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EDITORIAL

Our Dear Colleagues,

We are proud to publish the first issue of JORR in 2024. Our journal is published 4 times a year and is among the internationally indexed journals. Our aim is to publish more literature in the future and to have indexes with high impact factors.

We would like to thank all the authors who contributed to our magazine and everyone who contributed.

Kind regards.

Assist. Prof. Ayşe Gülşen DOĞAN
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ORIGINAL ARTICLES

REVIEWS

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Original Article

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Prevalence of vitamin D deficiency and insufficiency in adults in Ankara province

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ABSTRACT

Aims: Vitamin D deficiency is a prevalent health issue globally. Outpatient clinics frequently encounter complaints related to vitamin D deficiency in adults. This study aims to determine the prevalence of 25(OH) vitamin D deficiency in patients over 18 years old and to investigate potential differences in 25-OH D levels based on age, gender, and seasonal factors.

Methods: This cross-sectional study included 12,740 patients (9,550 females, 3,190 males) with a mean age of 45 years (ranging from 18 to 99 years) attending the Orthopaedics and Traumatology outpatient clinic and Internal Medicine outpatient clinic. The serum 25(OH) Vit D was measured using the ELISA method. The patients were divided into three groups: 1) patients with vitamin D deficiency (<20 ng/mL), 2) patients with insufficient vitamin D levels (21-29 ng/mL), and 3) patients with normal vitamin D values (>30 ng/mL). Binary logistic regression analysis was used to analyse the risk factors for vitamin D deficiency.

Results: The study found that 68.6% of the participants had a vitamin D deficiency, while 21.2% had a vitamin D insufficiency. Binary logistic regression analysis revealed that low levels of 25(OH) Vitamin D were associated with age, gender, and the spring season.

Conclusion: This study suggests that patients with related complaints or findings at outpatient clinic visits should be evaluated for vitamin D deficiency or insufficiency. If diagnosed, dietary support and vitamin D supplementation may be appropriate for those in high-risk groups.

Keywords: 25-hydroxy vitamin D, vitamin D deficiency, D vitamin insufficiency, age, gender, season

INTRODUCTION

Vitamin D deficiency is a prevalent global health issue, affecting a significant proportion of individuals across all age groups and geographical regions. It is important to note that this condition is often asymptomatic and can lead to various health complications if left untreated. Vitamin D deficiency is a prevalent global health issue, affecting a significant proportion of individuals across all age groups and geographical regions. Inadequate dietary supplementation, limited exposure to sunlight, and low calcium intake can all contribute to this consequence.[1] Inadequate levels of vitamin D have been associated with a range of factors, including elderly age, female gender, high latitudes, winter season, dark skin colour, limited sunlight exposure, dietary intake deficiency, malabsorption syndromes, indoor environment and clothing style.[2-4] Although the optimal level of vitamin D is uncertain, numerous studies have shown that vitamin D deficiency is common worldwide, especially in winter.[5,6]

Vitamin D plays an important role in maintaining calcium homeostasis and bone metabolism.[7] Vitamin D deficiency has been linked to various health conditions, including common types of cancer, autoimmune diseases, cardiovascular diseases, musculoskeletal diseases, and infectious diseases.[8] There are few foods that are a source of vitamin D, such as oily fish or fish oil. Humans mainly meet their vitamin D needs through sun exposure. Ultraviolet B (UVB) in sunlight triggers vitamin D synthesis in the skin. UVB causes the conversion of provitamin D (7-dehydrocholesterol) to previtamin D3 and then to vitamin D3 in the skin. Vitamin D3 synthesized in the skin is first hydroxylated in the liver, forming 25(OH) vit D. The kidney hydroxylates 25(OH) vitamin D to form the metabolically active 1,25(OH) vitamin D. This active form directly affects intestinal calcium absorption, bone mineralisation, and muscle tissue contractile activity.[9]

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To evaluate an individual's vitamin D level, it is recommended to examine their 25(OH)D level. This level has a half-life of 2-3 weeks and reflects both vitamin D intake and endogenous production. The biologically active form, 1,25(OH)2D, is not ideal for measurement due to its short half-life of 4-6 hours and circulating levels that are 1000 times lower than 25(OH)D. Numerous studies have been conducted to define vitamin D deficiency and insufficiency and to determine the normal range of 25(OH)D levels. Based on these studies, vitamin D deficiency is defined as having a 25(OH)D level lower than 20 ng/mL, while vitamin D insufficiency is defined as having a level between 21 and 29 ng/mL. An adequate level is considered to be higher than 30 ng/mL (with a preferred range of 40-60 ng/mL). Vitamin D intoxication is diagnosed when the level is higher than 150 ng/mL.[10] These values were accepted as reference values when forming the patient groups for our study.

In adults, vitamin D deficiency can cause proximal muscle weakness, defects in skeletal mineralisation, and an increased risk of falls, leading to an increased risk of fractures. Generalised body aches are often reported by patients with vitamin D deficiency.[9,10] We planned this study to elucidate the underlying etiology of these complaints, which we frequently encounter in daily outpatient clinic applications, and to diagnose vitamin D deficiency. The aim of this study was to determine the frequency of vitamin D deficiency by examining vitamin D levels in individuals over the age of 18 who applied to our secondary level state hospital. Additionally, we investigated whether there was a significant difference between 25-OH D levels based on age, gender, and seasonal factors.

METHODS

Ankara Etlik City Hospital Clinical Researches Ethics Committee granted ethical approval to our study (Date: 22.11.2023, Decision No: AEŞH-EK1-2023-704), and we obtained institutional permission from the Chief Physician Office of Kahramankazan State Hospital. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

From 01.01.2022 to 01.07.2023, we retrospectively analysed the results of 25-OH D level requests from patients over the age of 18 who visited the Orthopaedics and Traumatology Outpatient Clinic and Internal Medicine Outpatient Clinic of Kahramankazan State Hospital. The hospital information system was used for this purpose. The study excluded patients with chronic diseases such as diabetes mellitus, hypertension, thyroid diseases, and chronic renal failure. The study included 12,748 patients who were classified into different age groups. The 'Guideline for the Diagnosis and Treatment of Metabolic Bone Diseases' published by The Society of Endocrinology and Metabolism of Turkey in 2012 categorises patients into four groups based on their serum 25(OH) vitamin D concentration: severe vitamin D deficiency (<10 ng/mL), vitamin D deficiency (11-20 ng/mL), vitamin D insufficiency (21-29 ng/mL), and normal (>30 ng/mL).[9] The study divided patients into three groups based on their vitamin D levels:

1. those with a deficiency (<20 ng/mL)
2. those with insufficient levels (21-29 ng/mL)
3. those with normal vitamin D values (>30 ng/mL)

Statistical Analysis

The hospital information system data was computerised. Statistical evaluations were performed using the SPSS (26.0 for Windows) programme. Continuous variables were expressed as mean ± standard deviation. Binary Logistic Regression analysis was used to determine the risk factors for vitamin D deficiency. To determine the independent variables to include in the regression model, subgroups (with and without vitamin D deficiency) of the dependent dichotomous variable (vitamin D deficiency) were compared in terms of age, sex and distribution by month. We used the Mann Whitney U test to compare the mean age of patients with and without vitamin D deficiency. We analysed categorical data (months, gender) using the Pearson Chi-Square test. Binary logistic regression analysis included independent variables that showed significant differences, such as month, age, and gender. Results were considered statistically significant when the P value was less than 0.05.

RESULTS

The demographics of 12,740 patients, including 9,550 women and 3,190 men, are shown in Table 1. The highest proportion of patients who had their serum 25(OH) vitamin D concentration tested for vitamin D deficiency were aged between 45 and 64 years, accounting for 33.9%. This was followed by the patient group aged between 30 and 44 years, which accounted for 30.3% (Table 1).

Table 1. Demographic characteristics

Variable		n	%	N	
Gender	Female	9550	75,0	**12740**	**100**
	Male	3190	25,0		
Age	18-29	2626	20,6	**12740**	**100**
	30-44	3864	30,3		
	45-64	4322	33,9		
	65-74	1296	10,2		
	75-89	614	4,8		
	90 and above	25	0,2		
	Min. 8	**Max.** 99	**Mean** 45	**Std.** 10,8	

When analysing the seasonal distribution of outpatient clinic applications for the patients included in the study, it was found that 4,012 patients (31.5%) applied to the hospital during the summer season (Table 2).

Table 2. Seasonal distribution of patient visits to health institutions

Season	n	%
Spring	3897	30,6
Summer	4012	31,5
Autumn	2127	16,7
Winter	2704	21,2
	12740	**100**

The study participants were divided into three groups based on their serum 25(OH) vitamin D levels (Table 3). Of the total number of patients, 8,740 (68.6%) had vitamin D deficiency (<20 ng/mL), 2,700 (21.2%) had vitamin D insufficiency (21-29 ng/mL), and 1,300 (10.2%) had normal vitamin D levels (>30 ng/mL). The combined percentage of patients with vitamin D deficiency and insufficiency was 89.8% (Table 3).

Table 3. Distribution of serum 25(OH) vitamin D concentration in patients		
Serum 25(OH) vitamin D concentration	**n**	**%**
<20 ng/mL	8740	68,6
21-29 ng/mL	2700	21,2
>30 ng/mL	1300	10,2
	12740	**100**

The study found that female patients and those at relatively young ages were more likely to have Vitamin D deficiency (Tables 4 and 5). Analysis of serum 25(OH) Vitamin D concentrations by sex revealed that 71% of women and 61.5% of men had Vitamin D deficiency, indicating a significant correlation between serum 25(OH) Vitamin D concentration and gender ($\chi 2=9.003$ $p<0.001$). Female patients were found to have a vitamin D deficiency approximately 3.5 times more often than male patients. Additionally, their vitamin D levels were lower compared to male patients.

Table 4. Distribution of serum 25 (OH) vitamin D concentration in patients by gender						
Gender	**Serum 25 (OH) vitamin D concentration**					
	<20 ng/mL		**21-29 ng/mL**		**>30 ng/mL**	
	n	**%**	**n**	**%**	**n**	**%**
Female	**6780**	**71**	1840	19,3	930	9,7
Male	1960	61,5	860	26,9	370	11,6
	8740	**68,6**	**2700**	**21,2**	**1300**	**10,2**

When analysing the distribution of serum 25(OH) vitamin D concentrations among the patients included in the study, it was found that the most common age range for patients with vitamin D deficiency was 45-64 years old, with 2,817 patients. The 18-29 age group had the highest rate of vitamin D deficiency at 77.1% (Table 5). It is evident that the majority of patients with vitamin D deficiency were under the age of 65. There was a significant correlation between vitamin D levels and age periods ($\chi 2=2.064$, $p<0.001$).

Table 5. Distribution of serum 25 (OH) vitamin D concentration of patients by age groups						
Age periods	**Serum 25 (OH) vitamin D concentration**					
	<20 ng/mL		**21-29 ng/mL**		**>30 ng/mL**	
	n	**%**	**n**	**%**	**n**	**%**
18-29	**2025**	**77,1**	454	17,3	147	5,6
30-44	2679	69,4	838	21,7	344	8,9
45-64	2817	65,2	1001	23,2	501	11,6
65-74	804	62,1	278	21,5	213	16,4
75-89	396	64,5	125	20,4	4	16
90 and above	19	76	4	16	2	8
	8740	**68,6**	**2700**	**21,2**	**1300**	**10,2**

A significant correlation was found between vitamin D levels and seasonal periods when the distribution of serum 25(OH) vitamin D concentrations of the patients included in the study was analyzed according to the seasons ($\chi 2=3.704$ $p<0.001$). The incidence of vitamin D deficiency was highest during the spring months ($p<0.001$) (Table 6). The results of the binary logistic regression analysis indicate that gender, age, and the months in which vitamin D deficiency is detected are significant risk factors for low 25(OH)Vit D levels.

Table 6. Distribution of Serum 25 (OH) vitamin D concentration of patients according to seasons						
Season	**Serum 25 (OH) Vitamin D Concentration**					
	<20 ng/mL		**21-29 ng/mL**		**>30 ng/mL**	
	n	**%**	**n**	**%**	**n**	**%**
Spring	2920	74,9	632	16,2	345	8,9
Summer	2390	59,6	1108	27,6	514	12,8
Autumn	1340	63	574	27	213	10
Winter	**2090**	**77,3**	386	14,3	228	8,4
	8740	**68,6**	**2700**	**21,2**	**1300**	**10,2**

DISCUSSION

Studies from various countries indicate that vitamin D deficiency is a global health issue.[11] Inadequate levels of 25(OH)D are highly prevalent and are associated with fragility fractures, particularly hip fractures, and mortality.[12] Hovsepian et al.[13] reported a high prevalence of vitamin deficiency (50.8%) in the adult population attending polyclinics for routine check-ups. Mansoor et al.[14] conducted a study in Pakistan and found that the mean vitamin D level was 16.44 ng/mL. They also identified vitamin D deficiency in 69.9% of participants and vitamin D insufficiency in 21.1%, which closely aligns with the results of our study. A study conducted by Hekimsoy et al.[15] in 2010 found that the mean 25(OH) D level was 16.9±13.09 ng/mL. Of these, 74.9% had vitamin D deficiency (<20 ng/mL), 13.8% had vitamin D insufficiency (20-29.99 ng/mL) and 11.3% had normal values (>30 ng/mL). It is possible that the higher prevalence of vitamin D deficiency in this study compared to ours is related to the fact that it was conducted on a relatively younger patient population. In a study conducted by Uçar et al.[16] in Ankara province, the same region as our study, a high rate of vitamin D deficiency (51.8%) and vitamin D insufficiency (20.7%) were found. In our study, when 20 ng/mL was taken as the cut off value, 68.6% vitamin D deficiency and 21.2% vitamin D insufficiency were found in patients admitted to our hospital.

Regions far from the equator with insufficient sunlight have been observed to have decreased levels of vitamin D produced through the skin. This is a concern for the European population.[17] In cases of vitamin D deficiency, which is evident in closed clothing, it is recommended to take oral supplements or consume vitamin D-enriched foods. However, direct sunlight exposure of the face and hands for at least 10-15 minutes twice a week is sufficient for vitamin D synthesis.[9-17] Studies conducted in Middle Eastern and Asian countries have found a high prevalence of vitamin D deficiency.6 Similarly, studies conducted in Turkey have also reported a high prevalence of vitamin D deficiency.[4,15,16]

Serum 25(OH) vitamin D level shows seasonal variation. In the studies in the literature; serum 25(OH) vitamin D level reaches the highest level in summer.[18-19] Individuals living at latitudes of 37° and above are at a higher risk of vitamin D deficiency during winter months due to reduced UVB radiation. Denmark, located at 56°00' north latitude, reports common vitamin D deficiency during the winter-spring period.[19] Similarly, our country, located at 39°57' North latitude, may also experience vitamin D deficiency during the winter-spring period. The study results indicate that vitamin D deficiency is more prevalent during the spring months. Additionally, studies conducted in our country have identified the spring season as a risk factor.[16]

Vitamin D deficiency is more prevalent in women and at younger ages in the adult population.[13,15,19] Çidem et al.[20] found no significant gender difference in 25(OH)D levels. However, Hekimsoy et al.[15] reported that 25(OH)D deficiency was more common in women (78.7%) than in men (66.4%). Our study's findings align with those of Hekimsoy et al.[15] The higher prevalence of vitamin D deficiency in the young population may be due to the increased number of indoor work activities during their daily lives. Modern working life often requires people to stay indoors for 10-12 hours a day. In the region where the hospital where this study was conducted is located, industrial and factory settlement is highly developed, and the majority of those working in this sector are in the young age group. Staying indoors all day may lead to insufficient sun exposure and an increased risk of vitamin D deficiency. The higher prevalence of vitamin D deficiency in women and at younger ages may be due to awareness of osteoporosis prevention or the widespread use of vitamin D for treating osteoporosis in the elderly population.

This was a cross-sectional study conducted using archive search methods. To improve the accuracy of defining the relationship between complaints and vitamin D deficiency in patients admitted to the Orthopaedics and Traumatology Outpatient Clinic and Internal Medicine Outpatient Clinic, it would be beneficial to conduct prospective studies in a multicentre manner.

CONCLUSION

A high rate (89.8%) of vitamin D deficiency and insufficiency was detected in patients admitted to our hospital from Ankara and its neighbourhood, and it was concluded that this condition is more common in women and relatively younger ages and in spring months. We believe that dietary support and vitamin D supplementation may be appropriate for individuals at risk. Additionally, patient education on the importance of sun exposure and dietary intake may also aid in treatment.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ankara Etlik City Hospital Clinical Researches Ethics Committee granted ethical approval to our study (Date: 22.11.2023, Decision No: AEŞH-EK1-2023-704), and we obtained institutional permission from the Chief Physician Office of Kahramankazan State Hospital.

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Original Article

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The relationship between neutrophil lymphocyte ratio (NLR), platelet lymphocyte ratio (PLR), hemoglobin albumin lymphocyte and platelet (HALP) score and bone mineral density in Hemodialysis Patients

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ABSTRACT

Aims: The aim of this study is to develop new indices from hemogram and biochemical parameters to evaluate bone mineral density in hemodialysis patients.

Methods: 49 patients who had been receiving hemodialysis for at least 6 months were included in the study. The patients were divided into three groups according to bone mineral density (BMD). Neutrophil lymphocyte ratio (NLR), platelet lymphocyte ratio (PLR) and hemoglobin albumin lymphocyte and platelet (HALP) score were compared between all three groups. The correlation between all three indices and lumbar and femur BMD scores was examined.

Results: No correlation was found between NLR, PLR and HALP score and lumbar and femur BMD.

Conclusion: As a result, we concluded that NLR, PLR and HALP score cannot be used as an auxiliary marker to detect osteoporosis in hemodialysis patients.

Keywords: Bone mineral density, NLR, PLR, HALP score

INTRODUCTION

Chronic kidney disease (CKD) is an important public health problem all over the world and in our country.[1] Bone mineral density (BMD), an indicator of bone mass and mineralization, is one of the main determinants of bone strength. In chronic kidney disease patients, BMD is lower than in the general population and the prevalence of osteoporosis is more common.[2] Hemodialysis (HD) is the most important renal replacement therapy for patients with end-stage renal disease. As the survival time of HD patients increases, complications such as phosphorus-calcium metabolism disorder, energy and protein consumption and sarcopenia occur due to the combined effect of various factors. This condition predisposes patients to osteoporosis, which causes increased fragility. Osteoporosis causes increased rates of fractures, falls, hospitalizations and deaths.[3]

Microinflammation is common in HD patients. Inflammation has been shown to be one of the causes of osteoporosis in HD patients.[4,5] As new inflammatory indices, neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR) and hemoglobin (g/L) x albumin (g/L) x lymphocyte count (/L)/platelet count (/L) (HALP score) plays an important role in the prognosis of diseases such as coronary heart disease, myocardial infarction and neoplastic diseases.[6-8] Considering that studies on the effect of NLR, PLR and HALP score on bone mineral density in HD patients are very limited, this study will be the first study to address the HALP score in predicting osteoporosis in HD patients. The aim of this study is to examine the relationship between bone mineral density and simple, inexpensive parameters such as NLR, PLR and HALP score, which do not have any risk of complications, in the diagnosis of osteoporosis and osteopenia in HD patients.

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METHODS

In this cross-sectional study, 49 HD patients were included in the study between September and December 2023 at Hitit University Erol Olçok Training and Research Hospital. Approval for the study was received from Hitit University Clinical Researches Ethics Committee (Date: 01.11.2023, Decision No: 2023-78). Informed written consent was obtained from all participants in accordance with the principles of the Declaration of Helsinki. The inclusion criteria of the study are being between the ages of 19-74 and having received hemodialysis treatment for at least 6 months. Exclusion criteria were determined as cardiac arrhythmia such as atrial fibrillation, aortic stenosis, myocardial infarction or unstable angina in the last 6 months, uncontrolled hypertension (>180/100 mmHg), history of acute respiratory failure, history of thromboembolism, autoimmune diseases and malignancy.

49 patients who received hemodialysis treatment for at least 6 months and were followed up in our internal medicine clinic were included. In pre-dialysis blood tests, hemogram, biochemistry parameters such as urea, creatinine, lipid parameters and serum albumin levels were examined. The patients' age, gender, height, weight, smoking history, presence of diabetes mellitus, hypertension and the medications they used, if any, presence of hypothyroidism and hyperparathyroidism were recorded. Blood tests and bone densitometry (BMD) were requested from patients who met the inclusion criteria by internal medicine doctors. According to the total lumbar T score obtained from the BMD score, the patients were divided into 3 groups: normal, osteopenia and osteoporosis. All parameters were compared between groups.

Statistical Analysis

The data were evaluated in the statistical package program IBM SPSS Statistics Standard Concurrent User V 29 (IBM Corp., Armonk, New York, USA). Descriptive statistics were given as number of units (n), percentage (%), mean ± standard deviation, median, minimum and maximum values. Normal distribution of the data of numerical variables was evaluated with the Shapiro Wilk normality test. Homogeneity of variance of the groups was analyzed with the Levene test. When comparing numerical variables according to osteoporosis, osteopenia and normal patient groups, one-way analysis of variance was used if the data showed a normal distribution, and Kruskal-Wallis analysis was used if the data did not show a normal distribution. As a multiple comparison test, the Duncan test was used in one-way analysis of variance and the Dunn-Bonferroni test was used in Kruskal Wallis analysis. The relationship between Log-HALP scores and other numerical variables was first evaluated by single linear regression analysis. Variables with a p value of <0.10 in univariate analyzes were included in the multiple linear regression model. Multiple backward stepwise regression analysis was used to determine the final factors affecting log-HALP scores. A value of $p<0.05$ was considered statistically significant.

RESULTS

In the study, 16 (32.7%) in the osteoporosis group. A total of 49 patients were included, 18 (36.7%) in the osteopenia group and 15 (30.6%) in the normal group. The average age of the patients is 58.9±11.8 years. 26 (53.1%) of the patients are male. Additional diseases included hypertension in 40 (81.6%), diabetes in 29 (59.2%), and coronary artery disease in 4 (8.2%) (Table 1).

Table 1. Descriptive and clinical characteristics of patients (n=49)

Parameters	Statistics
Group *n (%)*	
Osteoporosis	16 (32.7)
Osteopenia	18 (36.7)
Normal	15 (30.6)
Age	58.9±11.8
Gender *n (%)*	
Male	26 (53.1)
Female	23 (46.9)
BMI	28.76±6.67
Comorbid Diseases* n (%)	
Hypertension	40 (81.6)
Diabetes Mellitus	29 (59.2)
Coronary artery disease	4 (8.2)
Hyperlipidemia	2 (4.1)

n: Number of patients %: Percentage value Numerical variables are summarized as mean±standard deviation. *: A patient may have more than one comorbid disease. BMI: Body mass index

In Table 2, hemogram and biochemical parameters are compared according to groups. According to Table 2, the uric acid values of the groups differ statistically. Uric acid levels of osteoporosis patients are statistically higher than osteopenia and normal patients. Uric acid values of patients in the osteopenia and normal groups are not statistically different.

According to Table 3, no statistically significant relationship was found between NLR, PLR, log-HALP scores and lumbar and femur BMD.

Table 3. Correlation of NLR, PLR and HALP score with bone mineral density

Parameters		
	r	*p*
NLR		
L1-L4 Total T score	0.167	0.252
L1-L4 Total Z score	0.164	0.261
Femur Neck T score	0.219	0.131
Femur Neck Z score	0.186	0.201
PLR		
L1-L4 Total T score	0.271	0.059
L1-L4 Total Z score	0.076	0.603
Femur Neck T score	0.017	0.908
Femur Neck Z score	0.004	0.977
HALP score		
L1-L4 Total T score	0.205	0.157
L1-L4 Total Z score	0.262	0.070
Femur Neck T score	0.149	0.306
Femur Neck Z score	0.159	0.276

*: Since the data showed a skewed distribution, log transformation was applied before analysis. rho: Spearman correlation coefficient

Table 2. Comparison of hemogram and biochemical parameters by groups

	Groups			Statistics	
Parameters	Osteoporosis	Osteopenia	Normal	Test value	p value
Glucose	125.5 (76.0-517.0)	144.0 (80.0-375.0)	184.0 (98.0-309.0)	1.134	0.567[&]
BUN	38.0 (11.0-71.0)	41.50 (26.0-71.0)	52.0 (30.0-69.0)	3.68	0.159[&]
Urea	81.00 (23.00-152.00)	88.5 (27.0-152.0)	112.0 (63.0-147.0)	3.586	0.166[&]
Creatinine	5.20 (3.40-12.80)	6.90 (1.10-8.90)	6.90 (3.60-10.80)	2.778	0.249[&]
Total protein	66.13±5.41	64.94±5.90	66.60±7.76	0.299	0.743[†]
Albumin	3.0.00±6.13	3.3.11±3.77	3.3.73±4.95	2.549	0.089[†]
Phosphorus	4.28±1.04	4.25±0.78	4.62±1.20	0.659	0.522[†]
Calcium	8.68±1.25	8.66±1.36	8.95±0.87	0.299	0.743[†]
Uric acid	8.68±2.04a	6.22±1.24b	5.17±1.02b	22.671	<0.001[†]
Triglyceride	181.5 (58.0-431.0)	122.5 (33.0-326.0)	156.0 (70.0-756.0)	0.555	0.758[&]
Total-C	180.0 (112.0-225.0)	163.0 (85.0-224.0)	179.0 (107.0-308.0)	1.563	0.458[&]
HDL-C	47.0 (32.0-97.0)	44.5 (20.0-68.0)	49.0 (26.0-81.0)	0.842	0.656[&]
LDL-C	102.5 (20.0-188.0)	87.0 (20.0-141.0)	96.0 (55.0-188.0)	2.090	0.352[&]
White blood cell	7.70±2.98	7.01±2.03	8.35±2.06	1.297	0.283[†]
Hemoglobin	11.13±1.41	11.11±1.75	11.42±1.58	0.182	0.834[†]
MCV	87.11±4.01	88.95±6.19	87.07±4.87	0.74	0.483[†]
Neutrophil	4.54 (2.32-11.50)	4.62 (2.32-8.14)	5.70 (3.40-9.43)	2.536	0.281[&]
Lymphocite	1.57 (0.92-2.60)	1.34 (0.57-3.43)	1.66 (0.65-2.80)	0.047	0.977[&]
Monocyte	0.72 (0.28-0.98)	0.54 (0.27-3.62)	0.71 (0.26-1.23)	3.456	0.178[&]
Platelet	244.5 (45.0-522.0)	247.5 (45. 0-368. 0)	242.0 (135. 0-360. 0)	0.397	0.820[&]
NLR	3.19 (2.17-6.25)	3.20 (2.29-7.19)	3.51 (1.78-9.17)	2.026	0.363[&]
PLR	177.99 (48.91-375.54)	172.78 (48.91-340.35)	166.67 (49.09-348.19)	0.151	0.927[&]
Ferritin	421.5 (41.0-1011.0)	496.5 (85.0-3285.0)	387.0 (52.0-1005.0)	2.149	0.342[&]
Parathormone	310.5 (70.0-877.0)	268.5 (40.0-823.0)	198.0 (50.0-639.0)	2.961	0.228[&]
CRP	7.45 (3.19-53.40)	9.15 (3.19-81.00)	17.90 (3.19-77.10)	4.064	0.131[&]
L1-L4 Total T score	-2.91±0.78[a]	-1.47±0.42[b]	0.71±1.05[c]	85.868	<0.001[†]
L1-L4 Total Z score	-1.63±1.40[a]	-0.55±0.74[b]	1.56±1.32[c]	29.458	<0.001[†]
Femur Neck T score	-2.15±1.30[a]	-1.41±0.97[b]	-0.31±0.77[c]	12.315	<0.001[†]
Femur Neck Z score	-1.08±1.25[a]	-0.40±0.85[a]	0.17±0.93[b]	5.730	0.006[†]
HALP Score	1.98 (0.74-6.21)	2.14 (1.05-6.21)	2.23 (0.91-8.82)	0.409	0.671[&]

Data are summarized as mean±standard deviation or median (minimum-maximum) value. [†]: One-way analysis of variance, [&]: Kruskal Wallis Analysis, superscripts a, b and c indicate differences between groups on the same line. There is no statistically significant difference between groups with the same superscripts.

DISCUSSION

49 HD patients were included in this study. It was performed to determine the predictive role of NLR, PLR and HALP score in BMD evaluation of chronic kidney failure (CKD) patients who have been on hemodialysis for at least 6 months. It was concluded that all three values do not have an index that will give an idea about the prognosis of bone mineral density in HD patients.

Osteoporosis is the most common metabolic bone disease characterized by low bone mass, deterioration of bone tissue and bone architecture, decreased bone strength and increased risk of fracture.[9] Studies have shown that bone mineral disorders are an important health problem in CKD patients and that fractures caused by osteoporosis significantly increase morbidity and mortality rates. While osteoporosis due to CKD was detected in approximately 53% of patients with CKD in the study of Festuccia et al.[10] this rate was found to be 43% in the study of Aslan et al.[11] In our study, the osteoporosis rate in CKD patients was found to be 32.7% and the osteopenia rate was 36.7%. Persistent chronic systemic inflammation in individuals with CKD can lead to various negative consequences such as cardiovascular disease, malnutrition, anemia, atherosclerosis, morbidity and mortality, as well as negative effects on bone metabolism.[12,13] Neutrophils stimulated by inflammatory cytokines such as IL-4 and TNF-α increase the stimulation of NF-kappa B-ligand (RANKL), which is transferred to their cell membranes. It has been shown that bone resorption increases in inflammatory conditions due to increased osteoclast activity.[14]

NLR and PLR are hemogram parameters and increase in inflammatory conditions. A cross-sectional study examining the relationship between NLR and bone density reported that NLR was an independent predictor of osteoporosis, negatively correlated with the lumbar spine and femoral neck. High NLR levels in elderly people with osteoporosis suggest that inflammation may play an important role in bone remodeling.[15]

In a study by Lee et al.[16] a negative correlation was found between NLR and lumbar BMD in postmenopausal women, while no relationship was found between femoral neck BMD. While Koseoglu et al.[17] study found that BMD values were inversely proportional to PLR but did not have a significant relationship with NLR, Yolaçan et al.[18] showed that NLR, as well as PLR, had an inverse relationship with BMD. In the study conducted by Ban et al.[19] in dialysis patients, NLR rates were independent of BMD. In our study, NLR and PLR values did not change according to BMD values.

Recently, there are studies showing that the HALP score reflects systemic inflammation and nutritional status. It has been proven to be a useful prognostic factor in patients with stomach, prostate, bladder and kidney malignancies and acute ischemic attack.[20] We did not find any study in the literature comparing bone mineral density and HALP score. Low BMI, which is among the risk factors for bone mineral density and exists in hemodialysis patients, may increase the susceptibility to osteoporosis in CKD patients. In addition, although it is considered that the presence of increased inflammation in CKD patients may contribute to low bone mass, no relationship was found between HALP score and BMD in this study.

Study Limitations

The limitation of this study is that there are many underlying mechanisms in the pathogenesis of osteoporosis in CKD patients and the small number of patients. In addition, the uncertainty of the effect of HALP score on prognosis in patients with independent CKD and low BMD compared to the healthy population is another limitation of this study.

CONCLUSION

As a result, no relationship was found between low BMD and NLR, PLR and HALP score in CKD patients.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was initiated with the approval of the Hitit University Medical Faculty Clinical Researches Ethics Committee (Date: 01.11.2023, Decision No: 2023-78).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Data Availability Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Original Article

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The effect of dynamic neuromuscular stabilization on trapezius muscle activation during shoulder exercises in individuals with rounded shoulder posture: a pilot study

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ABSTRACT

Aims: The aim of this pilot study is to investigate the impact of Dynamic Neuromuscular Stabilization (DNS) technique on the activation of the upper, middle, and lower parts of the trapezius muscle during commonly used shoulder exercises in individuals with rounded shoulder posture.

Methods: The study was conducted with 15 individuals exhibiting rounded shoulder posture. The determination of rounded shoulder posture was based on measuring the distance in centimeters between the posterior corner of the lateral acromion prominence and the bed in a supine position. If this distance was 2.5 cm or more, it was considered as rounded shoulder posture. Participants were taught three different shoulder exercises and the DNS respiratory technique, a component of Dynamic Neuromuscular Stabilization. The exercises were randomly performed with and without DNS, and the activation of the upper (UT), middle (MT), and lower (LT) parts of the trapezius muscle was measured separately using an 8-channel surface electromyography (EMG) system (Noraxon Ultium, Scottsdale, USA).

Results: The activation of all parts of the trapezius muscle was found to be higher when exercises were performed with DNS compared to without DNS ($p<0.05$). Additionally, the UT/MT and UT/LT activation ratios were compared during the exercises with and without DNS. It was observed that only during the 1st exercise, the UT/LT activation ratio was higher when exercises were performed with DNS ($p<0.05$), while in all other cases, it was similar ($p>0.05$).

Conclusion: The primary findings of the study suggest that the activation of all parts of the trapezius muscle is higher when exercises are performed with DNS. This implies that DNS may contribute to more effective exercise performance in terms of the activation of the relevant muscle group, indicating potential positive effects of DNS in rehabilitation programs. However, the participant profile in our study is limited to individuals with rounded shoulder posture. Further research in different populations is needed to generalize the obtained results.

Keywords: Dynamic neuromuscular stabilization, muscle activation, rounded shoulder

INTRODUCTION

Rounded shoulder posture is one of the prevalent postural abnormalities, contributing to 60% of shoulder problems. Its occurrence is reported to be 73% on the right side and 66% on the left side.[1] Considering the contemporary sedentary work conditions and prolonged use of technological devices such as smartphones and tablets, this condition appears to be commonplace. Individuals who sit for extended periods may experience fatigue in the lumbar extensors, adopting a comfortable and slouched sitting position. This prolonged flexed posture can lead to the distortion of the normal lordotic curve, increased anterior pelvic tilt, and, as a result, the development of rounded shoulder posture.[2]

As smartphones have become an integral part of daily life, they are recognized as a significant factor in the development of postural abnormalities. Unhealthy neck and shoulder postures are commonly observed during prolonged use of smartphones. Particularly, texting has been shown to significantly increase flexion angles in the cervical and upper

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thoracic spine and activate the upper part of the trapezius muscle.[3] Therefore, prolonged use of smartphones is reported to disrupt neck and upper back posture, leading to rounded shoulder posture.[4] Other causes of rounded shoulder posture include shortening of the upper trapezius (UT) muscle and weakness in the middle (MT) and lower trapezius (LT) and serratus anterior muscles. In this posture, the scapula assumes an anterior tilt position, and the shoulder moves forward. The scapula, serving as an anchor for muscles, plays a crucial role in the smooth and coordinated movement of the shoulder girdle. Therefore, alterations in scapular position can disrupt the normal biomechanics of the shoulder joint, leading to injuries.[1]

Changes in the position and kinematics of the scapula affect the activation of muscles in the scapulothoracic region.[5] Therefore, exercises targeting the muscles around the scapula play a crucial role in rehabilitation for rounded shoulder posture. Especially, the MT and LT muscles act as stabilizers in the scapulothoracic region.[6]

The increase in activation of the UT muscle leads to anterior tilting of the scapula, increasing shoulder protraction. Therefore, rehabilitation programs for the shoulder must include exercises targeting the trapezius muscle.[7]

Dynamic Neuromuscular Stabilization (DNS) aims to improve motor control, posture, and movement by building on the natural movement patterns exhibited by infants during their developmental stages. Furthermore, DNS emphasizes the importance of training the dynamic and stabilization functions of muscles within the kinetic chain. The DNS respiratory technique focuses on regulating intra-abdominal pressure by utilizing proper diaphragmatic function to enhance functional core stabilization. DNS provides stabilization of the spine and surrounding muscles during both static and dynamic movements. Deep spinal flexors and extensors, multifidus, diaphragm, pelvic floor muscles, and abdominal muscles are involved in this system. DNS uses the precise coordination of these muscles and the regulation of intra-abdominal pressure by the central nervous system for optimal performance. The co-contractions of these muscles increase intra-abdominal pressure, aiding in body stabilization.[8,9]

While numerous electromyography (EMG) studies have explored muscle activation during various exercises targeting scapulothoracic region muscles, no study has been found to investigate the use of DNS respiratory technique during commonly used shoulder exercises in individuals with rounded shoulder posture.

The aim of this study is to examine the impact of the DNS technique on the activation of the upper, middle, and lower parts of the trapezius muscle during commonly used shoulder exercises in individuals with rounded shoulder posture. The information obtained from this study is expected to provide guidance in the development of rehabilitation programs for rounded shoulder posture.

METHODS

The study was conducted with the participation of 15 volunteers at the Health Sciences University, Gülhane Faculty of Physiotherapy and Rehabilitation. Ethical approval was obtained from the Gazi University Ethics Committee (Date: 07.11.2023, Decision No: E-77082166-302.08.01-809534), and the study adhered to the 2018 updated Helsinki Declaration. Participants aged 18-30, with full shoulder range of motion, a body mass index less than 30 kg/m^2, and a rounded shoulder posture were included in the study. Individuals with orthopedic, neurological, rheumatological or systemic problems that could affect shoulder biomechanics were excluded from the study.

Demographic Characteristics

Gender, age (years), height (cm), and body weight (kg) of participants were recorded, and BMI was calculated (kg/m^2).

Determination of Rounded Shoulder Posture

In the supine position, the distance from the lateral acromion process's posterior corner to the bed was measured using a ruler. A measurement result of 2.5 cm or more was considered as rounded shoulder posture.[10]

Exercise Protocol

Three different scapular retraction exercises commonly used for rounded shoulders were selected as shoulder exercises. Exercises were performed using elastic bands with increasing resistance levels (Thera-Band®, Hygenic Corp, Ohio). In the first exercise (Exercise 1), the exercise band was looped around a fixed point at the level of the navel, and participants were instructed to pull the band backward with scapular retraction (shoulders by the sides, elbows flexed at 90 degrees, **Figure 1**).

Figure 1. Exercise 1

In the second exercise (Exercise 2), the exercise band was looped around a fixed point at shoulder height, and participants were instructed to grasp the band with both hands, pulling it backward to perform scapular retraction (arms abducted at 90 degrees, elbows flexed at 90 degrees, **Figure 2**).

Figure 2. Exercise 2

For the third exercise (Exercise 3), the band was looped around a fixed point above head level, and participants were instructed to grasp the band with both hands, pulling it downward and backward with scapular retraction (**Figure 3, Figure 4**).

Figure 3. Exercise 3

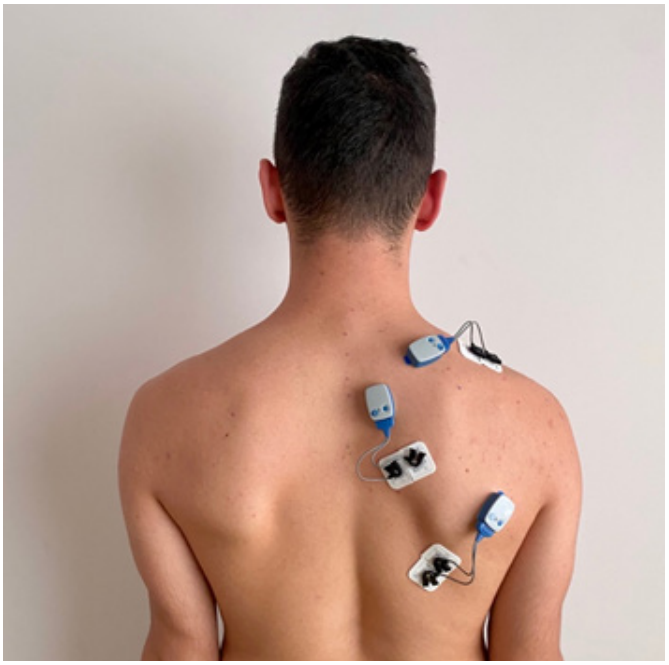

Figure 4. Electrodes placement according to SENIAM criteria

The OMNI Perceived Exertion Scale for Resistance Exercise (OMNI-RES) scale was used to determine the dosage during exercises. According to this scale, 6 points mean "somewhat hard" and 8 points mean "hard".[11] The resistance level corresponding to the 6-8 score range was selected as the dosage of elastic resistance.

Teaching of DNS Technique

The DNS respiratory technique, a component of DNS, was taught to participants by a physiotherapist with training in this technique. Participants were then asked to apply this respiratory technique along with the exercises. After ensuring that participants performed both the DNS respiratory technique and the exercises correctly, measurements were taken.

Measurement of Trapezius Muscle Activation

During the three different shoulder exercises, the activation of the upper, middle, and lower parts of the trapezius muscle on the dominant side was measured separately using an 8-channel surface electromyography (EMG) system (Noraxon Ultium, Scottsdale, USA). Silver/silver-chloride surface electrodes (3M™ Red Dot™) were used, and before electrode placement, the skin was cleaned. Electrodes were placed on the upper, middle, and lower parts of the trapezius muscle on the dominant side according to SENIAM criteria.[12] Maximum Voluntary Isometric Contraction (MVIC) values were measured separately for the three parts of the trapezius muscle and muscle activations during the exercises were normalized as %MVIC.[13,14]

Statistical Analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 21.0. Categorical variables were presented as frequencies and percentages. Variables were examined analytically using the Shapiro-Wilk test and visually using methods such as histograms and probability plots to determine normal distribution. Descriptive data were presented as median and interquartile range (25-75). As the data did not show normal distribution, the Friedman test was applied for multiple comparisons (comparison of upper, middle, and lower trapezius activations). Results were evaluated using Bonferroni correction for multiple comparisons. A total type-1 error level of 5% was used for statistical significance.

RESULTS

A total of 15 individuals with rounded shoulder posture participated in this pilot study (7 females, 8 males). All participants had their dominant upper extremity on the right side. The demographic characteristics of the participants are presented in **Table 1**.

Table 1. Demographic characteristics

	Median (IQR 25/75)
Age (years)	19 (18/19)
Height length (cm)	175 (163/180)
Body weight (kg)	69 (60/75)
BMI (kg/m^2)	22,3 (20,6/24,4)

IQR: Interquartile range, BMI: Body Mass Index

Acromion-bed distance, an indicator of rounded shoulders, and MVIC values for the upper, middle, and lower parts of the trapezius muscle are shown in Table 2.

Table 2. Other features

	Median (IQR 25/75)
Acromion-examining table distance	6 (4.5/7)
UT MVIC	507 (333/747)
MT MVIC	401 (277/681)
LT MVIC	185 (125/277)

IQR: Interquartile range, UT MVIC: Upper trapezius maximum voluntary isometric contraction, MT MVIC: Middle trapezius maximum voluntary isometric contraction, LT MVIC: Lower trapezius maximum voluntary isometric contraction

The UT muscle activation measured during exercises without and with DNS, normalized as %MVIC, is presented in Table 3. Similarly, MT muscle activation is shown in Table 4, and LT muscle activation is presented in Table 5. The activation of all parts of the trapezius muscle was found to be higher when exercises were performed with DNS compared to without DNS ($p<0.05$). P values are given one by one in the tables, and significant values are written in bold.

Table 3. Comparison of upper trapezius muscle activations during exercises

	Without DNS (n=32) Median (IQR 25/75)	With DNS (n=32) Median (IQR 25/75)	p
Exercise 1	13.8 (10.1/23.4)	28.6 (18.1/45.5)	**0.001**
Exercise 2	57.6 (41.7/80.4)	69.7 (61/92.9)	**0.001**
Exercise 3	27.5 (18.8/40.2)	42.4 (28.8/57.1)	**0.001**

IQR: Interquartile range

Table 4. Comparison of middle trapezius muscle activations during exercises

	Without DNS (n=32) Median (IQR 25/75)	With DNS (n=32) Median (IQR 25/75)	p
Exercise 1	27.6 (25/48.9)	43. 4 (29.6/59.3)	**0.001**
Exercise 2	62.7 (36/84.2)	73.8 (47.1/97.3)	**0.001**
Exercise 3	34 (26.9/44.9)	52.8 (47.7/68.7)	**0.008**

IQR: Interquartile range

Table 5. Comparison of lower trapezius muscle activations during exercises

	Without DNS (n=32) Median (IQR 25/75)	With DNS (n=32) Median (IQR 25/75)	p
Exercise 1	59 (37/78)	83 (57.8/101)	**0.001**
Exercise 2	50.2 (38/84.4)	62.2 (57.4/101.1)	**0.005**
Exercise 3	54.7 (30.7/71.5)	72.5 (41/87.5)	**0.008**

IQR: Interquartile range

The comparison of the UT/MT and UT/LT activation ratios of the trapezius muscle during three different exercises without and with DNS is given in Table 6. The analysis revealed that only during the 1st exercise, the UT/LT activation ratio was higher when exercises were performed with DNS ($p<0.05$), while in all other cases, it was similar ($p>0.05$). P values are given one by one in the table, and the significant p value is written in bold.

Table 6. Comparison of upper trapezius/ middle trapezius and upper trapezius/ lower trapezius muscle activation rates during exercises

		Without DNS (n=32) Median (IQR 25/75)	With DNS (n=32) Median (IQR 25/75)	p
Exercise 1	UT/MT	0.54 (0.30/1.06)	0.66 (0.32/1.16)	0.691
	UT/MT	0.28 (0.21/0.45)	0.36 (0.25/0.79)	**0.027**
Exercise 2	UT/MT	0.95 (0.61/1.30)	1 (0.77/1.22)	0.910
	UT/MT	1.1 (0.74/1.86)	1.1 (0.87/1.56)	0.233
Exercise 3	UT/MT	0.90 (0.51/1.28)	0.76 (0.6/1.13)	0.865
	UT/MT	0.59 (0.37/1.03)	0.61 (0.37/1.44)	0.233

IQR: Interquartile range UT: Upper trapezius, MT: Middle trapezius, LT: Lower trapezius

DISCUSSION

This pilot study aims to investigate how the activation of the upper, middle, and lower parts of the trapezius muscle changes during three different exercises commonly used in the rehabilitation of rounded shoulder posture when performed with and without DNS. The demographic characteristics of the participants are provided, and the activation of the UT, MT, and LT muscles during exercises without and with DNS is compared. The key findings of the study indicate that the activation of all parts of the trapezius muscle is higher when exercises are performed with DNS. This suggests that DNS may enhance the effectiveness of exercises in activating the relevant muscle group and points to the potential positive effects of DNS in rehabilitation programs.

In a study examining the impact of DNS on functional movements, 34 participants were divided into two groups (DNS group and physical fitness group) and subjected to a 6-week training program. Results were assessed through five different functional movement tests, consistently showing superior outcomes in the DNS group. The study concluded that DNS could be employed to enhance functional movements.[15] Marand et al.[16] also utilized DNS in the rehabilitation of MS patients, comparing its effects on balance, trunk function, mobility, fall prevention, and spasticity with core stabilization exercises. They found that DNS improved balance, trunk function, and mobility, effectively preventing falls and demonstrating superiority over core stabilization exercises. These results were attributed to the reflexive activation of the diaphragm, transverse abdominal muscles, pelvic floor, and multifidus muscles in coordination with spinal muscles, contributing to active postural stability. Similarly, Son et al.[17] reported that DNS increased postural stability in children with cerebral palsy, aligning with the findings of the aforementioned study. Furthermore, DNS is reported to be utilized and effective in stroke rehabilitation, athlete rehabilitation, and correcting poor posture.[18] Based on the results of our study, we believe that DNS can be employed in rounded shoulder posture rehabilitation. It is suggested that respiratory muscles play a significant role in both static and dynamic postural stability. DNS is known to increase intra-abdominal pressure (IAP) by utilizing the diaphragm, pelvic floor muscles, multifidus muscle, internal oblique muscles (IO), and transversus abdominis (TrA). There is a consensus that an increase in IAP stabilizes the spine. In the DNS technique, as the diaphragm descends during inhalation, it reflexively activates deep core muscles (TrA, IO, pelvic floor muscles, multifidus) eccentrically. Eccentrically activated

muscles contract concentrically, creating IAP, thereby providing the necessary core stabilization and postural stability during dynamic movements.[9,19] Additionally, it has been demonstrated that DNS can be used to strengthen core muscles and is more effective than many other core stabilization methods.18 In a study by Lee et al.[20], where they compared core stabilization techniques (abdominal drawing-in maneuver, abdominal bracing, and DNS) through assessment with ultrasound and EMG, they concluded that DNS is the most effective technique for core stabilization. This determination was based on its ability to achieve balanced and coordinated activation of the diaphragm and TrA muscles. In their study, Yoon et al.[21] investigated the effects of DNS and NDT (Neurodevelopmental Treatment) in healthy adults and individuals with hemiparetic stroke. They evaluated outcome parameters using EMG and ultrasound. The study reported that in both the healthy and patient groups, DNS demonstrated better activation of TrA and IO muscles compared to NDT. They emphasized that DNS, through the coordination of the diaphragm with the superficial core muscles, facilitates the co-activation of TrA, IO, pelvic floor muscles, and multifidus muscles, dynamically stabilizing the spine. The stabilization of the core region is defined as a prerequisite for the manifestation of functional extremity movements, as it facilitates power generation, transfer, and control.[22] Ensuring the stabilization of proximal body segments is crucial for revealing good functional movement in distal body segments.[23] DNS may enhance trapezius muscle activation by increasing spine stabilization. However, it is important to consider that DNS may also increase UT activation, which could be a potential drawback for shoulder rehabilitation. While some authors suggest a potential connection between shoulder pathologies and overall weakness of the scapulothoracic muscles, the current perspective leans towards attributing shoulder issues to scapular muscle imbalance rather than generalized weakness. Particularly, excessive activation of the UT may lead to abnormal scapular movement, accompanied by decreased control of the anterior deltoid and serratus anterior muscles.[24,25] Therefore, instead of general strengthening of the scapular muscles, selective activation of weak muscles and minimal UT activation are recommended in shoulder rehabilitation programs.[26]

Restoring balanced muscle activation can be challenging for clinicians. Selective activation of weak muscle parts with minimal activation of overactive muscles is a crucial component in reducing imbalances. The ratios of UT to MT and UT to LT muscle activations are particularly important, as the deficiency in activity in MT and LT trapezius often combines with the overuse of the UT. In shoulder rehabilitation, the goal is typically to create an exercise program where UT activation is low, and MT and LT activation is high.[27] It has been reported that excessive activation of the UT causes superior translation of the humeral head and anterior tilt of the scapula, narrowing the subacromial space.[28] According to Cools et al.[25], during an exercise given for the rehabilitation of scapular muscle balance, the UT/MT and UT/LT muscle activation ratio should be less than 0.60. In our study, UT/MT and UT/LT muscle activation ratios were examined, and it was found that only in the first exercise, the UT/LT activation ratio was higher when the exercise was performed with DNS. In other cases, similar ratios were observed. While the higher UT/LT activation ratio during the first exercise with DNS may initially seem unfavorable, it is still below the critical threshold determined by Cools et al.[25] (0.36). Even though UT activation increases with the relevant exercise performed with DNS, the UT/LT ratio remaining below the critical threshold suggests that this exercise can be prescribed with DNS. In all other cases, where the UT/MT and UT/LT ratios did not change when exercises were performed with DNS, we believe that these exercises can be safely used.

CONCLUSION

Our study is the first to examine the impact of DNS on the activation of the trapezius muscle during various shoulder exercises. Our findings underscore the potential benefits of DNS in exercise routines commonly used in rehabilitation programs. In conclusion, this study demonstrates that DNS can positively influence exercise performance by increasing trapezius muscle activation in individuals with rounded shoulder posture. However, the participant profile in our study is limited to individuals with rounded shoulder posture. Further research involving diverse populations is needed to generalize the results obtained.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Gazi University Ethics Committee (Date: 07.11.2023, Decision No: E-77082166-302.08.01-809534).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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The authors declared that this study has received no financial support.

Author Contributions

All of the authors declared that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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Total knee arthroplasty and rehabilitation

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ABSTRACT

Arthroplasty is the reconstruction of the joint to relieve pain, increase range of motion and provide stabilization in any joint. The main goals of total knee arthroplasty are to relieve pain, improve function, improve quality of life, create a long-lasting artificial joint, and prevent or reduce surgical complications. Joint infection, sepsis or systemic infections, neuropathic arthropathy, painful stiff knee fusion due to complex regional pain syndrome (CRPS), genu recurvatum due to neuromuscular weakness, painless and well-functioning knee arthrodesis are absolute contraindications to total knee arthroplasty. In addition, the patient should be monitored for circulation, sensation and infections during the acute period (1-5 days). An appropriate DVT prophylaxis should be given. There is evidence that long-term physical deficiencies persist after arthroplasty. Since decreased muscle strength, decreased flexibility, abnormalities in walking, and deficits in postural stability can be detected, it is recommended to continue exercise programs for at least 1 year.

Keywords: Arthroplasty, joint pain, knee, relieve pain

INTRODUCTION

Arthroplasty is the reconstruction of the joint to relieve pain, increase range of motion and provide stabilization in any joint. The main goals of total knee arthroplasty (TKA) are to relieve pain, improve function, improve quality of life, create a long-lasting artificial joint, and prevent or reduce surgical complications. The main indications for arthroplasty are knee pain with functional deterioration, inadequate activities of daily living (ADL), radiographic evidence of significant arthritic involvement, failure of conservative treatment, inflammatory arthritis, sequelae of previous pyogenic arthritis or osteomyelitis, avascular necrosis, tumors, congenital deformities.[1]

TOTAL KNEE ARTHROPLASTY REHABILITATION GOALS[1-3]

- To prevent complications such as deep vein thrombosis (DVT), pulmonary embolism, pressure sores that may develop due to bed rest
- Ensuring adequate and functional range of motion (ROM)
- Trying to reduce post operative pain
- Strengthen the muscles around the knee
- Ensuring independence in ambulation and IYA
- Improving the quality of life can be counted among our main goals.

Joint infection, sepsis or systemic infections, neuropathic arthropathy, painful stiff knee fusion due to complex regional pain syndrome (CRPS), genu recurvatum due to neuromuscular weakness, painless and well-functioning knee arthrodesis are absolute contraindications to total knee arthroplasty. Relative contraindications include severe osteoporosis, poor health status, dysfunctional extensor mechanism, painless and stable arthrodesis, significant peripheral vascular disease, patients who cannot comply with rehabilitation, body mass index over 50, recurrent urinary infections.[3]

TKA can be classified according to the compartment in which the prosthesis is applied, the mechanical support it provides and the type of fixation. According to the compartment in which the prosthesis is applied

1. Unicompartmental knee prostheses
2. Bicompartmental knee prostheses
3. It can be classified as tricompartmental knee prosthesis.

According to the mechanical support it provides

1. Constrained
2. Semi constrained
3. It can be evaluated as unconstrained.

According to fixation types;

1. Cemented
2. Cementless
3. Hybrid.[4]

With the development of new implant designs and surgical techniques, the long-term survival rates of cementless total knee arthroplasty (TKA) have become equal to those of cemented TKA, with excellent results

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reported in many studies. Studies on cemented TKA have shown that the outcomes of young and obese patients are worse than those of older and thinner patients. In addition, with cementless TKA, similar results have been obtained in young and obese patients to those in older and thinner patients. In this case, cementless TKA emerges as a more suitable option for young and obese patients.[4-6]

Rehabilitation in total knee arthroplasty is handled in 3 stages: preoperative, post operative, late post operative rehabilitation. Preoperative rehabilitation goals and objectives include starting aerobic exercises, patient education, pain management, teaching acute post operative exercises, and informing the patient about possible complications.[6]

For post operative rehabilitation, the first point to be mentioned is that despite all the developments in total joint arthroplasty, there is no standard post operative treatment protocol after TKA. The important point in rehabilitation planning is the type of prosthesis. In cemented prostheses, load bearing with a walker may be allowed as tolerated from the first postoperative day. In uncemented and hybrid prostheses, full load bearing is usually started after the 6th week. It has been proven that early mobilization has an important place in the rehabilitation program when appropriate conditions are provided.[7]

POST OPERATIVE ACUTE REHABILITATION

Pain assessment with visual analog scale (VAS) before and after treatment, rest, cold application, compression, elevation, continuous passive motion (CPM) device is used. With the CPM device, it is aimed to increase knee flexion up to 40 degrees on the 4th day, then increase by 10 degrees every day according to the patient's tolerance and reach 90 degrees of flexion at the end of the 1st week. Each cycle of the CPM device should be completed in one minute. Although it is accepted that the CPM device has no significant negative effect on wound healing, a few studies have suggested that flexion angles above 40 degrees in the first days of surgery impair tissue oxygenation. It is accepted that the CPM device does not reduce the incidence of deep vein thrombosis. It should be known that the CPM device does not reduce the use of analgesics and hospitalization time and has no effect on quadriceps strength. Despite such effects, the use of the CPM device has become widespread due to its advantages such as the patient feeling less pain compared to manual passive exercises during rehabilitation, not occupying the therapist, being theoretically applicable for 24 hours although it is not suitable for use for more than 4-6 hours, and good patient compliance.[8]

In addition, the patient should be monitored for circulation, sensation and infections during the acute period (1-5 days). An appropriate DVT prophylaxis should be given. TENS (Transcutenous Electrical Nerve Stimulation), NMES (Neuromuscular Electrical Stimulation) can be applied.[9]

Careful wound care should be practiced. Bedside exercises should be practiced. Most studies indicate that these exercises should be started immediately 2-4 hours postop. Ankle pumping exercises and quadriceps isometric exercises are beneficial. If there is no extension limitation, straight leg raising can be started. At the same time, isometric hip extension exercises, heel shifting exercises according to the patient's tolerance, terminal knee extension with the help of a pillow or a small support, patellar mobilization (when the incision site stabilizes) can be applied, and all these exercises are considered among the acute period goals.[2,8-10]

Post-operative Weeks 1-4

Achieving full extension, normalization of walking and focusing on increasing the flexion angle are among the most important goals of this period. Again in this period, gradually increasing the flexion angle from 90 degrees to 120 degrees and transition to independent functions in daily life activities are among the goals. It is very important to review the walking aids and make them safe for the patient. The importance of applying stretching exercises to the hamstring, gastrocnemius-soleus, iliotibial band, tensor fascia lata and lower extremity muscles in general has been stated in many studies. Balance exercises, increasing walking distance and improving walking tolerance, quadriceps sets, straight leg raises, gluteal sets, active assistive, active ROM exercises in sitting or supine position, horizontal cycling, bedside exercises with assisted or friction-reduced heel sliding exercises, terminal knee extension exercises with teraband, strengthening of gluteus medius and external rotator muscles, hip and knee circumference isometric exercises can be shown among other objectives in this period.[7,8,10-12]

Post-operative Weeks 4-12

Restoration of gait is among the main goals. Unilateral treadmill can be used with intact leg and bilateral upper extremity support. Closed kinetic chain exercises, parallel bar training, and ROM and strengthening exercises according to the patient's tolerance can be progressed according to the patient's clinic and response to treatment. There is evidence that NMES with quadriceps sets/straight leg raises is beneficial. Terminal knee extension, progressive hip abduction/adduction strengthening exercises can be applied. The patient should be ambulated on smooth surfaces and stairs with the least restrictive device or independently.[1-3,7-11]

9-12 Weeks and Above

Exercise progression and discharge plan are decided according to the patient's condition.

Recommendations for exercise and sports activities after total knee arthroplasty: After hip and knee arthroplasty, low and moderate intensity activities that do not overload the joint are allowed. Sports with high compressive and rotator loading on the joint and high risk of injury are not allowed.

- Activities such as swimming, walking, dancing, dancing, cycling, horseback riding, bowling, aquatic aerobic exercises, fitness, yoga, Thai-chi are recommended.
- Skiing, running/jogging, rowing, tennis and golf are recommended with limitations.
- Sports such as football, basketball, volleyball, handball, speed skating, figure skating, ice hockey, rock climbing are not allowed.[1-10]

There is evidence that long-term physical deficiencies persist after arthroplasty. Since decreased muscle strength, decreased flexibility, abnormalities in walking, and deficits in postural stability can be detected, it is recommended to continue exercise programs for at least 1 year.[11]

COMPLICATIONS OF TOTAL KNEE ARTHROPLASTY IN THE EARLY POSTOPERATIVE PERIOD[12-14]

Mortality (0.2-0.7% in the first 90 days after surgery)

- Thromboembolic event
- Neurovascular damage
- Infection
- Arterial injury (0.03-0.2%. But there is a risk of amputation in 25% of cases after injury.
- Peroneal nerve injury (with correction of severe valgus deformity)
- Patellofemoral problems (PF instability, component loosening, fracture, extensor mechanism rupture, patellar clunk syndrome)
- Periprostatic fractures*
- Patellar insitability*
- Aseptic relaxation*

*(Revision surgery is required in such complications)

- Flexion contracture
- Flexion limitation
- Pain and swelling, including

Patellar complications are quite common, accounting for approximately 10% of TKA-related complications. Despite advances in implant design and surgical techniques, these complications can still occur. If the underlying mechanisms of these complications are not well-defined, they can lead to repeated surgeries that do not achieve the desired outcome.[15]

Total knee arthroplasty (TKA) is a surgery to replace a damaged knee joint with an artificial joint. In about 1-12% of patients who undergo TKA, extensor mechanism problems can occur. Quadriceps tendon rupture is reported to occur in 0.1%, while patellar tendon rupture is reported to occur in 0.17%. Traditionally, tendon repair was the preferred treatment for these injuries. However, due to the high failure rates of this method, reconstruction has become the preferred treatment in recent years.[16-17]

The goal of total knee arthroplasty (TKA) is to restore the balance and range of motion of the knee joint and relieve pain. As the average life expectancy increases and the elderly population grows, the need for joint prostheses increases. However, weaknesses in muscles and ligaments in the elderly, prolonged immobilization due to additional diseases, and circulatory disorders can reduce the success of TKA. Multidisciplinary work is important for patients who have undergone TKA to return to their daily activities as soon as possible and to achieve a pain-free life. The analgesia applied after TKA is usually multimodal, including patient-controlled analgesia, peripheral nerve block, epidural analgesia, intra-articular or intra-synovial opioids or local anesthetics, and oral analgesics. Multimodal analgesia is provided by the use of analgesic agents that act on different parts of the pain pathway.[18-19]

Long-term pain following total knee arthroplasty (TKA) and the inability to relieve pain can disrupt rehabilitation. As a result, arthrofibrosis can occur. Increasing range of motion after TKA is very important not only for functional improvement but also for pain reduction. Studies have shown that some patients have concerns such as movement phobia (kinesiophobia), damage to the prosthesis, and increased pain. Movement phobia can be reduced with preoperative activity perception training.[20]

CONCLUSION

Arthroplasty is the reconstruction of the joint to relieve pain, increase range of motion and provide stabilization in any joint. The sooner you start, the more beneficial it will be. Therefore, patients need to continue this process with physical therapy and physiotherapy.

ETHICAL DECLARATIONS

Referee Evaluation Process: Externally peer-reviewed.

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Case Report

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Abnormal lesion that can be confused with medial meniscal tears, medial meniscocapsular band: a rare presentation

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ABSTRACT

This case report describes a meniscocapsular band, a structure extending from the medial capsule of the knee joint to the corpus of the medial meniscus, observed during arthroscopy in a 48-year-old woman. Preoperative physical examination findings were compatible with medial meniscal pathology only; magnetic resonance imaging showed an abnormal medial meniscus and was interpreted in favor of a tear. Arthroscopic examination showed an abnormal band inside the knee. This anatomical lesion is quite rare and similar lesions have been reported in the literature, but the extension of the band in our case is different from the extension in the cases seen in the literature. We believe that the identification of abnormal meniscal types or intra-articular bands is necessary to provide greater accuracy in MR imaging reporting.

Keywords: Arthroscopy, meniscocapsular bant, variation, meniscus

INTRODUCTION

Menisci are fibrocartilage, crescent-shaped, triangular cross-sectional structures located lateral and medial to the knee. They provide articulation between the concave femoral articular surface and the flat tibial plateau surfaces. They cover approximately 2/3 of the tibial plateau.[1,2] The menisci are connected to the tibia by coronary (meniscotibial) ligaments. The coronary ligaments are composed of capsular fibers; proximally they attach to the outer edges of the menisci and distally to the tibial condyles. The coronary ligaments attach to the tibial condyles a few mm below the articular surface, forming a synovial space.[3] The medial meniscus is C-shaped and occupies approximately 60% of the medial tibial plateau joint contact area.[4] Its posterior horn is wider than the anterior horn; it becomes progressively smaller from posterior to anterior and its anteroposterior diameter is larger than its medial lateral diameter. The medial meniscus is divided into five regions according to some anatomical features: anterior root region, anteromedial region, medial region, posterior region, posterior root region.[5]

Meniscal tears are more common in men than in women, although studies have reported different rates (2.5-4:1).[6] Both lateral and medial meniscal tears often involve the posterior horns; tears in the anterior horns are usually extensions of the posterior tears. Diagnosed isolated tears are three times more common on the medial side than the lateral. They usually occur after a severe rotational trauma, are in the vertical plane, and run longitudinally or obliquely.[6]

Magnetic resonance imaging (MRI) is one of the most commonly used methods for the diagnosis of meniscal tears. In various studies, the accuracy rate of MR in the diagnosis of meniscal lesions has been reported to be 65-99%.[7,8] Although the literature suggests that the use of PD (Proton Density) sequence is more useful than T2-a in the evaluation of meniscal tears, it has been reported that coronal T2-a images have a higher accuracy rate than PD in the evaluation of medial meniscal root tears. Therefore, all available sequences and images should be evaluated together in knee MRI. [8]

Meniscal tears or extrusions result in a larger direct contact area between the articular cartilage of the medial femoral condyle and the tibial plateau, increasing the risk of articular cartilage damage in the medial femorotibial compartment and thus causing or accelerating degenerative knee joint disease. Recent studies have observed a hypointense band extending in a slightly oblique transverse course between the medial femoral condyle and the anteromedial joint capsule overlying the anterior horn of the medial meniscus in cases of medial meniscal extrusion on MRI.[9] A band extending in a similar pattern but with different origo and insertion sites was observed in our case. Since the origo and insertion areas are different, these variations, which were confused with MCL (especially the deep branch) ruptures in the present study, showed an MR image finding that was confused with a medial meniscal tear in our case (**Figure 1**). In the arthroscopic examination of a patient with a preliminary diagnosis of medial meniscal tear, we observed an abnormal band-like structure in the area considered to be a meniscal tear on MR imaging (**Figure 2**). We hypothesized that it developed due to chronic instability in the knee. This hypothetical mechanism needs to be confirmed by biomechanical analysis.

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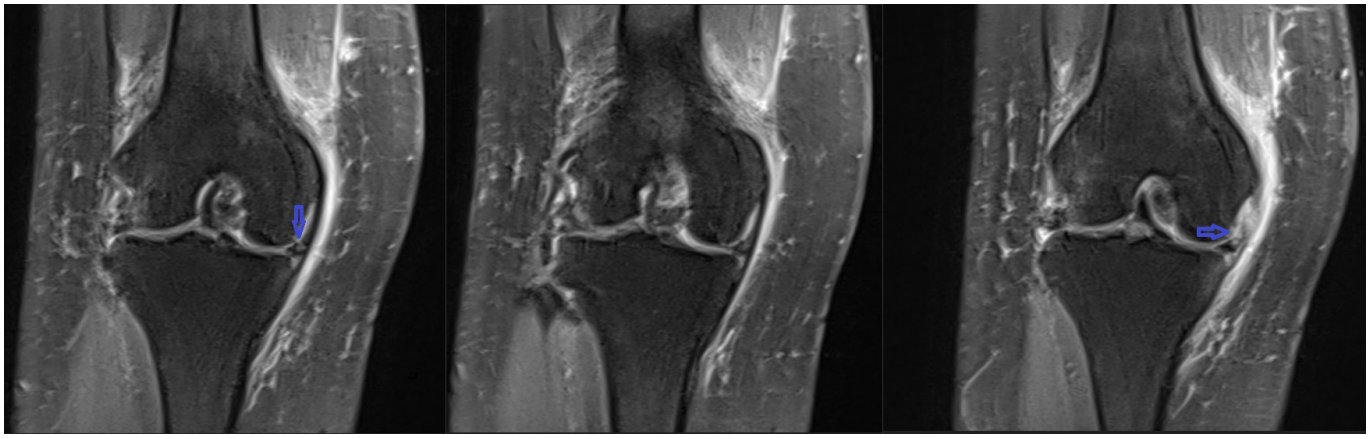

Figure 1. Abnormal band image (blue arrow) in the anteromedial region of the medial meniscus in the coronal planes on MR imaging, giving an appearance confusing with a meniscal tear.

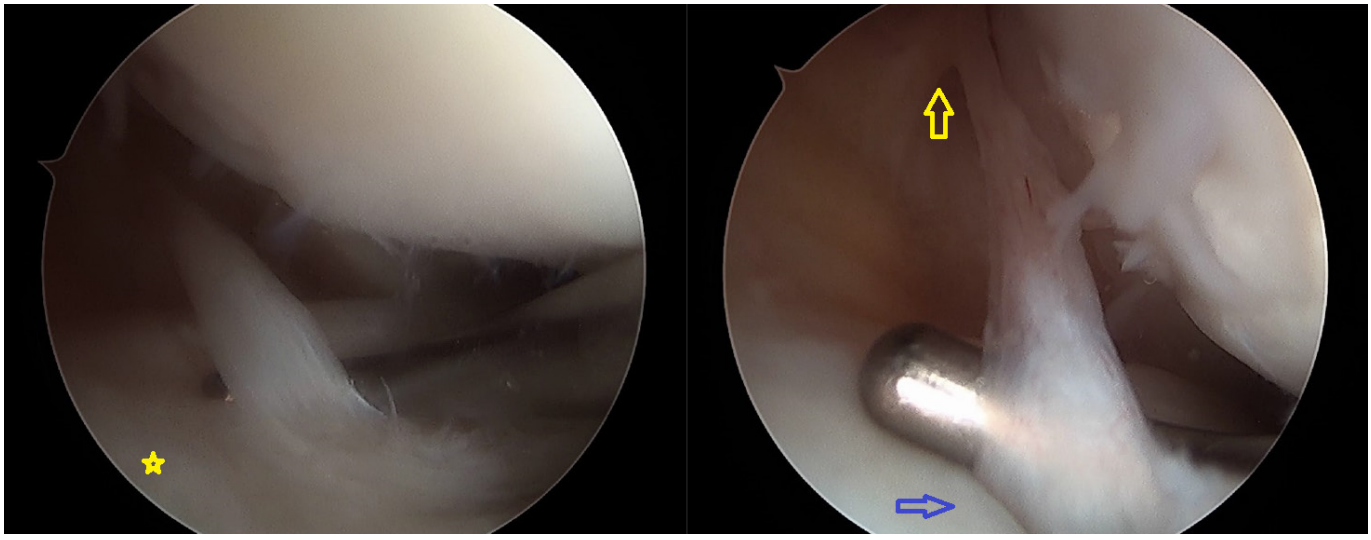

Figure 2. Arthroscopic knee joint medial compartment examination showing the appearance of an abnormal band from the medial capsule (yellow arrow) to the anteromedial region (blue arrow) of the medial meniscus (yellow star).

CASE

A 48-year-old woman was admitted to our service with complaints of right knee pain and click sound with movement for two years. There was no history of trauma. Physical examination confirmed effusion in the knee joint. Although there was pain in the last 30° flexion, range of motion imaging showed bone marrow edema consistent with contusion in the medial condyle of the femur. Articular cartilage was intact. There was pain in the medial joint line on palpation and Mc Murray test was positive. X-ray showed osteoarthrosis of the medial tibiofemoral and patellofemoral joint space. There was a 1 cm × 2 cm diameter Outerbridge stage 3 chondral defect in the medial femoral condyle related to magnetic resonance thickness and signal intensity of the right knee. There was effusion in the prepatellar bursa, suprapatellar bursa, hoffa and joint space. There is bone marrow edema in the medial condyle of the tibia consistent with contusion. The ACL, PCL, MCL and LCL structures preserved their continuity, formation and signal intensities. The lateral meniscus was normal and no tear was observed. A horizontal tear was observed in the medial meniscal corpus. Since conservative treatment was unsuccessful, we decided to apply arthroscopic surgery. Arthroscopic examination of the right knee confirmed a 1 cm×2 cm diameter Outerbridge stage 3 chondral defect in the medial femoral condyle. ACL and posterior cruciate ligament (PCL) were intact. No pathology was detected in the lateral joint. Examination of the medial compartment confirmed a band starting from the medial capsule and progressing obliquely to the white-white zone in the anteromedial region of the medial meniscus, which was very tightly attached to this region of the meniscus. No tear in the medial meniscus other than this band was detected on arthroscopic examination. This variant lesion in the medial compartment of the patient was excised by arthroscopic resection. The mensicus tissue was shaved. A 1 cm×2 cm diameter Outerbridge stage 3 chondral defect in the medial femoral condyle was intervened with the micro-fracture technique. The surgical operation was terminated. In the postoperative follow-up, our patient achieved a rapid recovery and full return to daily activity after both resection of the abnormal meniscocapsular band and arthroscopic debridement and microfracture technique of the grade 3 cartilage lesion.

DISCUSSION

A three-layered configuration of the medial capsular and supporting soft tissue structures of the knee was first proposed by Warren and Marshall, according to which layer 1 consists of the deep crural fascia; layer 2, the superficial MCL; and layer 3, the knee joint capsule, the deep MCL (meniscofemoral and meniscotibial extensions) and the patellomeniscal ligament.[10] The latest edition of Gray's Anatomy describes "fibers" in layer 3 that are sent from the capsule to the "medial meniscus".[11] Apart from this textbook information, no other study in the literature has been found regarding a meniscocapsular band in such a medial compartment.

In 2000, Lee and Min reported 2 Korean patients (3 knees). They found abnormal lateral meniscal structures on arthroscopy. They named their findings as abnormal lateral meniscal band. In both cases, the abnormal band was thin, snake-shaped and narrower than the underlying native lateral meniscus. The abnormal band showed peripheral attachments to the posterior horn and middle segment of the underlying normal lateral meniscus, but the intervening segment of the accessory meniscus was free and unrelated to the underlying true lateral meniscus. Arthroscopic resection resulted in symptomatic improvement in all cases.[12]

Our case illustrates an interesting abnormal band that has not been previously described in the literature. In our case report, both resection of the abnormal meniscocapsular band and arthroscopic debridement and microfracture of the grade 3 cartilage lesion resulted in a rapid recovery and full return to daily activity. However, it is unclear whether this improvement was due to resection of the abnormal meniscocapsular band or arthroscopic debridement and microfracture technique of the cartilage lesion.

The found in studies in the literature have mostly described variations that are confused with or resemble the deep MCL structure.[9] The reason for this is that the meniscal attachment of the bands in these studies is from the capsular region. In our case, the preoperative MR image of our case is more likely to be confused with a medial meniscal corpus tear because this connection is more from the white-white zone of the meniscus.

In our study, we showed that it is possible to identify abnormal meniscocapsular band patterns on MRI. This may raise the question of whether radiographically identifiable but clinically silent meniscal anomalies require surgical debridement. To our knowledge, no study has followed the natural history of clinically silent meniscal variations or abnormal bands. However, in the absence of direct chondral damage resulting from abnormal meniscocapsular band patterns, it is reasonable to follow such incidental findings conservatively. If another associated pathology requires surgical intervention, resection of the abnormal tissue may make sense, given the possibility of subsequent chondral injury.

CONCLUSION

Finally, a previously undescribed meniscocapsular band was described in this case report and this structure is confused with a meniscal tear on preoperative MR imaging. If such abnormal bands are detected in arthroscopic examinations, we recommend resection of the abnormal band, considering the possibility of chondral injury.

ETHICAL DECLARATIONS

Informed Consent

All patients signed the free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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