). Research has shown that exercise interventions improve parameters such as muscle strength and balance, helping to prevent falls, reduce kinesiophobia, and enhance quality of life (28). In our study, we observed a reduction in kinesiophobia levels post-treatment; however, this decrease was not statistically significant. Conversely, the anxiety levels in the face-to-face exercise group significantly decreased. Additionally, improvements in certain quality of life parameters were noted in both groups, though neither group showed a clear advantage over the other. The participation of patients in the face-to-face exercise group in group interactions and their direct communication with a physiotherapist may have contributed to a reduction in anxiety levels, resulting in a more substantial improvement in their quality of life compared to the telerehabilitation group. Therefore, we believe that telerehabilitation may be an appropriate method for improving the quality of life of patients who lack access to professional face-to-face exercise programs or who face barriers due to high risks of fractures, balance loss, and falls. Supporting our results, Wicks et al. (29) concluded in their meta-analysis that exercise-based telerehabilitation is not superior to face-to-face rehabilitation for older adults with musculoskeletal and cardiopulmonary conditions, but it is more effective than no intervention.

It is well known that resistance exercises, especially those involving moderate to heavy weights, effectively improve bone density and microarchitecture in OP (30). However, long-term, clinically supervised exercise programs are typically required to realize these benefits (31). Unfortunately, patients with OP and low bone density may struggle to participate in these exercise programs due to the high demands on the healthcare system, time constraints, and transportation challenges (32). Therefore, enabling patients to engage in supervised and safe exercise programs from home is crucial for mitigating OP and its secondary problems (33). A meta-analysis investigating the effectiveness and cost-effectiveness of telerehabilitation in musculoskeletal disorders reported that telerehabilitation should be considered as a cost- and time-efficient option in the rehabilitation process of musculoskeletal conditions, particularly when face-to-face rehabilitation is not optimally feasible (34). In a study involving 50 patients with chronic low back pain (35), participants were randomized into two groups: One group received telerehabilitation while the other followed a home exercise program. After eight weeks, telerehabilitation was found to be more effective than the home program in reducing pain and improving quality of life. In their meta-analysis of 13 articles (36), Cottrell et al. (36) emphasized that telerehabilitation appears to be effective in improving physical function and pain in various musculoskeletal disorders, comparable to traditional healthcare delivery methods. However, the researchers concluded that there is insufficient research to demonstrate whether telerehabilitation is an effective approach. Although there are studies examining the efficacy of telerehabilitation, these are limited, and further research is needed (37,38). Moreover, studies focusing on OP are particularly scarce. Our research, which compares telerehabilitation with face-to-face exercise in individuals with OP, is one of the first in this field, highlighting its strengths.

Study Limitations

Our study had some limitations. The lack of assessment of patient satisfaction and perspectives on telerehabilitation can be considered a limitation. Additionally, not conducting long-term follow-ups to ascertain the enduring effects of exercise programs may also be viewed as a limitation. Therefore, future studies should explore the feasibility of long-term telerehabilitation programs, patient compliance, and the effects during chronic phases.

Conclusion

In postmenopausal patients with OP, both face-to-face rehabilitation and telerehabilitation programs resulted in improvements; however, the enhancements observed in the face-to-face exercise group were greater than those in the telerehabilitation group. These improvements were particularly noted in anxiety and quality of life parameters. We believe that the reasons for this may include the interaction of patients in the face-to-face exercise group with their external environment, the confidence and comfort derived from direct communication with physiotherapists, and the supervised nature of their exercises. The integration of telehealth technologies into rehabilitation can facilitate the delivery of personalized interventions, monitoring, and support in individuals' homes or local communities, regardless of geographic location, socio-economic status, or mental capacity. We propose that telerehabilitation exercise programs be implemented to reduce risks such as falls, kinesiophobia, and fractures in individuals with OP, particularly those with barriers to participating in any face-to-face treatment programs. This could help mitigate the risks of falls and fractures, thereby preventing secondary issues arising from these problems. Since the effectiveness of telerehabilitation in patients diagnosed with OP has not been previously researched, we believe our study will contribute significantly to the existing literature.

Ethics

Ethics Committee Approval: Prior to the commencement of the study, approval was obtained from the Non-Interventional Clinical Research Ethics Committee of İzmir Bakırçay University (decision no: 459, date: December 22, 2021).

Informed Consent: All participants provided written informed consent before the participation in the study.

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Footnotes

Authorship Contributions

Concept: E.U.A., Design: E.U.A., T.A., Data Collection or Processing: E.U.A., T.A., Analysis or Interpretation: E.U.A., S.G.U., Literature Search: E.U.A., S.G.U., Writing: E.U.A., S.G.U.

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Comparison of Early Results of Corticosteroid, Hyaluronic Acid, and Collagen Injection in the Treatment of Patients with Subacromial Impingement Syndrome Accompanied by Acromioclavicular Arthrosis

Akromiyoklavikuler Artrozun Eşlik Ettiği Subakromiyal Sıkışma Sendromlu Hastaların Tedavisinde Kortikosteroid, Hiyalüronik Asit ve Kolajen Enjeksiyonu Uygulamalarının Erken Dönem Sonuçlarının Karşılaştırılması

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Abstract

Objective: Subacromial impingement syndrome (SAIS) is the most common and well-known form of shoulder pain. The aim of this study is to determine the effects of different injection techniques used in the treatment of shoulder SAIS patients on early period of pain, disability, upper extremity performance and kinesiophobia and to compare the advantages of these techniques.

Materials and Methods: Data from 45 patients diagnosed with SAIS and treated with hyaluronic acid, collagen, or corticosteroid injections between January 2024 and June 2025 were analyzed. Patients' shoulder pain, disability, upper extremity performance, and kinesiophobia were assessed right before and one month after injections.

Results: There were no significant differences between the groups in terms of mean age, body mass index, pain time of origin. Based on baseline data, there were no significant differences between the groups for the shoulder pain and disability index (SPADI), SPADI pain, SPADI disability, timed functional arm and shoulder test (TFAST), TFAST hand to head and back, TFAST wall wash, TFAST gallon jug, and Tampa variables. There was a significant difference between the baseline and week 4 scores of the SPADI Total, SPADI pain, and SPADI disability variables ($p<0.05$); however, no statistically significant difference was found between the pre- and post-treatment delta values of these variables. Additionally, there was a significant difference between the pre- and post-treatment delta values of the TFAST total, TFAST wall wash, and TFAST gallon jug variables, except for TFAST hand to head and back ($p<0.05$). However, there was no significant difference between the pre- and post-treatment delta values of the TAMPA variable.

Conclusion: Our study demonstrated that corticosteroid, hyaluronic acid, and collagen applications combined with extremity rest and simple exercises were significantly effective in reducing pain and disability in the early period. It also shows that corticosteroid applications provide more effective results in the recovery of upper extremity functions in the early period compared to hyaluronic acid and collagen.

Keywords: Subacromial impingement syndrome, corticosteroid, hyaluronic acid, collagen

Öz

Amaç: Subakromiyal sıkışma sendromu (SASS), omuz ağrısının birçok farklı nedeni arasında en yaygın ve iyi bilinenidir. Bu çalışmanın amacı, SASS hastalarının tedavisinde kullanılan farklı enjeksiyon tekniklerinin erken dönem ağrı, sakatlık, üst ekstremite performansı ve kinezyofobi üzerindeki etkilerini belirlemek ve bu tekniklerin avantajlarını karşılaştırmaktır.

Gereç ve Yöntem: Ocak 2024 ile Haziran 2025 tarihleri arasında SASS tanısı alan ve tedavide hiyalüronik asit, kolajen veya kortikosteroid enjeksiyonları uygulanan 45 hastanın verileri analiz edildi. Hastaların omuz ağrısı, sakatlığı, üst ekstremite performansı ve kinezyofobisi enjeksiyonlardan hemen önce ve bir ay sonra değerlendirildi.

Bulgular: Gruplar arasında yaş ortalaması, vücut kitle indeksi ve ağrının başlangıç zamanına göre anlamlı fark saptanmadı. Başlangıç verilerine göre omuz ağrısı ve sakatlık endeksi (SPADI), SPADI ağrı, SPADI engellilik, zamanlı fonksiyonel kol ve omuz testi (TFAST), TFAST elden başa

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ve geri, TFAST duvar yıkama TFAST gallon jug ve tampa değişkenleri için gruplar arasında anlamlı bir fark yoktu. SPADI toplam, SPADI ağrı ve SPADI engellilik değişkenlerinin başlangıç ve 4. hafta skorları arasında anlamlı fark vardı (p<0,05); ancak bu değişkenlerin tedavi öncesi ve sonrası delta değerleri arasında istatistiksel olarak anlamlı bir fark bulunamadı. Ayrıca, TFAST toplam, TFAST duvar yıkama ve TFAST gallon jug değişkenlerinin tedavi öncesi ve sonrası delta değerleri arasında, TFAST-elden başa ve geri hariç, anlamlı fark vardı (p<0,05). Ancak, TAMPA değişkeninin tedavi öncesi ve sonrası delta değerleri arasında anlamlı bir fark yoktu.

Sonuç: Çalışmamız ekstremitenin dinlendirilmesi ve basit egzersizlerle kombine edilen kortikosteroid, hiyalüronik asit ve kolajen uygulamalarının erken dönemde ağrı ve dizabilite üzerine anlamlı düzeyde etkili olduğunu ortaya koymuştur. Ayrıca kortikosteroid uygulamalarının erken dönemde üst ekstremite fonksiyonlarının geri kazanımında hiyalüronik asit ve kolajene kıyasla daha etkili sonuçlar verdiğini göstermektedir.

Anahtar kelimeler: Subakromiyal sıkışma sendromu, kortikosteroid, hiyalüronik asit, kolajen

Introduction

The shoulder joint has the widest range of motion in the body and is therefore one of the most vulnerable joints to trauma. The prevalence of shoulder pain in the general population ranges from 7% to 34%, with a lifetime prevalence exceeding 70% (1). This condition can lead to chronic pain and reduced shoulder mobility, leading to reduced performance in daily and occupational activities (2).

Among the various causes of shoulder pain, the most common is subacromial impingement syndrome (SAIS) (3). Neer first described it in 1972 as resulting from compression of the rotator cuff tendons and the long head of the biceps tendon beneath the inferior surfaces of the anterior third of the acromion and of the acromioclavicular joint (4). Medical history and physical examinations are crucial for diagnosing SAIS. Specific tests play a significant role in the diagnosis of this syndrome. Evaluations of the Hawkins, Neer, Jobe, and painful arc tests are highly valuable in the diagnosis of shoulder impingement syndrome (5). Studies indicate that, to support physical examination findings during diagnosis, conventional radiography and ultrasound are appropriate and yield good results in the initial diagnostic evaluation (6). However, shoulder magnetic resonance imaging (MRI) is considered the primary imaging modality for the evaluation of rotator cuff lesions and glenohumeral instability, and is strongly recommended, especially in patients with long-standing findings (7,8).

Pain, disability, and impaired upper extremity function are the primary clinical symptoms of SAIS (9). Recent studies suggest that shoulder pain primarily originates from the shoulder joint and surrounding structures, but other factors also play a role in the development and chronicity of pain and limitations (10,11). Deficiencies in strength, stability, function, and coordination of the shoulder girdle muscles are the primary physical factors contributing to shoulder pain (4,11,12). Identifying the physical and psychological factors contributing to pain is important for early intervention in the rehabilitation process. Kinesiophobia due to pain can emerge early and limit the individual more than the pain itself (11). Kinesiophobia, which is common in musculoskeletal disorders, can cause functional limitations and disability, and delay recovery by reducing participation in rehabilitation and adherence to exercise (12,13).

Conservative treatment is the preferred initial approach for SAIS. Treatment approaches include rest, activity modification, non-steroidal anti-inflammatory drugs, physical therapy modalities, therapeutic exercises, corticosteroid injections into the subacromial space, and suprascapular nerve blocks (14). Surgery may be considered in patients with severe, persistent subacromial shoulder pain and functional impairments that do not improve despite conservative treatment or in the presence of a concomitant full-thickness rotator cuff tear (15).

Purpose of Study

The aim of this study was to determine the effects of different injection techniques used in the treatment of patients with shoulder SAIS on early pain, disability, upper extremity performance, and kinesiophobia, and to compare the advantages of these techniques.

Materials and Methods

Ethical approval for the study was obtained from the Bakircay University Ethics Committee (08.10.2025/decision no: 2516/study no: 2504). Patients admitted to the Orthopedics and Traumatology Outpatient Clinic of Bakircay University Faculty of Medicine Hospital between January 2024, and June 2025 were included in this study.

Patients and their demographic data [age, gender, body mass index (kg/m^2), and pain onset time] were identified through the hospital information management system and recorded in patient files. Data was collected from patients who underwent examinations and tests, who were diagnosed with SAIS, and who received treatment with hyaluronic acid, collagen, or corticosteroid injections. These injections were administered to patients with similar complaints, examination findings, and radiological imaging results, without considering other criteria. A total of 96 patients were evaluated. Of these, 51 did not meet the inclusion and exclusion criteria, and the remaining 45 were included in the study. Patients receiving hyaluronic acid were designated Group 1, those receiving corticosteroids were Group 2, and those receiving collagen were Group 3, with 15 patients in each group.

Patients aged between 40 and 70 years who had complaints of shoulder pain and loss of function lasting more than 3 months, who underwent MRI as a diagnostic method, in whom MRI evaluation detected degeneration-arthrosis in the acromioclavicular joint, who were diagnosed with SASS supported by examination findings, and who had not been treated in the last 6 months were included in the study.

Exclusion criteria included serious pathologies, such as a non-partial tendon tear or a dislocation of the shoulder joint; receipt of shoulder injection therapy within the last year; a history of shoulder surgery; serious health problems, such as bleeding disorders or systemic connective tissue disease; severe visual or vestibular disorders; uncontrolled hypertension; pregnancy or breastfeeding; disabilities that could interfere with communication; professional athletes; other shoulder pathologies accompanying SAIS; and limited range of motion. Patients who met these criteria were excluded from the study.

No criteria were used to select the agent for patients receiving injections; each patient made the choice after being informed in detail about the available agents. All injections were administered by a single orthopedic surgeon under aseptic conditions, using the standard subacromial injection technique, without local anesthesia. Review of the applied treatment protocol showed that the materials administered to the patients as injections included 20 mg hyaluronic acid in 2 mL solution, 5 cc/2 mg type 2 collagen, or 20 mg triamcinolone hexacetonide. Additionally, patients were allowed to perform simple pendulum exercises twice a day after the injection, with the affected extremity protected from particularly strenuous activities (such as lifting, overhead activities, pushing, and pulling) for approximately 3 weeks.

The collected data was used to review the patients' pre- and post-treatment assessment results for shoulder pain, disability, upper extremity function, and kinesiophobia. The assessment results were recorded before injections and at 4 weeks post-treatment.

Shoulder pain and disability were assessed using the shoulder pain and disability index (SPADI). The SPADI comprises two subscales: The first assesses pain intensity and comprises five items, and the second assesses functional limitations in activities of daily living and comprises eight items. Higher scores indicate increased pain intensity and functional disability (17). The Turkish validation, reliability assessment, and cultural adaptation of the index were conducted by Bumin et al. (18). Patients were asked to score each item on a 10-cm visual analog scale. The total score for each subscale was divided by the highest possible score and multiplied by 100. The overall score was obtained by dividing the sum of all item scores by 130 and multiplying by 100 (17).

Upper extremity performance was assessed with the timed functional arm and shoulder test (TFAST). This test consists of three parts: (1) the hand to head and back test, (2) the wall wash test, and (3) the gallon jug test. In the hand to head and back test, patients were asked to touch their head with any part of their hand and then touch their back with the back of their hand; the number of repetitions completed in 30 seconds was recorded. In the wall wash test, patients were asked to follow four dots marked in a circular pattern on the wall while maintaining constant contact with the wall. The test was performed in both clockwise and counterclockwise directions, and the number of circles completed in each direction within 60 seconds was recorded. In the gallon jug test, participants were asked to lift and lower a 3.78 kg weight to a height of 50.8 cm. The number of repetitions completed in 30 seconds was recorded. All scores for the patients' affected extremities were calculated using the formula "hand to head and back test + (wall wash/4) + gallon jug lift" (19).

Kinesiophobia was assessed using the Tampa kinesiophobia scale. The scale consists of 17 items; each scored on a 4-point Likert-type scale. The total score ranges from 17 to 68, with higher scores indicating greater kinesiophobia (fear of movement) (20). The scale's validity and reliability in Turkish were assessed by Tunca Yılmaz et al. (21).

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics 20 (IBM Corp., Armonk, NY, USA). Normality of data distribution was assessed using the Shapiro-Wilk test, histograms, and Q-Q plots. Parametric tests were used for data analysis because all variables were normally distributed. Differences in values and in pre- and post-treatment change scores among the three treatment groups were analyzed using a One-Way ANOVA. When a significant overall group effect was detected, the Bonferroni post-hoc test was applied to determine the source of the difference. Within-group comparisons before and after treatment were made using the paired t-test. Statistical significance was accepted at $p<0.05$. Results are presented as mean ± standard deviation.

Results

There were no significant differences in mean age, body mass index, or pain onset time between the groups (Table 1). The gender distributions were as follows: Group I (13 females/2 males), Group II (8 females/7 males), and Group III (11 females/4 males).

At baseline, there were no significant differences between the groups in the following variables: SPADI, SPADI pain, SPADI

Table 1. Demographic data of patients

Groups	Age (year)	Body mass index (kg/m²)	Pain onset time (month)
Group I	54.9±10.4	30.6±11.6	19.7±13.1
Group II	57.3±10.5	28.9±3.8	14.6±15.3
Group III	59.5±9.2	27.2±4.0	18.0±29.8
p-values	0.473	0.472	0.806

Group I: Hyaluronic acid injection, Group II: Corticosteroid injection, Group III: Collagen injection, One-Way ANOVA

disability, TFAST, TFAST hand to head and back, TFAST wall wash, TFAST gallon jug, and TAMPA (Table 2). There were significant differences between the baseline and week 4 scores for SPADI total, SPADI pain, and SPADI disability ($p<0.05$); however, no statistically significant differences were found between the pre- and post-treatment delta values of these variables. Additionally, there was a significant difference between the pre- and post-treatment delta values of the variables TFAST total, TFAST wall wash, and TFAST gallon jug, except for TFAST hand to head and TFAST back ($p<0.05$). However, there was no significant difference between the pre- and post-treatment delta values for the variable TAMPA (Table 2).

Our results demonstrate that all three groups of agents used in the SPADI assessment produced significant improvements in patients. However, no statistically significant superiority of any of the three agents was found over the others in this area.

A statistical analysis of the TFAST results reveals that corticosteroids (Group 2 agents) are superior to hyaluronic acid and collagen (agents in Groups 1 and 3) in the TFAST total values. The effect and superiority of corticosteroid applications were statistically evident in all "hand-to-hand and back", "wall wash", and "gallon jug" evaluations used in the TFAST evaluation. No superiority between hyaluronic acid and collagen, which are Group 1 and 3 agents, has been determined. A review of the kinesiophobia and Tampa kinesiophobia scale values revealed no significant difference between the three groups.

Table 2. Intergroup comparisons of pain, disability, upper extremity functions, and kinesiophobia

Measurements	Group	Baseline (X ± SD)	4th week (X ± SD)	Delta (Δ) (X ± SD)	p-values (within group)	p-values (post-hoc)
SPADI total	I	73.6±20.3	49.2±29.9	-24.5±24.9	**0.002***	1.000, I vs. II
	II	68.6±18.7	48.1±22.7	-20.5±24.2	**0.006***	1.000, I vs. III
	III	70.7±20.3	50.8±23.3	-19.9±20.3	**0.002***	1.000, II vs. III
p-values		0.784	0.958	0.843		
SPADI pain	I	78.8±17.7	56.7±30.5	-22.1±27.1	**0.007***	1.000, I vs. II
	II	74.3±16.0	55.3±24.7	-19.1±20.9	**0.003***	1.000, I vs. III
	III	77.3±15.8	58.7±24.3	-18.7±19.0	**0.002***	1.000, II vs. III
p-values		0.754	0.940	0.900		
SPADI disability	I	70.4±22.8	44.5±31.6	-25.9±25.8	**0.002***	1.000, I vs. II
	II	64.9±19.7	44.6±22.2	-20.3±23.6	**0.005***	1.000, I vs. III
	III	66.0±24.95	45.9±23.6	-20.7±22.6	**0.003***	1.000, II vs. III
p-values		0.788	0.986	0.774		
TFAST total	I	22.2±6.1	24.3±6.7	2.1±5.7	0.104	**0.007, I vs. II***
	II	18.8±8,1	28.2±10.0	9.4±7.4	**<0.001***	1.000, I vs. III
	III	20.0±6.2	23.5±8.3	3.6±5.1	**0.002***	**0.040, II vs. III***
p-values		0.398	0.281	**0.006***		
TFAST hand to head and back	I	15.2±3.2	15.1±4.7	1.3±3.5	0.162	0.196, I vs. II
	II	12.7±4.3	15.4±5.1	3.9±3.9	**0.002***	1.000, I vs. III
	III	15.0±6.3	15.2±4.1	1.7±3.7	0.094	0.353, II vs. III
p-values		0.268	0.632	0.139		
TFAST wall wash	I	15.5±5.9	20.9±5.0	2.4±5.5	0.116	**0.014, I vs, II***
	II	14.5±6.3	25.7±9.5	8.1±6.6	**<0.001***	1.000, I vs, III
	III	15.3±4.4	21.8±5.2	3.4±2.7	**<0.001***	0.055, II vs, III
p-values		0.928	0.125	**0.011***		
TFAST gallon jug	I	6.4±2.9	6.6±3.6	0.2±2.4	0.748	**0.007, I vs. II***
	II	5.5±3.0	8.9±3.3	3.47±3.4	**0.001***	1.000, I vs. III
	III	5.7±3.4	6.7±4.0	1.0±3.1	0.136	0.058, II vs. III
p-values		0.701	0.158	**0.007***		
TAMPA	I	44.2±6.1	46.0±7.7	1.8±5.6	0.234	1.000, I vs. II
	II	40.3±7.4	40.8±7.9	0.5±6.5	0.755	0.260, I vs. III
	III	45.1±7.0	42.5±7.0	-2.6±8.25	0.243	0.656, II vs. III
p-values		0.139	0.169	0.208		

Group I: Hyaluronic acid injection, Group II: Corticosteroid injection, Group III: Collagen injection, SPADI: Shoulder pain and disability index, TFAST, Timed functional arm and shoulder test, TAMPA: Tampa scale of kinesiophobia, One-Way ANOVA, *: $p<0.05$, SD: Standard deviation

Discussion

The results of this study indicate that hyaluronic acid, corticosteroid, and collagen treatments significantly reduced pain and disability in all patients at 4 weeks after the injection. However, no statistically significant difference in effects on pain and disability was found among these three agents. Additionally, corticosteroid and collagen treatments improved upper-extremity performance 4 weeks after injection, while hyaluronic acid treatment did not affect upper-extremity performance. Corticosteroid treatment was superior to collagen and hyaluronic acid treatments for improving upper-extremity performance in the acute phase. However, hyaluronic acid, corticosteroid, and collagen treatments were not effective in reducing kinesiophobia 4 weeks after injection.

SAIS is in recurrent condition; therefore, patients often receive several treatments in combination. Although studies have shown that each treatment is effective in improving short-term pain and function, the optimal treatment choice for SAIS remains uncertain, and no standard treatment approach exists. Studies demonstrating the effectiveness of treatments applied alone or in combination are limited (22). Treatment of SAIS is primarily conservative, and successful results are generally achieved with this approach (23). Our study yielded results generally consistent with the literature; all three agents applied were significantly effective in reducing pain and disability, with improvements observed in patients in all three groups.

SAIS treatment aims to reduce pain and improve function, and includes the two most preferred conservative treatments, exercise and corticosteroid injection, in addition to patient education, oral analgesia, and cold application (24). Our results show the effectiveness of corticosteroid applications for upper-extremity function in the early period. Corticosteroid applications resulted in significantly better upper-extremity function than hyaluronic acid and collagen applications. In the upper extremity performance test group, corticosteroid applications demonstrated a positive effect and superiority over hyaluronic acid applications in the "wall wash" and "gallon jug" tests.

Corticosteroid injections are widely used to reduce the pain and inflammation associated with SAIS. Studies have shown that corticosteroid injections and physiotherapy have similar effectiveness for both SAIS and other shoulder problems. Numerous steroid preparations are available in clinical practice, and there is no clear evidence regarding which steroid should be used. Corticosteroid injections are widely used to rapidly reduce pain and control inflammation in SAIS. Pain relief and functional improvement are generally seen within the first few weeks of treatment. Although studies show that this treatment method is effective in the short term, some negative effects may occur in the long term (25). Despite their widespread use, local corticosteroid injections are not without potential side effects. Tendon weakness and tearing, skin and subcutaneous atrophy, systemic absorption, infection, and bursal deterioration are some of the long-term risks of corticosteroid therapy (26). Our results, consistent with the literature, demonstrate that early corticosteroid administration is effective in reducing pain and disability, and in restoring upper extremity function. Because the present study was not long-term, the adverse effects of corticosteroid administration reported in the literature were not observed.

Most studies examining the effects of hyaluronic acid on various joints, such as the hip, ankle, shoulder, and knee, have shown this treatment to be safe and effective. Hyaluronic acid provides cartilage stability and slows proteolysis and joint degeneration. Histological evidence suggests that sodium hyaluronate may prevent cartilage degradation and promote regeneration (27). In addition, it has been reported to reduce inflammation and protect against cartilage erosion. It has also been shown to exert direct and indirect analgesic and anti-inflammatory effects at the joint level. Literature on the effectiveness of intra-articular viscosupplementation has primarily focused on the knee, with limited studies on other joints. Strong evidence indicates that viscosupplementation is beneficial for treating knee pain due to osteoarthritis in patients who have failed conservative treatment (28). Hyaluronic acid may reduce pain in SAIS by supporting the cartilage structures in the shoulder joint and increasing synovial fluid. SAIS is often associated with rotator cuff tendinitis and subacromial bursitis. Hyaluronic acid injections can be used to relieve pain and promote healing in the treatment of these conditions (29). Hyaluronic acid injections have become an increasingly popular option for the treatment of SAIS (30). Literature demonstrates the effects of hyaluronic acid in reducing pain and supporting functional recovery. Studies emphasize that hyaluronic acid may be particularly effective in subacromial bursitis and rotator cuff tendinitis, but treatment responses may vary among individuals (31). In our study, consistent with the literature, we observed statistically significant early clinical improvements—particularly in pain and disability—after application of hyaluronic acid.

Collagen applications are attracting attention as an option to support tendon healing in conditions such as SAIS. The literature demonstrates that collagen injections and oral collagen supplements improve tendon health, reduce pain, and accelerate tissue repair. However, studies in this area have generally focused on tendonitis, tendon tears, and joint disorders, whereas research on SAIS is limited (31). Over the past decade, the literature has highlighted the role of hydrolyzed collagen as a therapeutic option in cases of osteoarthritis and other musculoskeletal disorders, including rotator cuff tendinopathy (32). Collagen, taken orally or administered by intra-articular injection, has been found to improve muscle performance in patients with knee osteoarthritis and rotator cuff pathologies, and to be effective in preventing soft tissue injuries in athletes (33). In our study, consistent with literature, collagen application produced statistically significant clinical improvement in the early period, particularly in pain and disability.

When the early treatment results of studies comparing local applications of hyaluronic acid and corticosteroids in

the treatment of SAIS are reviewed, corticosteroids appear more effective than hyaluronic acid, but this difference is not significant in the long term (34,35). In our study, corticosteroid application provided an early-term advantage in upper-extremity function compared with hyaluronic acid in the treatment of SAIS. Our study is like those reported in the literature when early results are considered.

When the studies by Shibata et al. (36), Sadeghifar et al. (37), and Kim et al. (30), which compared subacromial corticosteroid and hyaluronic acid injections with each other and with physiotherapy in patients with SAIS, were examined, our study showed generally similar results in terms of pain and disability, but corticosteroids produced better recovery of extremity function.

Agnieszka's study, which compared physiotherapy and rehabilitation with corticosteroid and collagen applications, reported that collagen applications may be an alternative treatment for SAIS in elderly patients with multimorbidity (38). Our study also presents collagen as an alternative to corticosteroids for early recovery from pain and disability.

Painful shoulder problems that limit shoulder function affect approximately one in three adults. The majority of patients report pain radiating to the shoulder and arm, particularly during overhead movements. Furthermore, pain can trigger fear-avoidance of movement, and this fear is known to limit the individual's functioning far more than the pain itself. The resulting fear of movement, known as kinesiophobia, can lead to limitations in daily life. This can lead to problems, such as limited joint movement, loss of strength, decreased function and performance, and poor posture (11). The treatment methods we applied in our study were not effective in reducing kinesiophobia in patients. Although the agents used have a therapeutic effect on pain, disability, and extremity function, this situation shows that there is no change in the fear of movement that the patients face in their daily lives.

In previous studies on SAIS treatment, two agents are generally compared in local injection applications. In our study, we compared the effects of local injections of three agents (corticosteroid, hyaluronic acid, and collagen) used in the treatment of SAIS on pain, shoulder function, clinical recovery, and, therefore, quality of life, unlike previous studies. We believe that the principal advantage of our study in this regard is that it evaluated three different agents.

Study Limitations

More statistically robust data can be obtained with a larger patient sample.

Our study is retrospective; prospective studies are needed.

The study reports early results of injection therapy in patients with SAIS. Studies with long-term, periodic follow-up are possible.

In our study, injection therapy was standardized by resting the extremity in a simple sling, avoiding strenuous activities, and performing simple home exercises. Different treatment strategies can be developed by combining injection therapies for SAIS with physiotherapy and other rehabilitation methods.

Conclusion

Our study demonstrated that applications of corticosteroid, hyaluronic acid, and collagen, combined with extremity rest and simple exercises, were effective in significantly reducing pain and disability in the early stages. Furthermore, corticosteroid application was more effective than hyaluronic acid and collagen in restoring upper-extremity function during the early stages. However, hyaluronic acid injections, corticosteroid injections, and collagen injections had no effect on kinesiophobia in the acute stage.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the Bakircay University Ethics Committee (08.10.2025/decision no: 2516/study no: 2504). Patients admitted to the Orthopedics and Traumatology Outpatient Clinic of Bakircay University Faculty of Medicine Hospital between January 2024 and June 2025 were included in this study.

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: C.K., Concept: C.K., K.O., T.S.K., Design: K.O., T.S.K., U.E., Data Collection or Processing: T.S.K., U.E., Analysis or Interpretation: C.K., U.E., Literature Search: C.K., K.O., T.S.K., Writing: C.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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An Important Cause of Hip Pain in a Patient with Rheumatoid Arthritis: Femoral Fragility Fracture

Romatoid Artritli Hastada Kalça Ağrısının Önemli Bir Sebebi: Femur Frajilite Kırığı

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Abstract

Rheumatoid arthritis (RA) is the most common chronic systemic inflammatory disease. In RA, systemic inflammation, autoantibodies, glucocorticoid use, and physical inactivity can lead to the development of osteoporosis. The prevalence of osteoporosis in RA is approximately twice that of the healthy population. The most significant clinical outcome of osteoporosis is fragility fractures. Fragility fractures in patients with RA impair quality of life and functional status and may result in increased mortality. This patient population should be assessed in terms of bone mineral density and fracture risk, and appropriate treatments should be planned when necessary to prevent fragility fractures. If a fragility fracture occurs, diagnosis and treatment should not be delayed. In this case report, we discuss a patient with RA who was diagnosed with a femoral fragility fracture. The aim is to raise awareness of osteoporosis and fragility fractures in RA.

Keywords: Rheumatoid arthritis, osteoporosis, fracture

Öz

Romatoid artrit (RA); en sık görülen, kronik, sistemik, enflamatuvar hastalıktır. RA'da sistemik enflamasyon, otoantikorlar, glukokortikoid kullanımı, fiziksel inaktivite nedeniyle osteoporoz gelişebilir. RA'da osteoporoz prevalansı sağlıklı popülasyonun yaklaşık iki katıdır. Osteoporozun en önemli klinik sonucu frajilite kırığıdır. RA'lı hastalarda frajilite kırığı; yaşam kalitesini, fonksiyonel durumu kötüleştirir, mortaliteye sebep olabilir. Bu hasta grubu, kemik mineral yoğunluğu ve kırık riski açısından değerlendirilmeli, frajilite kırığını önlemek için gerekli durumlarda uygun tedaviler planlanmalıdır. Frajilite kırığı oluştu ise tanı ve tedavisinde geç kalınmamalıdır. Bu olgu sunumunda femurda frajilite kırığı tespit ettiğimiz RA'lı bir hasta tartışılmıştır. RA'da osteoporoz ve frajilite kırığı konusunda farkındalığın artırılması amaçlanmıştır.

Anahtar kelimeler: Romatoid artrit, osteoporoz, fraktür

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease characterized by arthritis of peripheral joints. One of the most significant complications of RA is bone loss resulting from increased bone resorption and decreased bone formation. Bone loss may lead to periarticular osteopenia, joint erosions, and osteoporosis (1).

Osteoporosis is a common systemic disease characterized by low bone mass and microarchitectural deterioration of bone tissue (2). The prevalence of osteoporosis in RA is approximately twice that of the healthy population. Despite this, osteoporosis is often underdiagnosed and inadequately treated in the RA population (3).

The most significant clinical consequence of osteoporosis is fragility fractures (2). Defined as fractures occurring spontaneously or due to minimal trauma, fragility fractures in RA negatively impact quality of life and functional status and may lead to mortality (1).

In this paper, we aim to present a case of RA in which a fragility fracture of the femur was identified and discuss the effects of RA on bone metabolism, as well as the diagnosis and treatment methods for osteoporosis.

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Case Report

A 51-year-old male patient presented to our outpatient clinic with complaints of right hip pain. He reported difficulty walking due to the pain. The pain had started approximately one month earlier and worsened with movement but decreased slightly with rest. There was no nocturnal pain. There was no recent history of trauma. The patient had been under follow-up for RA for about ten years and was taking methotrexate 15 mg/week and prednisolone 5 mg/week. On physical examination, range of motion (ROM) of the right hip joint was complete, although pain was noted particularly with external rotation and abduction. Flexion abduction external rotation and flexion, adduction, and internal rotation tests were positive on the right. Lumbar ROM was normal. Femoral stretch, sacroiliac joint stress, and sciatic stretch tests were negative. Neurological examination was normal. Biochemical tests revealed the following: leukocyte count: 17.83 (n=4-10×10^9/L), erythrocyte sedimentation rate: 71 (n=0-20 mm/h), C-reactive protein: 53.29 (n=0-5 mg/L), rheumatoid factor (RF): 217.9 (n=0-20 mmol/L), calcium (Ca): 8.8 (n=8.8-10.6 mg/dL), phosphorus: 3.36 (n=2.3-4.7 mg/dL), 25-hydroxyvitamin D_3 [25-(OH)D_3]: 33.1 (n=30-100 ng/mL), parathyroid hormone (PTH): 70 (n=12-72 pg/mL), alkaline phosphatase: 68 (n=30-120 u/L), thyroid-stimulating hormone: 0.38 (n=0.35-4.2 mIU/L), glomerular filtration rate: 97, creatinine: 0.9. Disease activity was assessed using the disease activity score-28 (DAS-28): 4.8.

Anteroposterior pelvic and lumbosacral two-view X-rays revealed no pathology (Figure 1a). Magnetic resonance imaging of the right hip revealed hypointense signals on T1-weighted images and hyperintense signals on T2-weighted images in a 3 cm area at the femoral head-neck junction, consistent with edematous changes. A linear hypointense line on T2-weighted images was observed, suggestive of a microfracture (Figures 1b and 1c). Given these findings, the patient was evaluated for fragility fracture, and bone mineral density was measured by dual-energy X-ray absorptiometry. T-score values were: L1-L4: -1.8, femoral neck: -2.0. Fracture risk assessment tool (FRAX) score revealed a 10-year major osteoporotic fracture risk of 5.9% and a hip fracture risk of 0.5%. Due to the history of steroid use, the patient was started on alendronate 70 mg once weekly and a Ca-vitamin D_3 supplement (1200 mg Ca/day and 880 IU vitamin D_3/day). In addition, 2 g of sulfasalazine in divided daily doses was added to the RA treatment to suppress disease activity in the patient with high acute phase reactants and high disease activity. The patient was referred to the orthopedic and traumatology department, where surgery was not recommended. Consequently, the patient was advised to use a cane for 3 weeks, to perform partial weight-bearing on the affected extremity, and to do isometric strengthening exercises for the hip muscles. For pain control, diclofenac sodium 150 mg/day was prescribed. At the 3-week follow-up, the patient reported a pain score of 1 on the visual analogue scale. A home exercise program was provided including balance and coordination training, strengthening exercises for bilateral lower extremities, and gait training.

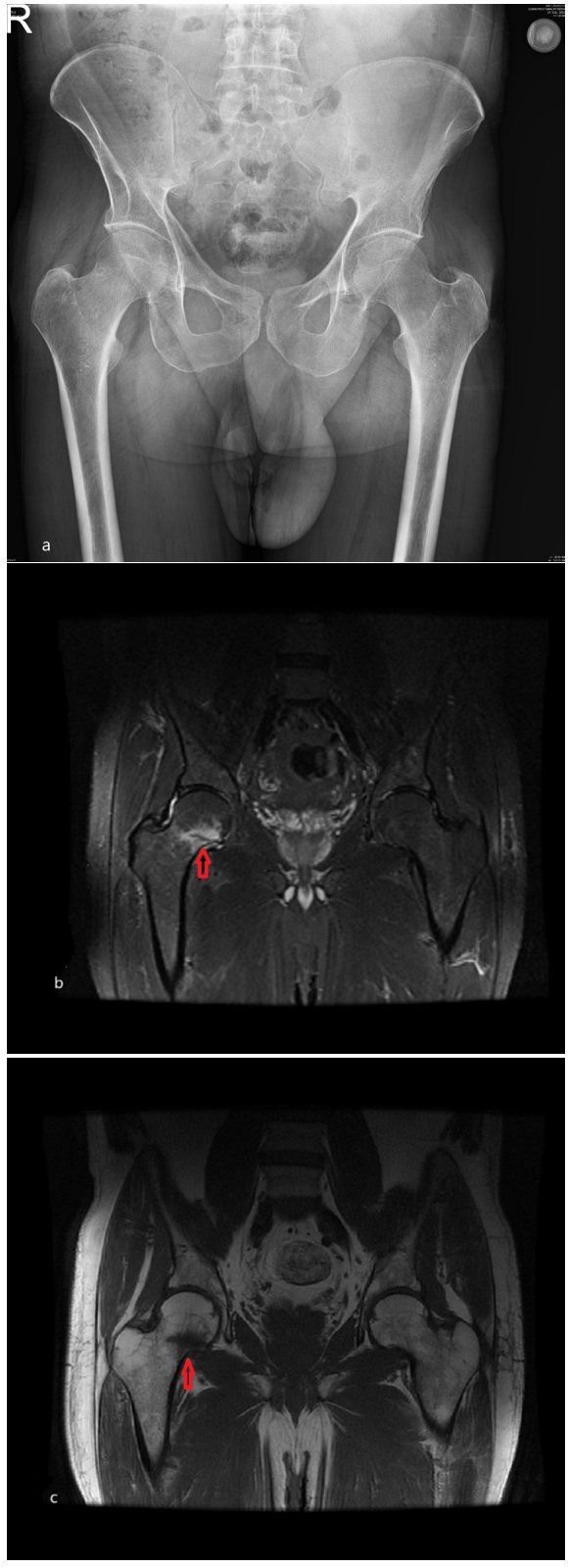

Figure 1. a) No pathology detected in the anteroposterior pelvic radiograph, **b)** T2-weighted MRI showing hyperintense signal alteration at the femoral head-neck junction with a linear hypointense line suggestive of microfracture, **c)** T1-weighted MRI demonstrating hypointense signal changes in the same region

MRI: Magnetic resonance imaging

Discussion

RA is the prototype of osteoimmunological diseases characterized by bone loss. RA and osteoporosis share common risk factors such as female sex. Traditional osteoporosis risk factors like advanced age, low body mass index, menopause, diabetes, and thyroid disease are also relevant in RA patients. In addition, RA-specific risk factors include systemic inflammation associated with disease activity, autoantibodies, glucocorticoid use, disease duration, altered body composition, and physical inactivity (2).

Inflammatory cytokines that play a central role in RA pathogenesis also influence the development of osteoporosis in the general population (4). Cytokines such as interleukin (IL)-1, IL-6, and tumor necrosis factor-α stimulate osteoclasts directly and inhibit osteoblast function, promoting bone resorption (5). Moreover, inflammation leads to loss of muscle mass and function, which reduces mechanical loading on bones, further diminishing bone mass and increasing fragility and fall risk (4).

Glucocorticoids, widely used in RA treatment, increase bone resorption, reduce bone formation, and alter bone quality through osteocyte apoptosis, resulting in decreased bone mineral density. They also contribute to muscle mass and function loss, thereby promoting bone loss, falls, and fractures (4). Inflammation and glucocorticoids may suppress gonadotropin-releasing hormone, leading to reduced sex hormone production and subsequent hypogonadism. However, glucocorticoids may also reduce inflammation, joint pain, and stiffness in RA, which may mitigate some of their harmful effects on bone mineral density. The optimal glucocorticoid dose that balances effective RA management and minimal harm to bone density remains unclear (3).

Given that high-dose methotrexate is known to cause bone loss in oncology patients, its impact on bone mineral density (BMD) has become a topic of interest in the treatment of RA, where it is frequently used. In a study conducted by Rexhepi et al. (6) in premenopausal RA patients, no negative effect of methotrexate on BMD was found.

Osteoporosis and fractures in patients with RA are more common in individuals with disease duration exceeding 10 years, RF positivity, high titer anti-citrullinated protein antibodies, high disease activity, and cumulative structural damage (2). Tong et al. (7) also found that osteoporosis and vertebral fractures in RA patients were associated with long disease duration and high disease severity. In our case, high acute phase reactants and a high DAS-28 score indicate that inflammation has not been sufficiently suppressed. Given the known effects of disease activity and inflammation on osteoporosis and fractures, the patient's RA treatment has been reviewed. The patient was informed about his current condition and conventional synthetic disease-modifying antirheumatic drugs combination therapy was deemed appropriate. 2 g of sulfasalazine was added to the current treatment to suppress disease activity. After suppressing disease activity, prednisolone was planned to be discontinued.

The 2022 guideline of the National Osteoporosis Foundation recommends BMD screening for all RA patients over the age of 50 (8). Similarly, the 2022 guideline of the American College of Rheumatology on glucocorticoid-induced osteoporosis recommends BMD screening for all patients aged 40 years and older who have been taking ≥2.5 mg/day of prednisone (or its equivalent) for 3 months or longer (9).

To assess fracture risk, the use of the FRAX tool is recommended. However, FRAX does not take into account RA-specific factors such as disease severity, duration, or autoantibody positivity. Thus, it may not accurately predict fracture risk in this patient population (4). RA patients may experience fractures even at higher BMD levels compared to individuals without RA (2). A meta-analysis identified vertebrae, hips, forearms, and proximal humerus as the most common sites of fragility fractures in RA patients (10). Recently, an increased incidence of hip fractures in this population has been reported (4). In our case as well, a microfracture was identified in the femoral neck region.

There is currently no specific guideline for the prevention and treatment of osteoporosis in RA. Existing guidelines recommend initiating pharmacological treatment in postmenopausal women and men over 50 years of age with RA if the T-score is ≤-2.5, or if the T-score is between -1.0 and -2.5 and the FRAX score indicates a ≥20% risk for major osteoporotic fracture or ≥3% risk for hip fracture (8,9). The American College of Rheumatology's 2022 guideline on glucocorticoid-induced osteoporosis stratifies patients into risk categories. Patients with a history of osteoporotic fracture, as in our case, are categorized as very high risk. For patients over 40 years of age in this category, oral bisphosphonate therapy is strongly recommended over no treatment; PTH or PTH-related protein therapy is conditionally recommended over antiresorptives; and denosumab, intravenous bisphosphonates, raloxifene, and romosozumab are conditionally recommended over no treatment (9).

Osteoporosis is the most significant etiological factor in femoral neck fractures. These fractures are most often managed surgically, with options including internal fixation or arthroplasty. The choice of surgical approach depends on factors such as the patient's age, general health, pre-fracture mobility level, degree of fracture displacement, and time elapsed since the fracture. In non-displaced fractures, conservative treatment may be considered (11). In our case, conservative management was recommended due to the presence of a microfracture.

Conclusion

One of the most significant complications of RA is the development of osteoporosis. Fragility fractures, which may result from osteoporosis, are important causes of morbidity and mortality in these patients. Therefore, RA patients should be evaluated for osteoporosis and treated appropriately when necessary. In patients presenting with pain complaints, the possibility of fragility fracture should be considered. Early

diagnosis and appropriate treatment of such fractures can help improve quality of life and prevent disability.

Ethics

Informed Consent: A written informed consent was obtained from the patient.

Footnotes

Financial Disclosure: The author declared that this study received no financial support.

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Lumbar Transverse Process Pseudoarticulation: Congenital Versus Post-traumatic – A Case Report

Lomber Transvers Çıkıntı Psödoartikülasyonu: Konjenital mi Travmatik mi? – Olgu Sunumu

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Abstract

Bone bridging between lumbar transverse processes is a rare anatomical variant, most often post-traumatic but occasionally congenital. Although frequently asymptomatic, it may present with low back pain, scoliosis, or neurological deficits, and can complicate radiological interpretation. Differentiation between congenital and post-traumatic forms relies on detailed imaging assessment and clinical history. We report the case of a 76-year-old male presenting with acute low back pain, right lower limb weakness, and foot drop due to lumbar disc extrusion. Imaging incidentally revealed a pseudoarticulation between the right L3 and L4 transverse processes. Morphology and history supported a post-traumatic origin prior to skeletal maturity. The patient underwent decompression and fusion surgery, followed by a structured rehabilitation protocol including gait training, balance exercises, progressive resistance training, and targeted muscle strengthening, resulting in marked improvement in neurological function and overall functional capacity. This case highlights the importance of recognizing transverse process pseudoarticulation as a rare but clinically relevant finding that may influence diagnostic evaluation and surgical planning in lumbar spine pathology.

Keywords: Low back pain, lumbar vertebrae, pseudarthrosis, spinal fusion, ankylosis

Öz

Lomber transvers çıkıntılar arasındaki kemik köprüleşme, çoğunlukla post-travmatik ancak nadiren konjenital olabilen nadir bir anatomik varyanttır. Çoğu zaman asemptomatik olmakla birlikte, bel ağrısı, skolyoz veya nörolojik defisit ile ortaya çıkabilir ve radyolojik yorumlamayı zorlaştırabilir. Konjenital ve post-travmatik formların ayırıcı tanısı, ayrıntılı görüntüleme değerlendirmesi ve klinik öyküye dayanır. Bu yazıda, lomber disk ekstrüzyonuna bağlı akut bel ağrısı, sağ alt ekstremitede güçsüzlük ve düşük ayak ile başvuran 76 yaşında bir erkek olgu sunulmaktadır. Görüntülemede, sağ L3 ve L4 transvers çıkıntıları arasında tesadüfen saptanan psödoartikülasyon mevcuttu. Morfoloji ve öykü, iskelet matürasyonu öncesinde gelişmiş post-travmatik bir kökeni destekledi. Hastaya dekompresyon ve füzyon cerrahisi uygulandı; ardından uygulanan, yürüme eğitimi, denge çalışmaları, progresif dirençli egzersizler ve hedefe yönelik kas güçlendirme uygulamalarını içeren yapılandırılmış rehabilitasyon protokolü ile nörolojik fonksiyonlarda ve genel fonksiyonel kapasitede belirgin iyileşme elde edildi. Bu olgu, transvers çıkıntı psödoartikülasyonunun nadir ancak klinik açıdan önemli bir bulgu olduğunu ve lomber omurga patolojilerinde tanısal değerlendirme ile cerrahi planlamayı etkileyebileceğini vurgulamaktadır.

Anahtar kelimeler: Bel ağrısı, lomber omurlar, psödoartroz, spinal füzyon, ankiloz

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Introduction

Osseous bridging between lumbar transverse processes is an extremely rare anatomical variant, with only a limited number of cases reported in the literature. It is typically asymptomatic but may occasionally present with low back pain, scoliosis, or neurological deficits (1,2). While congenital forms have been described, the majority are post-traumatic, often related to repetitive or direct mechanical stress.

Following trauma, heterotopic ossification within the intertransverse soft tissues may lead to either pseudoarticulation or true bony fusion (3). Differentiation between congenital and post-traumatic origins relies on radiological characteristics—such as bridge morphology, symmetry, and cortical continuity—criteria previously described as key diagnostic features in the literature (3) and should be integrated with a detailed clinical history.

Recognition of this entity is important not only because of its rarity but also due to its potential to be misinterpreted during lumbar imaging, particularly in patients with back pain or structural anomalies. Here, we present a case of lumbar disc herniation with foot drop, in which intertransverse pseudoarticulation was incidentally detected. The morphological characteristics and clinical implications are discussed with reference to current literature.

Previous reports have predominantly focused on isolated case descriptions, often lacking detailed analysis of clinical relevance. Although the incidence is low, recognition of transverse process pseudoarticulation has increased with advances in imaging modalities, particularly computed tomography (CT). Case reports have indicated that in patients with unexplained back pain or atypical scoliosis, such anatomical variants may serve as diagnostic clues or, conversely, as confounding factors in clinical interpretation (4-7). This underscores the importance of heightened awareness among clinicians and radiologists, especially when evaluating older adults or individuals with a history of mechanical loading, such as occupational lifting.

Therefore, this case aims to contribute to the understanding and diagnostic differentiation of intertransverse osseous bridging, with particular emphasis on distinguishing between congenital and post-traumatic etiologies, and to highlight its potential impact on diagnostic evaluation and surgical planning in lumbar spine pathology.

Case Report

A 76-year-old male presented with acute low back pain that began ten days earlier after heavy lifting. Although the back pain had partially subsided, he reported progressive numbness and sharp pain radiating to the posterior thighs and calves, along with weakness in right ankle dorsiflexion and frequent tripping during ambulation. He denied bowel or bladder dysfunction or saddle anesthesia.

Neurological examination revealed a positive straight leg raise at 50° on the right and globally restricted lumbar range of motion. Muscle strength was normal in the left lower limb. In the right lower limb, ankle dorsiflexion and hallux extension were graded 1/5, while strength in the quadriceps, hamstrings, and plantar flexors was preserved. No atrophy or abnormal muscle tone was observed. Sensory examination revealed hypoesthesia in the right L4 dermatome. Deep tendon reflexes, including the patellar and achilles reflexes, were diminished on the right. Babinski sign was absent bilaterally. The patient demonstrated an unsteady gait with frequent tripping on the right side, consistent with foot drop. There was no history of significant comorbidities or previous spinal trauma.

Lumbar magnetic resonance imaging (MRI) demonstrated a right foraminal disc extrusion at L3-L4, compressing the exiting L3 nerve root, accompanied by mild diffuse disc bulging at L4-L5 and L5-S1 without significant central or foraminal stenosis (Figure 1A-D). Standing anteroposterior radiographs of the lumbar spine incidentally revealed a pseudoarticulation between the right transverse processes of L3 and L4, associated with right-sided lumbar scoliosis measuring a Cobb angle of 15° (Figure 1A-1B). High-resolution CT confirmed the pseudoarticulation, showing a corticated osseous bridge with a narrow pseudo-joint space, consistent with a post-traumatic morphology (Figure 2A-F). Postoperative CT images demonstrated the integrity of the L2-L5 posterior fusion instrumentation and satisfactory alignment (Figure 3).

Given the presence of foot drop, the patient underwent L3-L4 total laminectomy, right-sided discectomy, and L2-L5 posterior spinal fusion. Postoperative recovery was uneventful, and written informed consent was obtained for publication of the case.

Following surgery, the patient was enrolled in a structured rehabilitation protocol comprising task-specific gait training, static and dynamic balance exercises, progressive resistance training focused on the ankle dorsiflexors, and targeted lower limb muscle strengthening. Fall prevention strategies were emphasized due to his age and initial instability. Neurological recovery and functional status were monitored through serial clinical evaluations and gait performance assessment. Over six weeks, the patient demonstrated gradual improvement in right ankle dorsiflexion strength (from 1/5 to 3/5), reduced tripping episodes, and increased walking endurance, reflecting significant gains in both neurological function and overall functional capacity.

Discussion

Osseous bridging or pseudoarticulation between adjacent lumbar transverse processes is most commonly post-traumatic in origin (4). In a review of 72 cases, only 11 were classified as congenital, highlighting the rarity of the congenital form (3). Billet et al. (3) proposed radiological criteria for differentiating traumatic from congenital bridges: Traumatic lesions are typically irregular, asymmetrical, and involve narrow-angle connections.

The morphology of the bridge may offer insights into the underlying mechanism of trauma. Approximately 45% of

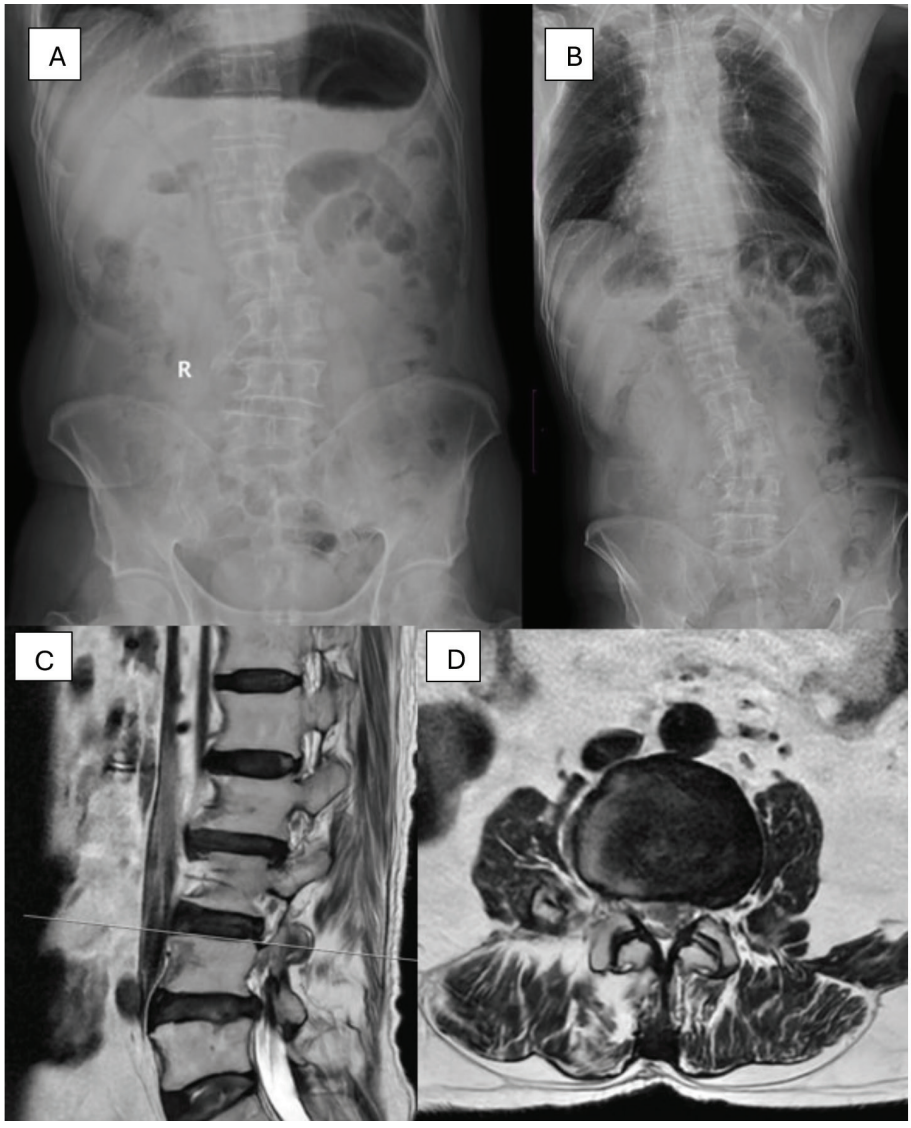

Figure 1. A and B; Simple anteroposterior radiograph shows osseous bridging between the right transverse processes of L3 and L4 vertebrae along with minor scoliosis and narrowing of the disc space. C and D) Sagittal and axial T2-weighted MRI of the lumbar spine disc herniation at L3-L4 level
MRI: Magnetic resonance imaging

traumatic bridges exhibit an "H" or "h" shape, likely resulting from mid-transverse process fractures due to indirect repetitive strain. Another 20% present with "K" or "Y" configurations, often associated with basal fractures from more severe trauma. About 15% are fragmented or "Z"-shaped, typically seen in high-energy injuries. These forms can mimic progressive myositis ossificans (PMO), a condition characterized by heterotopic bone formation within muscle tissue following trauma (3,7). On imaging, PMO may initially appear as amorphous calcifications in the soft tissue adjacent to the transverse processes. Over time, it can mature and resemble organized bony structures, making differentiation from true bridging difficult. However, in our patient, the presence of cortical continuity with the vertebra and structured articulation clearly excluded PMO as a diagnosis.

In the present case, an "h"-shaped osseous bridge was observed between the right transverse processes of L3 and L4. The irregular and asymmetrical appearance, along with the absence of congenital anomalies, strongly suggests a traumatic origin, likely related to a past, undiagnosed fracture sustained before skeletal maturity.

In contrast to traumatic forms, congenital bridges typically appear as symmetrical, smooth, and well-corticated connections. These may present as rounded "O"-shaped tips of the transverse processes with continuity extending from the vertebral body (5). Dunoyer described this pattern as "kissing-interspinous" morphology, in which the adjacent transverse process tips are closely apposed with smooth cortical margins (5). Congenital bridging may coexist with skeletal anomalies such as spina bifida

occulta, accessory ribs, sacralization of L5, or the presence of six lumbar vertebrae—none of which were observed in this patient (3).

The direction of accompanying scoliosis can also offer etiological clues. In congenital cases, the convexity of the curve typically points away from the affected side, possibly due to growth inhibition. In traumatic cases, the convexity often faces the affected side, potentially reflecting dysfunction of the ipsilateral quadratus lumborum muscle (6). Interestingly, in this case, the convexity was toward the unaffected side, which supports the hypothesis of trauma occurring during skeletal development, rather than a congenital anomaly.

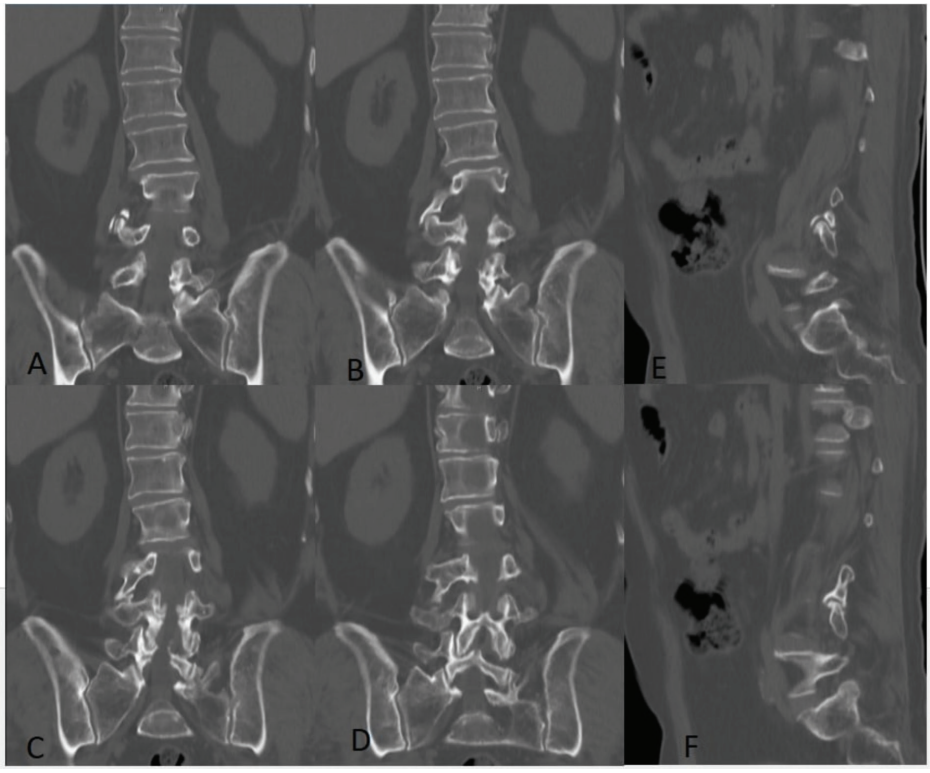

Figure 2. A-D; Coronal, E, and F; sagittal CT image shows "h" shaped osseous bridging and pseudoarticulation between the right transverse processes of the L3, and L4 vertebrae, pseudoarthrosis
CT: Computed tomography

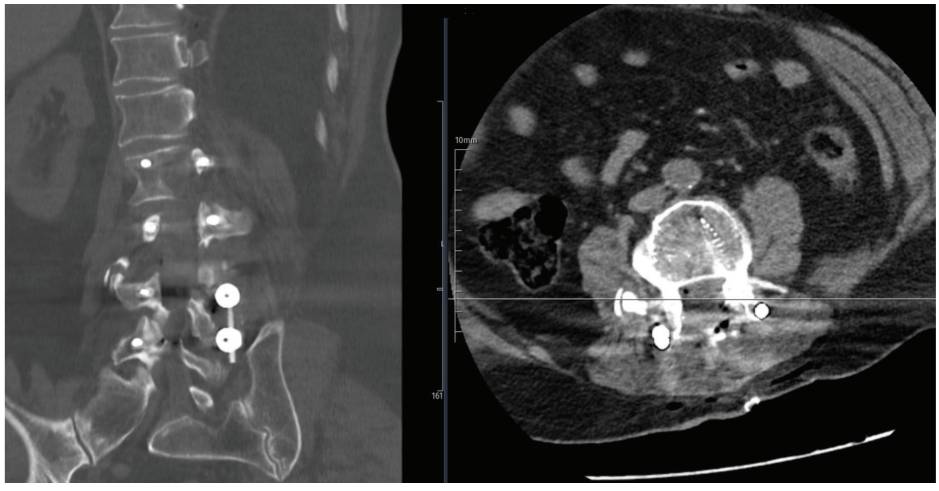

Figure 3. Postoperative CT images demonstrating spinal instrumentation from L2 to L5 and the relationship to the bridging site
CT: Computed tomography

Some reports suggest that the absence of degenerative changes in adjacent joints supports a congenital etiology (7). However, this remains controversial, as degeneration is multifactorial—affected by age, loading, and joint mobility (8). Pseudoarthrosis is present in approximately 62% of transverse process bridges, particularly in the mobile lower lumbar segments (5). In congenital cases, it results from differential growth rates in ossification centers; in traumatic cases, it is attributed to inadequate immobilization post-injury (9).

From a diagnostic standpoint, the distinction between congenital and traumatic transverse process bridges can be challenging, particularly in the absence of clear trauma history. Radiographic signs such as irregular margins, asymmetry, and narrow angulation point toward a traumatic origin, while smooth, symmetrical formations support a congenital basis. Integrating clinical details—such as age, symptom onset, and associated spinal findings—with detailed CT or MRI evaluation is essential to avoid misclassification. Failing to recognize these features may lead to unnecessary diagnostic procedures, delayed treatment, or misdirected surgical planning. Therefore, a multidisciplinary approach involving radiologists, spine surgeons, and rehabilitation specialists is recommended when incidental bony anomalies are encountered in symptomatic patients.

In patients with atypical lumbar symptoms or unexplained scoliosis, transverse process bridging—though rare—should be considered, particularly in older adults with a history of mechanical stress. In our patient, the combination of irregular bridge morphology, absence of congenital markers, and scoliosis direction supported a diagnosis of post-traumatic pseudoarticulation acquired before skeletal maturity. Although often asymptomatic, such anatomical variations may become relevant in the context of back pain or neurosurgical evaluation (10). This case not only illustrates the importance of recognizing rare but clinically meaningful anatomical variants in spinal imaging but also underscores the need for thorough preoperative imaging assessment, as incidental findings may influence surgical approach and postoperative rehabilitation planning.

Conclusion

This case underscores that intertransverse pseudoarticulation, although rare and often asymptomatic, should remain in the differential diagnosis of lumbar pathology, particularly in patients presenting with back pain and incidental imaging findings. Careful assessment of radiographic morphology, scoliosis direction, and the presence or absence of associated congenital anomalies can help differentiate post-traumatic from congenital origins. Awareness of such anatomical variants is crucial not only to avoid diagnostic pitfalls but also to inform surgical planning, guide postoperative rehabilitation strategies, and ultimately optimize patient outcomes in complex spinal cases.

Ethics

Informed Consent: Written informed consent was obtained from the patient for the use of anonymized clinical data and images for publication.

Footnotes

Authorship Contributions

Concept: B.N.A., Design: B.İ., Data Collection or Processing: B.N.A., Analysis or Interpretation: B.N.A., B.İ., Literature Search: B.N.A., Writing: B.N.A., B.İ.

Conflict of Interest: No conflict of interest was declared by the authors.

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The Clinical Significance of Ultrasound Guided Needling the Peroneal Muscles for Chronic Ankle Instability and Lateral Leg Pain

Kronik Ayak Bileği İnstabilitesi ve Lateral Bacak Ağrısında Peroneal Kasların Ultrason Eşliğinde İğneleme Tedavisinin Klinik Önemi

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Keywords: Peroneal muscle dysfunction, myofascial trigger points, ultrasound-guided dry needling, chronic ankle instability, lateral leg pain
Anahtar kelimeler: Peroneal kas disfonksiyonu, miyofasiyal tetik noktalar, ultrason eşliğinde kuru iğneleme, kronik ayak bileği instabilitesi, lateral bacak ağrısı

Dear Editor,

The peroneal muscles, including the peroneus longus (PL) and peroneus brevis (PB), are critical components of the lower leg's lateral compartment (1). Muscles that originate on the fibula and insert on the base of the first metatarsal and medial cuneiform (PL) and the tuberosity of the fifth metatarsal (PB); these muscles are primarily ankle evertors and stabilizers (1-3). They play a crucial role in dynamic postural control, providing a counterforce against excessive supination and preventing lateral ankle sprains (2,3). Muscle dysfunction in these tissues is often linked to chronic lateral ligament instability, entrapment, recurrent sprains, and neuromuscular deficiencies, resulting in persistent gait and balance impairments.

Myofascial trigger points (MTrPs) in the peroneal muscles may mimic lateral ankle pain and instability, typically described as referred pain along the lateral aspect of the leg and foot (Figure 1) (4,5). When active, trigger points in these muscles cause muscle pain, weakness, and proprioceptive changes, creating a cycle of vulnerability to repeat ankle injuries. The PB, notably, can also refer pain to the lateral malleolus and dorsum of the foot, complicating differential diagnoses. Since the functional anatomy of these muscles suggests that identification and treatment of MTrPs should be a central component in the restoration of ankle stability and normal biomechanics in those with chronic ankle instability (3-5).

Diagnosis of peroneal muscle MTrPs has proven to be difficult clinically, especially because the PB is located underneath the PL. Interrater reliability in finding taut bands, nodules, and local twitch responses (LTRs) has been variable as palpation techniques could not detect these reliably with a good degree of accuracy (5). Moreover, recent studies have shown, simply examining the structures is not very precise, especially for deeper structures, again demonstrating the need for something more objective for diagnosis. The potential for misdiagnosis and the difficulty differentiating between peroneal dysfunction and other lateral ankle pathologies suggests that imaging-based assessment should be included in clinical practice.

Musculoskeletal ultrasound improves the precision of both trigger point detection and intervention, but there are limitations. Lower resolution limits detection of subtle fascial and muscular pathologies, especially at deeper anatomical levels, and it is operator dependent. Musculoskeletal ultrasound, however, substantially enhances the treatment of peroneal muscle

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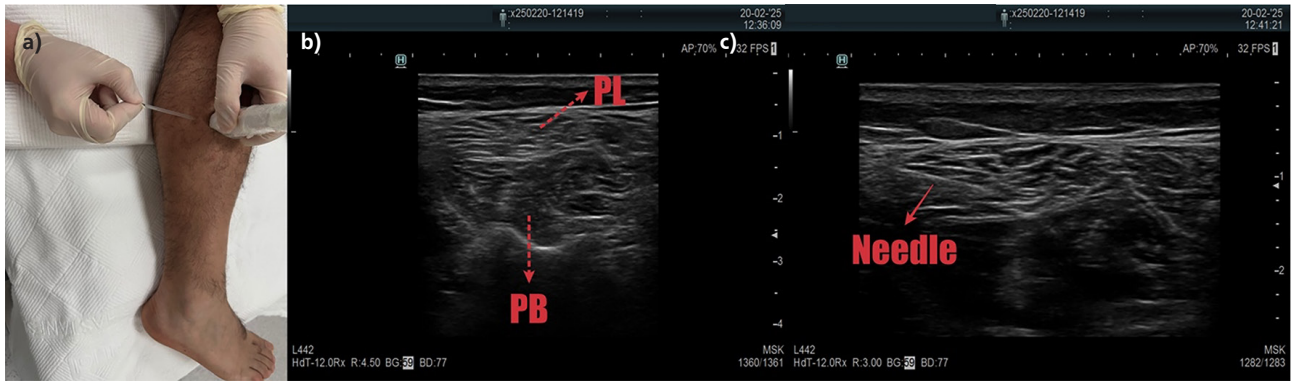

Figure 1. a) Patient positioned in a side-lying position with the treated leg on top, allowing optimal access to the peroneal muscles, b) Ultrasound image of the peroneal muscle anatomy. The peroneus longus (PL) is located more superficially, while the peroneus brevis (PB) is positioned deeper. Real-time visualization aids in identifying myofascial trigger points and fascial restrictions, c) Needle placement under ultrasound guidance. The needle is directed precisely into the (PL) muscle, allowing for accurate targeting of myofascial trigger points while minimizing the risk of injury to adjacent structures

dysfunction through the real-time identification of anatomy, morphology, fascial compromise and MTrPs. Although manual palpation is the first step, ultrasound identifies the situated taut bands and fibrotic changes in the trigger point with precision and is used to guide the needles in dry needling treatments.

In conclusion, ultrasound-guided dry needling greatly enhances treatment accuracy, allows for easier LTR activation, and minimizes the risk of neurovascular damage. Due to the diagnostic and therapeutic difficulty of peroneal myofascial dysfunction, ultrasound-guided technique should be introduced in routine clinical practice to improve patient outcomes.

Footnotes

Authorship Contributions

Concept: B.A., B.T.D., M.H.T., M.T.Y., Design: B.A., M.H.T., F.B., Data Collection or Processing: D.F., B.T.D., Analysis or Interpretation: D.F., B.T.D., M.H.T., F.B., Literature Search: D.F., M.T.Y., F.B., Writing: D.F., F.B.

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Humanoid Assistance in Osteoporosis Care: A New Frontier in Digital Health

Osteoporoz Bakımında İnsansı Robot Destekli Yaklaşımlar: Dijital Sağlıkta Yeni Bir Ufuk

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Keywords: Artificial intelligence, digital health, humanoid robotics, osteoporosis, risk assessment
Anahtar kelimeler: Yapay zeka, dijital sağlık, insansı robotlar, osteoporoz, risk değerlendirmesi

Dear Editor,

Osteoporosis is one of the most underdiagnosed and undertreated public health problems globally, especially among older adults (1). It is characterized by low bone mass and the microarchitectural deterioration of bone tissue, and it results in increased fragility and susceptibility to fractures. Despite the availability of effective diagnostic tools and evidence-based therapeutic strategies, important gaps in screening, delayed diagnosis, low treatment initiation rates, and poor long-term adherence remain relevant for optimal disease management. The barriers lead to high incidence of fragility fractures, morbidity, loss of independence and in turn, considerable healthcare costs worldwide (1).

Given these challenges, we propose an innovative and forward-looking solution based on the integration of humanoid robots, such as Pepper, NAO or TIAGo, to osteoporosis care pathways. Used in geriatric rehabilitation and chronic disease management, these semi-autonomous robotic platforms have the potential to yield meaningful contributions along the continuum of osteoporosis prevention, treatment, and rehabilitation (2). We recommend their incorporation into the areas of osteoporosis care listed below in five domains:

1. Dual Energy X-ray Absorptiometry (DEXA) scan coordination: Humanoid robots can help patients for DEXA-scans, contributing with instructions, adjusting to recovery, and making the process less stressful.

2. Medication adherence monitoring: Robots can prompt patients to take antiresorptive (e.g., bisphosphonates, vitamin D) medications or supplements in a timely manner, keep records of missed doses, and send alerts to healthcare providers (3).

3. Patient education and fall prevention: Via interactive auditory and visual articulation, robots are able to provide personalized education on topics such as osteoporosis, lifestyle changes, nutrition, and fall risk prevention strategies-all important features of long-term disease management (4).

4. Artificial intelligence (AI)-based risk stratification: Humanoid systems can help to identify high fracture risk individuals, and encourage timely referral for further evaluation or treatment initiation, using risk tools like FRAX or QFracture integrated into the humanoid system.

5. Post-fracture rehabilitation and monitoring: Robots can assist home-based exercise protocols after osteoporotic fractures, provide input on movement, track compliance, and promote re-entry to functional activity in a graded fashion, "particularly relevant to elderly individuals" (5).

When integrated together, these functions can help alleviate some burden from healthcare providers, with particular benefit for those in resource-limited contexts, and improve the accuracy and continuity of osteoporosis care. The empathic interfaces and natural language processing capabilities of humanoid robots position them as ideal prescribers for older adults, enhancing engagement, satisfaction and consequently, therapeutic outcomes.

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However, before its widespread implementation, ethical and practical issues must be resolved. These are related to the data privacy, cost effectiveness, user acceptance, and training needs. However, we believe the advantages significantly outweigh the barriers, and this represents an opportunity to advance care for metabolic bone diseases through smart, human-centered technology.

We call on academic medical centers, rehabilitation hospitals, geriatrics units, and developers in the health tech industry to collaborate on pilot projects and clinical research evaluating the feasibility and efficacy of humanoid-assisted osteoporosis care. The convergence of robotics, AI, and rehabilitative science holds immense potential to address the pressing needs of our aging population and shift the paradigm of osteoporosis management from reactive to proactive.

Footnotes

Authorship Contributions

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