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EDITORIAL

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ORIGINAL ARTICLE

REVIEW

CASE REPORT

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Original Article

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Exploring the relationship between scapular dyskinesia and the injury risk among overhead athletes

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ABSTRACT

Aims: The present study attempted to investigate the relationship between scapular dyskinesia (SD) and injury risk in overhead athletes and to compare the injury risks between athletes with SD and those without.

Methods: We recruited a total of 96 athletes for this study on a voluntary basis, including 18 basketball players, 64 volleyball players, and 14 handball players. Initially, we noted down their demographic and physical characteristics. Then, we assessed their SD using the Scapular Assistance Test (SAT), the Scapular Retraction Test (SRT), and the Lateral Scapular Slide Test (LSST). Moreover, we assessed their injury risks using the Functional Movement Screen (FMS).

Results: Our findings revealed SD in 29 (30.2%) overhead athletes. Moreover, 26 of these 29 athletes showed poor FMS performance with a score below 14 points, the critical threshold in the FMS. On the other hand, 63 athletes without SD demonstrated good FMS performance with a score of 14 points or more. Accordingly, we concluded a significant relationship between SD and FMS total score among our participants ($p< 0.05$).

Conclusion: Overall, we concluded that overhead athletes with SD may have significantly higher injury risk than their counterparts without SD.

Keywords: Overhead athletes, scapular dyskinesia, injury risk, functional movement

INTRODUCTION

Any changes to shoulder biomechanics may lead to unpredictable injuries, and the scapula assumes a significant role in this regard.[1] The primary task of the scapula in the shoulder is to balance muscle activation during overhead activities and to allow the bones in the shoulder complex to move in harmony. The scapula undertakes an active role in movements, such as up-down motions, protraction-retraction, internal-external rotation, and anterior-posterior tilt, for the above-mentioned task in the shoulder.[2,3] Good scapula mobility is of great importance regarding optimal upper extremity functions.[4,5]

Scapular dyskinesia (SD) is a condition characterized by the abnormal resting position of the scapula or abnormal scapular motions with the motion of the upper extremity that leads to deterioration of the scapulohumeral rhythm.[6] Scapular winging, the most commonly known abnormal scapular position, is characterized by the prominence of the medial edge. The main factor leading to scapular winging is paralysis of the thoracic longus nerve and/or scapular muscle weakness, which may be evident among those engaging in overhead activities or in various shoulder pathologies. The consequences of scapular winging may appear as loss of muscle strength, limitation of upper extremity motion, and pain.[7,8]

SD prevalently appears in overhead activities (e.g., basketball, volleyball, and handball) possibly due to repetitive overhead activities in the shoulder joint, direct traumas during competition or training, injuries to other structures of the shoulder, muscle strains, and overuse related fatigue.[9]

Predicting possible injuries in sports and taking relevant precautions seem to be a key to athletes' maintaining their performance efficiency.[10] Functional Movement Screen (FMS) is an early warning screening that can be administered quickly and conveniently in the field without the need for further laboratory tests or costly equipment to predict possible injuries among athletes.[11]

The previous research set a score of 14 points as the critical threshold in the FMS and recognized scores below this cut-off score as poor FMS performance. These studies also documented a significant relationship between an FMS score below the cut-off score and injury risk.[12-15]

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This study was conducted to examine the relationship between scapular dyskinesia (SD) and injury risk in overhead athletes and compare the injury risks between athletes who develop scapular dyskinesia and those who do not.

No study has been found in the literature showing the relationship between scapular dyskinesia and Functional Movement Analysis (FMS) scores in overhead athletes. It is thought that this study will make up for this deficiency in the literature.

METHODS

The present study was carried out at Siirt University, School of Physical Education and Sports between July-December in 2022. Those who were a) 18-35 years old, b) professional basketball, volleyball, or handball players, c) have been actively playing basketball, volleyball, or handball for at least six months, d) had a body mass index (BMI) between 18.5-25 kg/cm², and e) voluntary to participate in the study participated in the study. Yet, those who a) had undergone a surgical operation involving the musculoskeletal system in the last six months, b) had a condition that prevented performing the tests to be performed within the study, and c) had a chronic systemic disorder or a tumoral disease were excluded from the study.

Power analysis was used to decide the number of overhead athletes to be included in the study. Accordingly, Type 1 error was predicted at the probability of 5% and 80% power when including at least 80 athletes in the study. The standard deviation values reported in previous studies[16-18] were taken into account in calculating the required sample volume for the relevant significance level and desired power level.

Therefore, a total of 96 overhead athletes were recruited for the study. The Clinical Research Ethics Committee of Kirikkale University Faculty of Medicine granted ethical approval to the study (No: 2022.06.13 dated 06.29.2022). The athletes provided their written informed consent form prior to data collection. The principles of the Declaration of Helsinki in all procedures were strictly followed in this study. Then, the data was collected by administering a demographic information form for obtaining the following data: name, height, body weight, BMI, sports branch, seniority (years), dominant hand, and monthly training/competition hours.

Evaluation of Scapular Dyskinesia

The participating athletes' SD was evaluated by using the Scapular Assistance Test (SAT), the Scapular Retraction Test (SRT), and the Lateral Scapular Slide Test (LSST).

In the SAT, the athletes were positioned with their backs to the researcher. The scapula was supported by an upward rotation motion during active shoulder flexion. If this support led them to have increased arc of motion, increased or decreased pain, the test result was considered to be positive.[3,19]

In the SRT, the athletes were positioned with their backs to the researcher, and the researcher took his position by them. The scapula was stabilized in the retraction position. If symptoms caused by labral injury or internal impingement were relieved when the scapula was in the retraction position, the test result was regarded positive.[20]

In the LSST, the athletes were positioned with their backs to the researcher. The assessment was done in three different arm positions: 1) neutral position with arms hanging by the body, 2) hands on the waist with thumbs facing back, and 3) shoulders in bilateral abduction and arms in maximum internal rotation. In these three different positions, the distance between the lower angle of the scapula and the spinous processes of the thoracic vertebrae was measured bilaterally using a tape measure. Then, SD was marked as "present" if detecting a difference greater than 1.5 cm between the two sides during the measurements.[21]

Evaluation of the FMS Scores

Each movement pattern was scored between 0-3 according to the quality of movement and pain status. Next a FMS total score was calculated by summing the scores from seven movement patterns in the test. While two of these seven basic movements in the test (deep squat, trunk stability push-up) were evaluated unilaterally, the others (hurdle step, inline lunge, shoulder mobility, active straight-leg raise, and rotary stability) were assessed bilaterally. Accordingly, only lower-scored one was considered to be among the bilaterally evaluated movements.[22-24]

Statistical Analysis

Shapiro-Wilk test was used to explore the normality of distribution. Spearman correlation coefficient was calculated for the relationship between scapular dyskinesia (SD) and injury risk. The analyses were carried out by using the IBM SPSS Statistics v.22 program and accepted a p-value < 0.05 as statistically significant.

RESULTS

Table 1 presents the participating athletes' demographic and physical characteristics.

Table 1. Athletes' demographic ve physical characteristics

	M	Median	SD	Min.	Max.
Age	22.32	22.00	3.04	18	34
Weight	68.66	68.50	7.97	51	85
Height	1.73	1.75	0.09	1.57	2.05
Body mass index	22.66	22.90	1.72	18.52	25.00
Seniority	4.04	4.00	2.02	1	9
Training hour	29.57	30.00	13.88	10	80

As shown in **Table 1**, the mean age of the participants was 22.32±3.04 years with a mean weight of 68.66±7.97 kg. and a mean height of 1.73±0.09 m. In addition, the findings revealed their mean seniority (years) to be 4.04±2.02 years, while the mean monthly training hour was found to be 29.57±13.88 hours.

Table 2 summarizes the results of the SD assessment for the athletes

Table 2. Results of the SD assessment for the athletes

	n	%
LSST 1st Position (≥ 1.5 cm)	26	27.1
LSST 2nd Position (≥ 1.5 cm)	20	20.8
LSST 3rd Position (≥ 1.5 cm)	25	26
SAT-Dominant (+)	29	30.2
SAT-Non-dominant (+)	8	8.3
SRT-Dominant (+)	29	30.2
SRT-Non-dominant (+)	8	8.3

SD was discovered among 27.1% of the athletes in the 1st position, 20.8% in the 2nd position, and 26% in the 3rd position in the Lateral Scapular Slide Test (LSST). Moreover,

the Scapular Assistance Test (SAT) and Scapular Retraction Test (SRT) positivity was found to be 30.2% on the dominant hand and 8.3% on the non-dominant hand.

The compatibility results of the tests for SD are presented in Table 3.

Table 3. Compatibility results of the tests for SD

	n	%
Lateral Scapular Slide Test (LSKT) (+)	29	30.2
Scapular Assistance Test (SAT) (+)	29	30.2
Scapular Retraction Test (SRT) (+)	29	30.2

Among the overhead athletes included in the study, 29 were consistently positive in three different tests assessing scapular dyskinesia (SD). In other words, the findings of 29 athletes with SD were found to be compatible with each other.

The athletes' FMS results by their SD status are given in Table 4.

Table 4. The athletes' FMS results by their SD status

	Overhead Athletes		r	p
	With SD (n=29)	Without SD (n=67)		
FMS Total Score <14 (Number of Cases)	26	4	.829	.000*
FMS Total Score ≥ 14 (Number of Cases)	3	63		

* p<0.05; r: Spearman correlation coefficient

The majority of the athletes with scapular dyskinesia (SD) (n=26) were found to show poor performance with a score below the critical threshold in the Functional Movement Screen (FMS). On the other hand, 63 athletes without SD demonstrated good FMS performance with a score of 14 points or more. Accordingly, a significant relationship between SD and FMS total score was found out among the participants ($p < 0.05$; $r=0.829$).

DISCUSSION

The present study was conducted to explore the relationship between SD and injury risk among overhead athletes and compare the injury risks of those with SD and those without. The relevant literature seems to miss the relationship between SD and the FMS score among athletes engaging in overhead activities.

The literature offers a plethora of SD assessment methods; nevertheless, there is still no consensus on what method had better be utilized. Given the hot discussions in the literature, not only a single method was used to assess the participants' SD. Instead, the SAT, the SRT, and the LSST were conducted for this purpose. The findings revealed high compatibility between the results of these three assessment methods.

In the study, It was detected SD in 29 (30.2%) of the 96 athletes, overlapping the previous research. Given similar studies in the literature, Maor et al.[25] discovered SD among 30% of the young competitive swimmers in pre-training. In addition, Hickey et al.[26] found that 38.2% of the asymptomatic athletes had SD. The results of the LSST yielded an SD in 27.1% of the athletes in the 1st position, 20.8% in the 2nd position, and 26% in the 3rd position. Moreover, it was discovered that SAT and SRT were positive to be 30.2% on the dominant hand and 8.3% on the non-dominant hand. In their study, Ercan et al.[27] concluded SD presence at the rate of 34.4% in the 1st position, 34.4% in the 2nd position, and 36.7% in the 3rd position in the LSST. In the same study, it was 28.6% vs. 27.7% on the dominant hand and 8.7% vs. 5.5% on the non-dominant hand in the SAT and the SRT, respectively.

The previous research set a score of 14 points as the critical threshold in the FMS and recognized scores below this cut-off score as poor FMS performance. These studies also documented a significant relationship between an FMS score below the cut-off score and injury risk.[12-15] When it comes to the results of the present study, it was concluded that 26 of 29 athletes with SD showed poor FMS performance with a score below 14 points. On the other hand, 63 athletes without SD demonstrated good FMS performance with a score of 14 points or more. Accordingly, a significant relationship between SD and the FMS total score was found out among the participants.

The fact that three-dimensional analysis methods were not used to evaluate the scapular dyskinesias of athletes doing overhead activities can be considered as a limitation of the present study.

CONCLUSION

Overall, it was detected SD in 29 (30.2%) of the 96 overhead athletes included in the study. Moreover, 26 of these 29 athletes showed poor FMS performance with a score below 14 points, the critical threshold in the FMS. On the other hand, 63 athletes without SD demonstrated good FMS performance with a score of 14 points or more. Accordingly, it was concluded a significant relationship between SD and FMS total score among our participants ($p < 0.05$; $r=0.829$).

In light of the present findings, it was concluded that overhead athletes with SD may have significantly higher injury risk than their counterparts without SD.

Since the risk of injury for athletes with scapular dyskinesia who perform overhead activities is higher than those who do overhead activities without scapular dyskinesia, more comprehensive protective approaches should be adopted to prevent possible injuries for these athletes with scapular dyskinesia.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Kırıkkale University Faculty of Medicine Clinical Research Ethics Committee (Date: 29.06.2022, Decision No: 2022.06.13).

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.

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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 effect of balneotherapy and physical therapy applied to patients with chronic lack pain on pain intensity, quality of life, disability and mental symptoms

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ABSTRACT

Aims: The aim of present study was to evaluate effects of balneotherapy and physical therapy combination against only physical therapy on pain, guality of life, disability and psychological symptoms in chronic low back pain.

Methods: Sixty patients with chronic low back pain were included in the study. Patients were divided into two groups: Balneotherapy and physical therapy group (n=30) and physical therapy group (n=30). Balneotherapy group hospitalized for 20 minutes a day every day for 3 weeks to balneotherapy sessions with 40°C thermomineral water and 5 days a week for 3 weeks to 15 sessions of physical therapy session. Physical therapy group recieved 5 days a week for 3 weeks to 15 sessions of physical therapy session in the treatment unit Both groups recieved ultrason treatment which has 1.5W/cm 2 dose and 1MHz frequency for 6 minutes, Transcutaneous Electrical Nerve Stimulation (TENS) (50-100 Hz) for 20 minutes and hot pack for 20 minutes as physical therapy. Patients in both groups were given a patient-based standardized lumbar exercise in addition to physical therapy. The following parameters were measured: Visual Analog Scale (VAS) for pain intensity, Short Form-36 (SF-36) to evaluate guality of life, Oswestry Disability lndex (ODI) to evaluate functional disability and Symptom Check List-90 to query psychological symptoms. First evaluations were done at the beginning of treatment and second evaluations were done at the end of treatment before and after treatment.

Results: We observed more significant decrease in VAS scores in the group administered balneotherapy (FT+BT) and physical therapy compared with the group treated only physical therapy (FT) (p<0,05). At the end of treatment in FT+BT group subscale of guality of life; Physical role limitations, mental health, pain and general health were significantly higher than the FT group (p<0,05). In FT+BT group except social functioning and in FT group except vitality and general health, ali other dimensions of guality of life showed significant improvement (p<0,05). Although pretreatment disability rate of FT+BT is more, in this group decline of scores were more (30.4% to 14.2%). When compared to before and after treatment scores on the SCL-90 sub-parameters in FT+BT individuals were significantly different in ali the sub-parameters but in FT group except phobic anxiety and paranoid ideation, found significant differences in other parameters (p<0,05). In addition the decline of statistically significant decrease in the parameters was observed lesser extent in FT group compares to FT+BT group.

Conclusions: In present study we observed that balneotherapy in addition to physical therapy against routin physical treatment program showed more decline in pain and functional disability, more increase in guality of life and more improvements in psychological symptoms in addition relationship between psychologic symptom scores and disability is stronger than the relationship between psychologic symptom scores and pain scores.

Keywords: Chronic low back pain, guality of life, functional disability, psychological symptoms, balneotherapy

INTRODUCTION

Low back pain is defined as pain, muscle tension and stiffness in the region between the lower border of the 12th costa and the lower gluteal sulcus proximal to the thigh, with or without leg pain.[1] Low back pain is classified as acute if it is less than 6 weeks, subacute if it is 6-12 weeks, and chronic if it is more than 12 weeks.[2] In a review published on the approach to chronic low back pain, it is said that low back pain in the United States costs $14 billion per year.[3] The aim of the treatment of chronic low back pain is to control pain, reduce the number, severity and duration of new attacks, disability, distress, anxiety and disease behavior, increase the level of functional activity and educate the patient.[4]

Many treatment methods can be used in the treatment of chronic low back pain. Exercise programs, physical therapy agents, medical treatment, complementary medicine applications, surgical treatment and combined treatments are

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frequently used options.[1] Although treatment methods such as exercise, superficial heat pack, transcutaneous electrical nerve stimulation (TENS) and ultrasound are controversial in the literature, it has been shown that they are used in non-inflammatory chronic pain and can be effective.[5] Among the methods used in the treatment of such a common health problem are healing waters, mud, and massage used in various diseases since ancient times.[6-8] Today, these treatments can be given together within the scope of the concept of spa cure or spa treatments.[9] Chronic low back pain can lead to deterioration in the patients' quality of life, disability, physical and psychological problems.[10]

Chronic pain has now become a syndrome rather than a finding as a common health problem in clinical practice, and the coexistence of psychiatric symptoms is quite high.[11-13] Sometimes it can be a symptom of depressive disorder, and sometimes it can lead to disruptions in the mental world of the person as a physical disorder.[11] Anxiety Disorders, Somatoform Disorders, Psychosis, Personality Disorders, Post-Traumatic Stress Disorder, especially Depressive Disorders "diagnoses frequently appear as co-diagnosis in patients with chronic pain.[14]

Considering all these positive effects of physical therapy modalities and balneotherapy on chronic low back pain, it is thought that subjecting these individuals to these treatments for chronic low back pain will have a positive effect on patients' pain scores, quality of life, disability, and mental symptoms. In this study, we aimed to examine the early effects of physical therapy alone and with the combination of balneotherapy and physical therapy applied to patients with chronic low back pain on pain severity, quality of life, disability and mental symptoms.

METHODS

The study included 60 patients aged 18-85 years with noninflammatory chronic low back pain who were admitted to the clinic of the Department of Physical Medicine and Rehabilitation of Cumhuriyet University Faculty of Medicine between July 2014 and February 2015. The study was initiated with the approval of the Cumhuriyet University Medical Faculty Clinical Researches Ethics Committee (Date: 18.06.2014, Decision Number: 2014-06/02). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Exclusion criteria were the presence of uncontrollable systemic disease, previously known psychiatric disease history, low back pain with red flags, presence of malignancy, osteoporosis accompanied by a vertebral fracture, and surgical lumbar history. Before the treatment, the patients were questioned in terms of age, gender, pain severity, quality of life, functional disability and mental symptoms. The patients were divided into two groups as physical therapy-balneotherapy (PT+BT) group and physical therapy (PT) group. Both groups underwent physical therapy at a dose of 1.5 W/cm², 1MHz frequency and 6 minutes of ultrasound treatment, 20 minutes of Transcutaneous Electrical Nerve Stimulation (TENS) (50-100 Hz) and 20 minutes of heat pack application. In addition to physical therapy, both groups were given a patient-specific waist exercise program. In addition, all patients continued to receive routine medical treatment (nonsteroidal anti-ınflammatory drugs (NSAIDs), myorelaxant, and topical analgesics). In addition to the FT+CT group, balneotherapy treatment with thermo-mineral water at 40°C for 20 minutes every day for 3 weeks was applied for a total of 15 sessions. After the treatment, the patients were questioned again in terms of pain severity, quality of life, functional disability and mental symptoms. Balneotherapy, physical therapy and exercise programs were planned by the doctor. During physical therapy, patients were accompanied by a research assistant doctor and a physical therapy technician. Before and after the balneotherapy session, the vital signs (blood pressure, pulse, fever, respiratory rate, etc.) of the patients were checked and a nurse accompanied the patients during the balneotherapy.

Evaluation Parameters

Sociodemographic information form: The gender and age (year) of the patients were recorded in the sociodemographic information form when they were included in the study.

Visual Analog Scale (VAS): The pain intensity was measured using the VAS. Patients were asked to rate their pain on a 10-cm line anchored by two descriptors: 0: no pain and 10: unbearable pain

Short form-36 (SF-36): The quality of life was assessed using the validated Turkish version of the SF-36. The SF-36 is a multidimensional tool measuring eight domains: physical functioning, physical role limitation, body pain, general health, vitality, social functioning, emotional role limitation and mental health. Domain scores range from 0 to 100 and higher scores indicate a better quality of life.

Oswestry Disability Index (ODI): Oswestry Disability Index (ODI) was used before and after treatment to determine the degree of disability. ODI consists of 10 items that measure pain intensity, personal care, lifting, walking, sitting, standing, social life, sleeping, traveling, and the level of pain. Each item is graded between 0-5, and as the total score increases, the level of disability increases. The maximum score is 50 points. It is evaluated as heavy between 31 and 50, moderate between 11-30, and mild between 1-10.

Symptom Checklist-90 (SCL-90): Mental symptom questionnaire was performed with the SCL-90 questionnaire before and after treatment. SCL-90 consists of 90 items and 10 subtests. It consists of somatization (SOM), obsessive-compulsive (O-C), interpersonal sensitivity (INT), depression (DEP), anxiety (ANX), anger-hostility (HOS), phobic anxiety (PHOB), paranoid ideation (PAR), psychoticism (PSY) and additional items.

Statistical Analysis

When the data obtained from our study were uploaded to the SPSS version 22 program and the parametric assumptions were fulfilled in the evaluation of the data (Kolmogorof-Smirnov), the significance test of the difference between two means in independent groups, the significance test of the peer-to-peer difference; Mann Whitney U test and Wilcoxon test were used when parametric test assumptions could not be fulfilled. Our data were specified as arithmetic mean ± standard deviation in the tables and the level of error was taken as 0.05.

RESULTS

While the ages of the patients in the PT+BT group were 56,46±13,65, the ages of the patients in the PT group were 51,30±15,64. The difference between the groups in terms of age was insignificant (p=0,178). 15 (50%) of the individuals in both groups were male and 15 (50%) were female. When the pre-treatment VAS values of the individuals in both groups were compared, the difference was found to be insignificant (p>0.05). When the post-treatment VAS values were compared, the difference was found to be significant (p<0.05) (**Table 1**).

Table 1. Comparison of pre-treatment and post-treatment VAS measurements between groups

		Average	Standard deviation	p-value
Pre-treatment VAS	PT+BT	8.43	0.97	0.163
	PT	7.63	1.92	
Post-treatment VAS	PT+BT	3.80	1.21	*0.008
	PT	6.70	9.0	

*(p<0.05), PT+BT: Physical Therapy and Balneotherapy group PT: Physical Therapy group

When the pre-treatment and post-treatment VAS measurements of the patients in the PT+BT group were compared, the difference between the measurements was found to be significant. When the VAS measurements before and after treatment were compared in the PT group, the difference between the measurements was found to be significant, but the pain values tended to decrease more in the PT+BT group (Table 2).

Table 2. Comparison of pre-treatment and post-treatment VAS measurements within the groups

Groups		Average	Standard Deviation	p-value
PT+BT	Pre-treatment VAS	8.43	.97	0.001*
	Post-treatment VAS	3.80	1.21	
PT	Pre-treatment VAS	7.63	1.92	0.018*
	Post-treatment VAS	6.70	9.00	

*(p<0.05), PT+BT: Physical Therapy and Balneotherapy group PT: Physical Therapy group

When the measurements of the post-treatment quality of life sub-dimensions of the individuals in both groups were compared, a significant difference was found in terms of physical role limitation, mental health, pain and general health (p<0.05). When post-treatment quality of life was evaluated in terms of physical role limitation, mental health, pain and general health, it was significantly higher in the PT+BT group compared to the PT group (Table 3). When the pre-treatment and post-treatment Oswestry Disability Index (ODI) scores of the individuals in the PT+BT group were compared, a significant difference was found (p=0,001). When the pre-treatment and post-treatment Oswestry Disability Index (ODI) scores of the individuals in the PT group were compared, the difference was also found to be significant (p=0.001). The decrease in scores was found to be higher in the PT+BT group (30.4% vs 14.2%).

Table 3. Intergroup comparison of quality of life measurement sub-dimensions post-treatment

Post-treatment SF-36 parameters	Groups	Average	Standard Deviation	p-value
Physical function %	PT+BT	59.83	21.31	0.631
	PT	57.00	24.09	
Social function %	PT+BT	53.70	20.23	0.770
	PT	52.22	18.71	
Physical role limitation %	PT+BT	80.00	26.58	0.001*
	PT	47.50	44.69	
Emotional role limitation %	PT+BT	86.66	24.13	0,087
	PT	73.33	34.35	
Mental health %	PT+BT	75.46	9.89	0.006*
	PT	65.06	17.41	
Vitality %	PT+BT	57.16	17.79	0.252
	PT	51.16	22.15	
Pain %	PT+BT	65.92	14.27	0.001*
	PT	50.37	16.17	
General health %	PT+BT	65.00	15.64	0.016*
	PT	55.00	15.42	

*p<0.05, PT+BT: Physical Therapy and Balneotherapy group PT: Physical Therapy group

Table 4. Comparison of Oswestry Disability Index scores of PT+BT and PT groups pre-treatment and post-treatment

	Oswestry Disability Index score (%)	Average	Standard Deviation	p-value
PT+BT	Pre-treatment	66.36	14.14	0.001
	Post-treatment	35.66	14.39	
PT	Pre-treatment	54.06	17.21	0.001
	Post-treatment	39.86	15.22	

When the scores of the SCL-90 sub-parameters of the individuals in both groups were compared, a significant difference was found only in the anger-hostility parameter. SCL-90 scores were found to be higher in all parameters in the PT group compared to the PT+BT group (Table 5).

Table 5. Comparison of scores related to post-treatment Symptom Checklist-90 (SCL-90) sub-parameters between groups

SCL-90 sub-parameters	Groups	Average	Standard Deviation	p value
Somatization	PT+BT	0.78	0.47	0.062
	PT	1.14	0.77	
Obsessive-compulsive	PT+BT	0.70	0.48	0.146
	PT	0.98	0.72	
Interpersonal sensitivity	PT+BT	0.56	0.52	0.727
	PT	0.70	0.76	
Depression	PT+BT	0.44	0.39	0.130
	PT	0.73	0.76	
Anxiety	PT+BT	0.48	0.46	0.435
	PT	0.63	0.73	
Anger-hostility	PT+BT	0.31	0.31	0.038*
	PT	0.67	0.75	
Phobic Anxiety	PT+BT	0.29	0.42	0.071
	PT	0.54	0.73	
Paranoid Ideation	PT+BT	0.41	0.45	0.235
	PT	0.68	0.77	
Psychotism	PT+BT	0.24	0.24	0.058
	PT	0.50	0.62	
Additional symptoms	PT+BT	0.60	0.34	0.677
	PT	0.75	0.68	
General symptom index (GSI)	PT+BT	0.48	0.30	0.179
	PT	0.73	0.68	

*p<0.05, PT+BT: Physical Therapy and Balneotherapy group, PT: Physical Therapy group, SCL-90: Symptom Check List-90

DISCUSSION

Pain, quality of life and inadequacy in chronic low back pain are parameters that have causal relationships with each other and have been used in many cross-sectional or randomized controlled studies in the literature. Pain can greatly affect a person's life by impairing their quality of life and leading to inadequacy.[15] Balogh et al.[16] compared the effects of balneotherapy (30 patients) and hydrotherapy with tap water (30 patients) in a study involving 60 patients. Patients were subjected to outpatient balneotherapy and hydrotherapy sessions in water at 36OC for 30 minutes a day, 6 times a week for 2 weeks for a total of 12 sessions. The patients were evaluated in terms of VAS score, spinal mobility and disability before treatment, after the second week and in the third month. At the end of 2 weeks, the balneotherapy group showed improvement in all parameters except functional disability, and this improvement continued until the third month. In the hydrotherapy group, only the improvement in pain scores at the end of the second week was found to be significant.

Kulisch et al.[17] compared the effects of balneotherapy (36 patients) and hydrotherapy with tap water (35 patients)

in a study involving 71 patients. Patients were subjected to outpatient balneotherapy and hydrotherapy sessions in water at a temperature of 34 C for 20 min. daily for a total of 17-21 sessions for 3 weeks. In addition to both groups, electrotherapy was applied 3 times a week before the balneotherapy session. The patients were evaluated in terms of VAS score, Schober Test, disability and quality of life before treatment, after 3 weeks and at 15 weeks. In the balneotherapy group, a significant improvement was observed in all parameters at week 3 and continued until week 15. On the other hand, only the pain score and quality of life parameters (lower than the balneotherapy group) were improved in the hydrotherapy group.

Tefner et al.[18] compared the effects of balneotherapy (30 patients) and hydrotherapy with tap water (30 patients) in a study involving 60 patients. Patients received outpatient balneotherapy and hydrotherapy sessions in water at 31°C for 30 minutes a day, 5 times a week for 3 weeks for a total of 15 sessions. The patients were evaluated in terms of VAS score, spinal mobility, disability and quality of life before treatment, after 3 weeks and at 10 weeks. When the groups were compared, the balneotherapy group was found to be superior in all parameters. These effects continued at 3 and 10 weeks. There was no significant change in the hydrotherapy group.

Kesiktas et al.[19] compared the effects of balneotherapy (30 patients) and physical therapy (30 patients) in a study involving 60 patients. Patients in the balneotherapy group received outpatient balneotherapy in water at 36°C for 30 minutes a day, 5 times a week for 2 weeks for a total of 10 sessions. The control group (physical therapy group) received 10 outpatient sessions of TENS, ultrasound and infrared treatment. Both groups were given back school and patient-specific exercise programs. The patients were evaluated in terms of VAS score (at rest and movement), Schober test, disability and quality of life, paracetamol dose and lumbar muscle test before treatment, after 2 weeks and at 3 months. In the balneotherapy group, waist extensor muscle test, Schober Test, functional disability, some SF-36 subscores (energy/valency, social function, physical role restriction and general health) showed significant improvement compared to the control group and this effect continued until the third month. Balneotherapy was found to be more advantageous in terms of quality of life and flexibility.

Onat et al.[20] compared the effects of balneotherapy and physical therapy combination (37 patients) and physical therapy alone (44 patients) in a study of 81 patients. Patients in the treatment group received inpatient balneotherapy in water at 38°C for 20 min. per day, 5 times a week for 3 weeks for a total of 15 sessions, and TENS (50-100Hz) for 20 min. heat pack for 20 min. and ultrasound therapy (1 W/cm² dose, 1 MHz frequency) for 45 min. per day, 5 times a week for 3 weeks for a total of 15 sessions. The control group received only physical therapy. Both groups were included in the standard exercise program. Patients were evaluated with VAS, ODI and SF-36 before and after treatment. The improvement in pain, functionality and quality of life scores was significantly higher in the balneotherapy group compared to the control group. In a similar study, Doğan et al.[21] compared the effects of balneotherapy and physical therapy combination (35 patients) and physical therapy alone (25 patients) in 60 patients. Patients in the treatment group received inpatient balneotherapy in water at 40°C for 20 minutes a day, 5 times a week for 3 weeks for a total of 15 sessions, and TENS (50-100Hz) for 20 minutes, heat pack for 20 minutes and ultrasound therapy (1.5 W/cmz dose, 1 MHz frequency) for 6 minutes, 5 times a week for 3 weeks for a total of 15 sessions. The control group received only physical therapy. Both groups were included in the standard exercise program. The patients were evaluated for pre-treatment and post-treatment VAS, disability, and spinal mobility. Pain scores, disability and improvement in the Schober test were found to be more significant in the balneotherapy group than in the physical therapy group alone. In our study, when the VAS values of the individuals in both groups were compared before treatment, the difference was found to be insignificant, but significant after treatment. When the VAS measurements before and after treatment were compared within the groups, the difference between the measurements was found to be significant in both groups, but the decrease in pain was more significant in the PT+BT group. The results were similar to those of Onat et al. and Doğan et al. but the VAS decrease in the PT group was lower in our study compared to these studies. As a result, balneotherapy played a role in pain reduction with an additive effect. With the treatments we gave in our study, we obtained different results in each subscale of SF-36. When post-treatment quality of life was evaluated in terms of physical role limitation, mental health, pain and general health, it was found significantly higher in the PT+BT group compared to the PT group (**Table 3**). Significant improvement was found in all sub-dimensions of quality of life except social function in the PT+BT group and vitality and general health in the PT group.

As a result, it can be said that balneotherapy is effective in almost all parameters of quality of life in chronic low back pain and provides more improvement in physical role restriction, mental health, pain and general health compared to physical therapy. The fact that patients in the PT+BT group stayed away from the physical and emotional stress of daily life and had more resting opportunities may have contributed to this situation. The results were similar to those in the studies of Kesiktas et al.[17], Tefner et al.[18] and Kulisch et al.[19] When the pre-treatment and post-treatment ODI scores of the individuals in both groups were compared, the difference was found to be significant. Although the pre-treatment disability rate of the PT+BT group was higher, the decrease in scores was found to be higher in this group (30.4% to 14.2%). The study of Balogh et al.[16] did not show any improvement in the functional disability score of the balneotherapy group at the end of the treatment, contrary to our study. On the other hand, the decrease in ODI scores in our study was similar to the studies conducted by Kulisch, Tefner, Kesiktas, Onat, Doğan et al.[21] In conclusion, our study in accordance with the literature shows that the addition of balneotherapy to the treatment increases the functionality of the patients and increases the quality of life. Chronic low back pain may lead to deterioration in the quality of life and disability of patients, as well as psychological problems. In a study of inpatients with acute and chronic lumbar syndrome,

Quint et al.[22] found that somatization, depression, anxiety, phobia and psychoticism scores were significantly higher in patients with acute and chronic low back pain compared to the asymptomatic control group; while in the comparison of chronic and acute low back pain, phobia scores and the total number of positive symptoms in chronic pain were significantly higher.

In their systematic review, Pincus et al.[23] investigated the psychological factors in the chronicization of low back pain and found that depressive mood and somatization were important in chronicization. In a multi-center study involving 8304 patients from 86 outpatient physical therapy clinics, George et al.[24] evaluated the patients who were divided into four different anatomical regions: upper extremity, lower extremity, neck and waist, the SCL-90 depression sub-scale before physical therapy, the Numeric Rating Scale (NRS) to determine the severity of pain before and after treatment, and the functional status. As a result, the prevalence of severe depression was found to be more common in women, patients with chronic pain, and patients undergoing surgery. On the contrary, low prevalence was detected in patients over 65 years of age and with upper or lower extremity pain. Depressive symptoms contributed to pain severity and functional status in all anatomical localization except for post-treatment values of the neck region. In the study, it was not specified which patients or patient groups were subjected to which physical therapy modalities methodologically, and the effect of balneotherapy was not examined as in our study, and other sub-parameters of SCL-90 were not evaluated.

Nickel et al.[25] evaluated the quality of life and psychic stress at the first hospitalization and at the end of the first year in a prospective cohort study of 30 patients who underwent inpatient lumbar surgery and 79 patients who did not undergo inpatient surgery in the orthopedic clinic. The decrease in SCL-90 somatization scores at the end of the 1st year in the surgical group was much less than in the other group and it was found that susceptibility to somatization impaired the improvement in physical and mental quality of life. This effect was found to be less in the other group. In our study, when the scores of SCL-90 subparameters were compared after treatment, there was a significant difference only in the anger-hostility parameter, and SCL-90 scores were found to be higher in all parameters in the PT group compared to the PT+BT group. This situation can be explained by the fact that the patients in the PT+BT group stayed away from the physical and emotional stress of daily life and showed more improvement in terms of mental health. When the post-treatment SCL-90 sub-parameter scores of the individuals in the PT+BT group were compared, the difference was significant in all sub-parameters, except for phobic anxiety and paranoid ideation in the FT group. In addition, the decrease in statistically significant parameters was less in the PT group than in the PT+BT group.

Study limitations: Our study is include the limited patient population, the fact that the long-term effects of balneotherapy and physical therapy were not addressed, the patients were not evaluated in terms of spinal mobility, and they were not questioned in terms of drug use, obesity, smoking, education level and occupational status.

CONCLUSION

As a result, in our study, the balneotherapy application added to physical therapy was only compared to the routine physical therapy program; it was found that the patients had more reduction in pain, more regression in their functional disability, more improvement in their quality of life and more improvement in their mental symptoms. We found that it was stronger than the relationship between pain and psychic symptoms. Therefore, adding balneotherapy to routine physical therapy programs as a conservative treatment method may provide additional benefits. The values in our study supported the studies in the literature. There is a need for studies that compare the efficacy of balneotherapy and physiotherapy, include more patients, are methodologically more robust, evaluate the long-term effects of treatments, and investigate treatments in terms of cost-effectiveness.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of the Cumhuriyet University Medical Faculty Clinical Researches Ethics Committee (Date: 18.06.2014, Decision Number: 2014-06/02).

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.

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Mid-term results in adult humeral fractures with titanium elastic nail fixation versus plate and screw fixation and locking intramedullary nailing

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ABSTRACT

Aims: To compare plate-screw fixation, intramedullary nailing (IMN), and titanium elastic nailing (TEN) as a new fixation method with respect to nonunion, complication rates, and functional outcomes in the repair of adult humeral shaft fractures.

Methods: A total of 38 adult patients who were treated due to humeral shaft fracture at our clinic and were followed for minimum six months between January 2012 and January 2015 were retrospectively analyzed. Age, sex, fracture etiology an length of hospitalization were recorded. Fractures were classified according to the Association for Osteosynthesis(AO) classification. Nonunion rates as assessed by X-ray during visits, angulation, shoulder, elbow and hand disability scores were evaluated using the DASH, Mayo Elbow and UCLA Shoulder scoring, and Stewart Hundley criteria.

Results: There was no significant epidemiological difference between the groups. The length of hospitalization was lower in the TEN group. There was no significant difference in nonunion rates and functional scores according to the type of treatment. Angulation rate was slightly higher in the TEN group. The effect of angulation on functional score showed no influence on the functional status. The three treatment types mostly achieved excellent and good outcomes.

Conclusion: Our study results suggest that TEN seems to be a good alternative treatment in eligible patients with humeral shaft fractures considering complications of other treatments. However, we believe that further, large-scale, randomized-controlled, prospective studies with longer follow-up duration are required to confirm these findings and to establish a definite conclusion. Level of Evidence: Therapeutic Level III.

Keywords: Humerus, diaphyseal fractures, TEN

This manuscript has been oral presented in 6th International Hippocrates Congress on Medical and Health Sciences as an full text and placed in congress book.

INTRODUCTION

Humeral shaft fracture is the most common fracture type encountered in daily practice and the treatment options vary from conservative and surgical treatments. Many surgical techniques have been described in the treatment of humeral shaft fractures such as plate fixation, IMN, and external fixation, and these techniques have resulted in considerably high (>95%) union rates.[3-8] These fractures and surgical options are also associated with potential complications defined in the literature such as soft tissue damage, radial nerve palsy with plate screw fixation, and shoulder problems in IMN.[1,6,9-14]

Despite availability of various conservative and surgical treatment options with proven efficiency in the treatment of humeral shaft fractures, many factors such as increasing expectation for functional extremity in recent years, tendency toward minimally invasive surgery and cost analyses have contributed to the lack of agreement between orthopedic surgeons.[2]

METHODS

Patients

The study was carried out with the permission of Necmettin Erbakan University Meram Faculty of Medicine Non-Pharmaceutical and Non-Medical Device Researches Ethics Committee (Date: 13.02.2015, Decision No: 2015/112). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

In this retrospective study, a total of 62 patients who were admitted to Meram Medicine Hospital were analyzed. 3 patients for another fractures which affects scoring, 3 patients with pathological fracture, 4 patients had insufficent follow up, 8 patients under 18 age and 6 patients with concervative treatment of total 24 patients were excluded.

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RESULTS

The mean age (48.8 years) and duration of follow-up (19.3 months). 34.2% (n=13) females and 65.8% (n=25) males. Of the study participants had A3 (31.6%, n=12) and A2 (28.9%, n=11) type fractures according to the AO/OTA classification. Among all patients, four cortices union rate was 73.7% (n=28), 3 cortices union rate was 15.8% (n=6), and two cortices union rate was 5.3% (n=2), while one patient had one cortex union and nonunion. 50% of the fractures (n=19) were treated with plate fixation, 11 fractures (28.9%) with TEN, and eight fractures (21.1%) with IMN. The DASH scores, UCLA Shoulder scores, and Mayo and Stewart-Hundley scores are shown in Table 1.

Table 1: Hand, shoulder, and elbow scores

	Excellent	Good	Fair	Poor
UCLA	23(60,5%)	7 (18,4%)	2 (5,3%)	6 (15,8%)
MAYO	29 (76,3%)	6 (15,8%)	2 (5,3%)	1 (2,6%)
Steward-Hunley	24 (63,2%)	7 (18,4%)	6 (15,8%)	1 (2,6%)
	Mean±SD	**Median**	**Min**	**Max**
DASH	13,66±15,70	6,7	0	57,50

(DASH: Disability of Shoulder, Elbow and Hand)

In the assessment of postoperative extremity length, extremity shortness was more remarkable in the plate fixation group (4.2 mm). The mean length of hospital stay was higher in the plate and screw fixation group (10.5 days). Varus/valgus angles were higher in the TEN group (30, 70). The mean ranges of motion in the shoulder and elbow joints were more restricted in the IMN group (Figure 1).

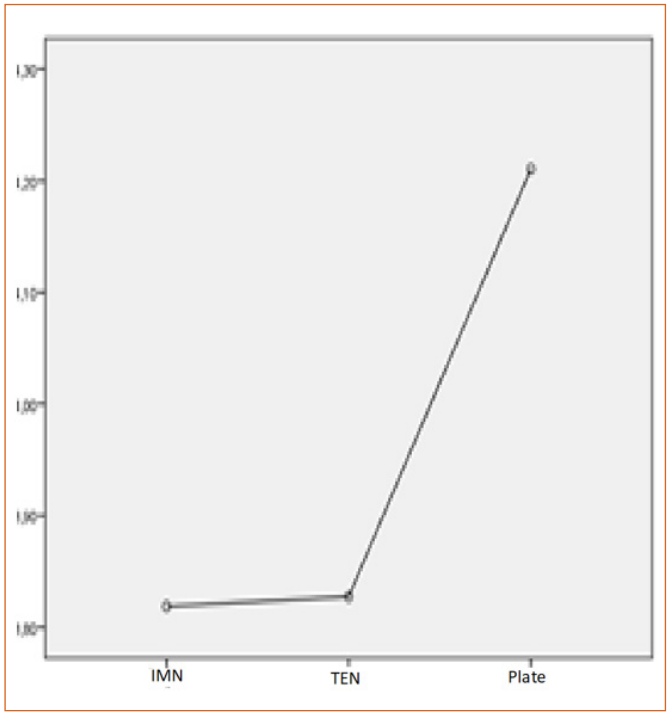

Figure 1. Mean shortness according to type of surgery

In the IMN group poor outcomes according to the UCLA score was than the others (50%). There was no good outcomes in the IMN group according to the MAYO; however, 20% of the patients had good outcomes in the other two groups. According to Steward-Hunley criteria the proportion of the patients did not significantly differ across the groups (Table 2).

Table 2. Distribution and relationship level of score according to type of surgery

Operation type	Locking IMN N (%)	TEN N (%)	Plate N (%)	p
UCLA				0.038*
Excellent	3 (37.5%)	6 (54.5%)	14 (73.7%)	
Good	1 (12.5%)	4 (36.4%)	2 (10.5%)	
Poor	0 (0%)	1 (9.1%)	1 (5.3%)	
Fair	4 (50%)a	0 (0%)b	2 (10.5%)	
MAYO				0.168
Excellent	6 (75	8 (72.7%)	15 (78.9%)	
Good	0 (0%)	2 (18.2%)	4 (21.1%)	
Poor	1 (12.5%)	1 (9.1%)	0 (0%)	
Fair	1 (12.5%)	0 (0%)	0 (0%)	
Steward-Hunley				0.421
Excellent	4 (50%)	9 (81.8%)	11 (57.9%)	
Good	1 (12.5%)	1 (9.1%)	5 (26.3%)	
Poor	2 (25%)	1 (9.1%)	3 (15.8%)	
Fair	1 (12.5%)	0 (0%)	0 (0%)	

There was no correlation between varus/valgus values and DASH (R=0.113, p=0.501). Varus/valgus angles were higher in patients with fair results in the UCLA. The patients with fair results in the MAYO had lowest angulation. Accordingly, it can be argued that increasing angulation negatively affects UCLA; however, angulation did not significantly affect the outcomes (Figure 2-4).

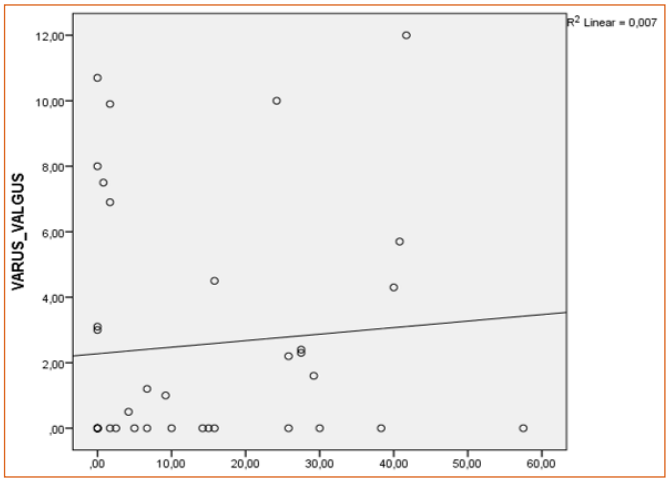

Figure 2. Relationship between DASH and Varus/Valgus

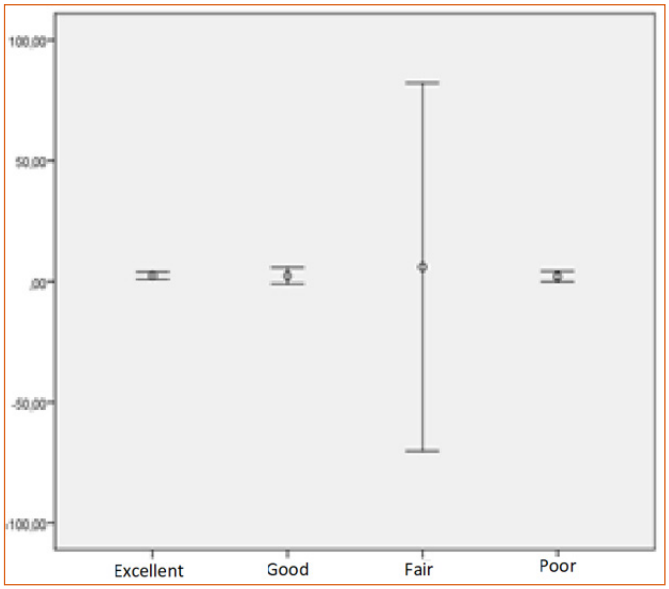

Figure 3. Relationship between UCLA and Varus/Valgus

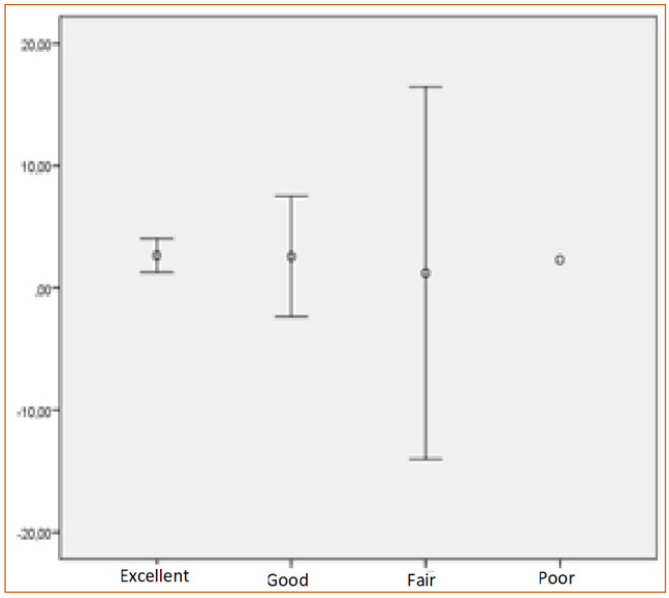

Figure 4. Relationship between MAYO and Varus/Valgus

No complications occurred in the majority of the patients 84.2%, n=32). The rate of radial nerve deficit before surgery did not differ between the groups, whereas radial nerve palsy in the postoperative period was observed only in the plate fixation group. During visits, two and three cortices union were more common in the plate groups, whereas four cortices union was high and close to each other. Infection occurred in three patients in the plate fixation group, whereas three patients in the TEN group with skin irritation.

DISCUSSION

Aim of this study is comparing the outcomes of TEN and other fixation methods in adult humeral diaphyseal fractures, and attempted to find an answer for whether it is possible to reduce soft tissue injury, shoulder problems, radial nerve injury and costs.

Humeral shaft fractures are the most common fractures in daily practice of orthopedicians.[1] Union is an important parameter of fractures. Merchan[3] reported a 95% union rate in patients with humeral fracture treated by plate fixation and IMN methods. Meekers[15] reported a union rate of 85% in the IMN and 100% in the plate fixation. In the study by Mc Cormak[16] the rate of nonunion was 4.3% in the plate and 9.5% in the IMN. Khurana[17] reported delayed union in two patients treated with 59 Ender nails. In 174 patients, Brug[8] used IMN in 84 patients, plate fixation in 58 patients, conservative approach in 9 patients, and monofixator in the remaining patients. The rate of nonunion was 1.2% in the IMN and 1.7% in the plate group. In a randomized prospective study of Chapman[13] used plate fixation in 46 patients and IMN in 38 patients. There was no significant difference between the groups. In another study Wali[18] published a prospective series of 50 patients comparing DCP plate fixation and IMN. There was two nonunion in each of the two groups up to 6 months after surgery. Kessler[7] suggested that in plate osteosynthesis caused extensive soft tissue damage so circulatory impairment and delayed healing. They also suggested that conservative treatment is associated with certain disadvantages such as inability to use affected arm for weeks, insufficient pain relief and self-care. Seidel nailing are good considering all these disadvantages. However due to the possibility of IMN's loosening and subacromial impingement syndrome; use of IMN is an alternative treatment in porotic bones and fresh fractures. Williams[19] reported union within a mean of six months in acute fractures and delayed union up to 12 weeks in one pathological fracture and five nonunion with Marchetti-Vicenci elastic nailing. Despite insufficient number of series that evaluated the outcomes of elastic nailing in humeral shaft fractures, they suggested that elastic nailing could be an option also in difficult humeral shaft fractures. The present study showed a union rate up to 98% and only one patient had nonunion. However, there was no significant difference between union rates of plate, IMN and TEN groups. The present study, therefore, used TEN fixation to decrease the discomfort of conservative therapy and to soft tissue injury with plate fixation and shoulder problems of IMN. As suggested by Williams we consider that TEN can be an important alternative option in humeral shaft fractures, although there is a paucity of published series in this regard.

Due to its proximity, radial nerve is important structure at risk of injury due to trauma and surgical technique. The prevalence of radial nerve palsy ranges from 6.6% to 8.5% in humeral shaft fractures.[6,10,11] Complete laceration or severe degeneration of the radial nerve after fracture has been reported to be 12 to 23%, whereas the rate of spontaneous recovery ranges from 73 to 92%.[20,21] Ekholm[12,22] reported that the prevalence of palsy was higher (14.5%) in the presence of "butterfly fragment". Wright[23] and Zuckerman[24] suggested that radial nerve paralysis occurs most frequently in fracture of the distal 1/3 of humerus. Foster[9] showed that permanent radial neuropathy was mostly caused by laceration or entrapment of nerve between the fragments. They highlighted that first signs of recovery of radial palsy after a mean of 7 weeks and complete recovery after 15 weeks, and electromyelographic evidences of recovery become prominent after 3-4.5 months. They did not recommend early exploration in closed fractures. They recommended surgical exploration during stabilization of the open fracture, primary repair in the nerve laceration, and reconstruction with nerve grafting 6 weeks after the lacerations caused by gunshot injuries. Shah[28] observed complete recovery before surgery in patients with Holstein-Lewis type fracture.

Kesemenli[6] reported radial paralysis in four patients with plate fixation and no paralysis in the IMN group. Osman[10] reported that radial injuries after treatment with IMN was lower than conservative treatment and plate fixation. There are also studies demonstrating higher rate of radial nerve deficit in patients treated with IMN.[6,12,16] In a prospective series of 50 patients reported by Wali[18] one patient in the IMN group and two patients in the plate fixation group developed radial paralysis. One of these patients underwent exploration and radial nerve was found to be entrapped under the plate. However, these conditions did not affect functional outcomes of the patients. In a review of 4,517 patients with humeral fracture reported by Shao[25] outcomes were similar between patients that underwent exploration eight weeks after and early exploration. In the present study four patients had radial nerve deficit before surgery. Of these patients, one had underwent IMN, one had underwent TEN, and two had underwent plate fixation. The patients treated with plate fixation underwent nerve exploration during surgery. Nerve palsy recovered in two patients in the early period after surgery, and two patients recovered within 6 to 8 weeks. These data suggest that early exploration may not be

appropriate unless there is solid evidence for full thickness or partial nerve injury, early or late exploration does not change functional outcomes, and exploration might be an unnecessary surgical intervention for a possibly reversible condition.

Varus is the most commonly observed angulation deformity in humeral shaft fractures.[26] Biomechanically, many different forces act on the humerus such as twisting and mediolateral bending have been reported to be the case of varus after humeral fracture.[27] Varus deformity may act as an unfavorable factor affecting healing of fractures, but it may also result in cosmetic problems.[28] Habernek[29] treated 19 patients using IMN. Four patients developed recurvature up to 5° and 3-10° varus deformity. Shoulder movements returned to normal up to 6 weeks and the patients returned to their usual activities within 6-10 weeks. The highest varus angulation in the present study was in the TEN group with a mean angulation of 4.46°. This finding was statistically significant, compared to the other groups, and these values were within the acceptable range for humeral diaphyseal fractures. In the assessment of angulation deformities affected the functional scores of the patients; relationship between scoring systems and varus/valgus rate was also not statistically significant.

Many studies reported higher rates of complications among with IMN such as shoulder problems.[6,18,19] In a study of 111 patients, Baltov1 reported 52 complications included distraction in the fracture, long proximal locking screw, and concurrent fracture. In the postoperative period, breakage of locking screw in 1 patient, proximal protrusion of IMN in 4 four patients, nonunion in one patient, and avascular necrosis of humeral head in two patients, and radial nerve deficit in one patient. Chapman[13] reported one reflex sympathetic dystrophy in the IMN group and three deep infection in the plate group. Six patients in the IMN group had shoulder pain, and six patients in the plate fixation group had elbow problems. Khurana[17] followed 59 patients treated with ender nails for a mean duration of 19 months. Fifty-three patients had angular deformity of less than 5° and six patients had a deformity between 5°-10°. The authors suggested that intramedullary elastic fixation has biological, mechanical and practical advantages and this method could be preferred in particularly elderly patients to avoid the risk of major surgery. Wali18 evaluated the outcomes of plate fixation versus IMN, the authors reported shoulder stiffness and pain in four patients in the IMN group and subacromial impingement in one patient, and the patient with impingement required removal of the implant. One patient in the IMN and 2 patients in the plate group developed superficial infection treated with oral antibiotics. One deep infection in the plate fixation group was treated with serial debridement and parenteral antibiotics. In the present study, skin irritation occurred in three patients in the TEN group, and TENs were removed upon union in these patients. Two superficial infection treated with oral antibiotics. Deep infection in one patient was treated with debridement repeated twice followed by removal of the implant. The fracture was treated with external fixator, and internal fixation was then performed after alleviation of infection. One patient treated with IMN developed varus deformity and nonunion. However, the patient rejected the offer to perform a second surgery.

Nonetheless, there are some limitations to this study. Retrospective design, small sample size, heterogen age group and short follow up groups are the main limitations.

CONCLUSION

Our study results suggest that TEN seems to be a good alternative treatment in eligible patients with humeral shaft fractures considering complications of other treatments such as soft tissue injuries, radial nerve problems of plate fixation, shoulder problems of IMN and comfort disadvantages of conservative methods. However, TEN is a new method on adult humeral shaft fractures as a traditional methods we believe that further, large-scale, randomized-controlled, prospective studies with longer follow-up duration are required to confirm these findings and to establish a definite conclusion.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Necmettin Erbakan University Meram Faculty of Medicine Non-Pharmaceutical and Non-Medical Device Researches Ethics Committee (Date: 13.02.2015, Decision No: 2015/112).

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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Review

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Leech therapy for the treatment of venous congestion in digital re-plants and revascularizations

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ABSTRACT

Leech therapy was first used in Egypt around 1500 BC to treat a range of ailments from nosebleeds to gout. Medicinal leeches have been part of the therapeutic armamenterium of hand surgeons for more than 60 years. Venous congestion after digital replantation or revascularization threatens digit survival in theimmediate postoperative period. External bloodletting, including leech therapy, provides a central role in salvage of the congested finger. Although there have been previous studies few published articles and no consensus guidelines have discussed the weaning of leeches in the postoperative period.describing the initiation of leech therapy for digits experiencing venous insufficiency. Analyzing articles on treatment and follow-up after finger replantation published between 2000 and 2022 on the treatment of venous congestion after finger replantation and revascularization. We conducted a systematic review, taking into account the studies that applied leech therapy. The collected data revealed the relevant indications, treatment procedures, efficacy, adjuvant treatments, side effects. For this indication, the success rate of leech therapy ranged from 65 to 85% (83.7% in our series) according to the situations encountered. Optimal frequency of application ranged from 2 to 8 hours, while average overall duration ranged from 4 to 10 days. Antibiotic prophylaxis against Aeromonas is highly advisable. A ciprofloxacin and trimethoprim-sulfametoxazole combination currently appears as the most relevant prophylactic antibiotherapy. Hirudotherapy is a reliable treatment in cases of patent venous insufficiency of only artery only digit replantation. Even though the relevant literature is highly heterogeneous, we have attempted to put forward a specific protocol bringing together dosage, delivery route, frequency of administration and appropriate prophylactic antibiotherapy

Keywords: Leech therapy, digit replantation, digital amputation, hirudo therapy

INTRODUCTION

Venous congestion is the most common cause of failure after free tissue transplants and finger replantation's.[1] Medicinal leeches play an important role in providing venous drainage until angiogenesis develops.[2] During the medical leech therapy, hundreds of bioactive products are secreted into the surrounding tissue. Among them, hirudin, which is known as the most potent, prevents coagulation by inhibiting thrombin in the coagulation cascade. Other bioactive products released into the environment during leech therapy include acetylcholine, histamine-like peptide, and hyalinuridase. These provide tissue blood flow with a local vasodilator effect.[3] While a single leech can suck up to 10 ml of blood, it allows the removal of venous blood up to 50 mm in the bitten area with passive bleeding during leech application.[4] Leech therapy Helping to remove blood up to 48 hours after leech application provides an advantage in treatment until angiogenesis develops.[5] It has been used successfully to prevent venous congestion that develops due to anastomoses that are prone to thrombosis.[6] In cases of replantation without arterial circulation, finger losses take up to 13 hours, while development of necrosis starts in 3 hours in free tissue transplantations and finger replantation without venous return.[7] For this reason, it is important to provide venous return until angiogenesis develops in free tissue transplants and finger replantation. Hirudo therapy and leech applications were approved by the FDA in 2004 and leech was registered as a medical device. Although many benefits of leech application have been proven in free tissue transplantation and finger replantation with congestion, it has side effects. These include Aeromonas bacteria colonizing the leech digestive tract, blood transfusions due to bleeding disorders, anaphylaxis, and prolonged hospitalizations. Our aim is to share the experiences of leech applications in finger replantation cases.

Leech Therapy History

The first written evidence of leech practices was created by the Egyptians and dates back to 1500 BC. Its use for therapeutic purposes dates back to the civilizations of Greece, Rome and India around 500 AD.[8] Later, it was popularized

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among French surgeons and started to be used in 1970s to prevent venous congestion in free flaps.[9] Their use after finger replantation and the first publications were published in the 1990s, and its use in cases that did not respond to medical treatment became popular.[10]

Leech Application Conditions and Current Evidence

As a result of the literature review, Hirudo medicinalis is used for the treatment of venous congestion (**Figure 1**). In some cases, Hirudo verbana and Hirudo michaelseni were used for similar treatment modality.[11] The sizes of these leeches, which are used for medical purposes, vary between 3-5 cm and their weights vary between 2-3 grams (**Figure 2**).

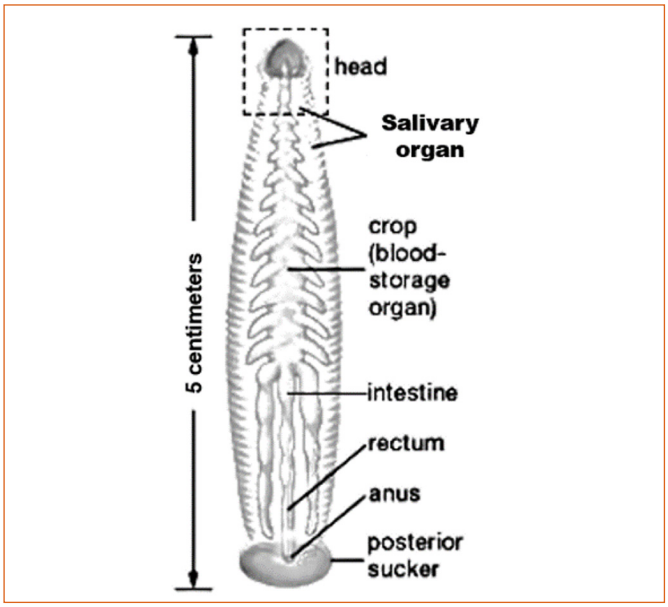

Figure 1. Leech application after finger replantation

Figure 2. Hirudo medicinalis morphology

There are suction organs at both ends of the leeches, and the suction process continues for about 15 minutes to 2 hours after the application. After the suction process is finished, it leaves the application area spontaneously. While bleeding in the application area continues for 6-8 hours, it decreases and disappears within 2 days.[12]

There is a general consensus on the use of antibiotic prophylaxis in patients given leech therapy for venous congestion. Appropriate antibiotic prophylaxis is applied together with treatment against Aeromonas species that are choline in the leech intestinal tract.[13]

2-3. The generation cephalosporin's, fluoroquinolones, trimethoprim-sulfamethoxazole, tetracycline and aminoglycosides can be used for prophylaxis. It should be started simultaneously with the treatment. After the examination of the samples taken from the leech tanks, 21 aeromonas species were found and 74.7% of them were sensitive to ciprofloxacin and 100% of them trimethoprim sulfamethoxazole. There are publications suggesting that antibiotic prophylaxis should be given just before the start of the application and to continue for 24 hours after the application. Another protocol advocates continuation of antibiotic prophylaxis for 2 weeks after administration.[14] Benzodiazepins and narcotic analgesics are not recommended for the treatment of pain in patients treated with leeches. It has been observed that narcotic analgesics suppress leech activity.[14] After the process, the leeches are killed in 70% ethanol and destroyed as medical waste. After wiping the application area with sterile sponge moistened with isotonic serum, it is recommended to leave it wet with a heparin dressing. In this way, the continuation of the hemorrhage should be ensured. In cases where venous system repair cannot be achieved after finger replantation or there is a risk of venous congestion, hirudo therapy can be started immediately after surgery. Hirudo therapy can be applied under systemic heparinization and aspirin therapy. If the leech is having trouble holding on, bleeding can be achieved by opening microholes on the skin with the help of a lancet, and leeches can be attached to these bleeding areas. Leeches should be changed at 2-hour intervals and clinical progression should be monitored. The clinician and the nurse must adapt to each situation by proposing first a "trial" interval of 2 to 6 hours according to congestion severity during the first 12 hours, and then a "maintenance" interval of 4 to 8 hours according to congestion reduction and blood color during bleeding. While measurement of the blood gases on the flap may be helpful, in our experience blood color and congestion should suffice. Nurses need to be trained for leech application.

Length of Treatment

In order to end leech therapy, the development of venous channels and completion of angiogenesis are required. Considering the development of angiogenesis, the development of venous channels in the tissue that has been repaired begins on the 2nd day. In another histological study on free tissue flaps with arterial flow, it was observed that venous capillaries developed on the 3rd day after repair.[15] There are large case series showing that the time required for venous angiogenesis after finger replantation is 5 days.[2,16] For this reason, it is recommended to continue leech therapy for 5 days after replantation. Again, it is recommended that the decision to terminate the treatment should be made by considering factors such as soft tissue blood supply, temperature and color. Another factor affecting the duration of treatment and the number of leeches to be applied is the level of amputation. Longer-term treatments are recommended because of the increase in tissue volume that will develop venous congestion in amputations from the proximal level. Leech applications were found to be successful for 10-12 days in amputations from Zone 1 and more proximal.[16,17] Another factor affecting angiogenesis is the age of the patient, and 48 hours of leech therapy was found to be sufficient in fingertip amputations in children under 10 years of age, and this period reaches 7 days in the older age group.[18]

External Bleeding Methods in Digit Replantation's

Multiple techniques have been described to satisfy outflow from artery-only replants. These include puncturing, scrubbing or lacerating the replant to promote bleeding; repairing both digital arteries; and creating a cutaneous-venous fistula, chemical leeching (local subcutaneous heparin), milking massage.[19-24] Success rates of these methods vary between 60-100%. The paraungal stab bleeding method showed the lowest success. Other methods have shown similar success.

Contraindications

Contraindications for leech application include arterial insufficiency, bleeding disorders, hematological malignancies, sepsis, HIV infection, decompensated hepatobiliary disease, leech intolerance. It is not recommended for vasoactive drug users, lactating and pregnant women.

Treatment Success

The success rate in finger replantation cases with only artery repair, especially in zone 1 and distal cases, varies between %60.9-90.[2,16,18]

CONCLUSION

Hirudo therapy, leech therapy is a successful method that can be used to prevent venous congestion in cases where venous repair cannot be performed or the repair is thought to be unsuccessful. Prophylactic antibiotics are strongly recommended. Close follow-up of the patient is recommended in terms of side effects that may develop during the application.

ETHICAL DECLARATIONS

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Case Report

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Non-small cell cancer of the lung metastasized to the central nervous system presenting with drop foot: a case report

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ABSTRACT

Drop foot usually presents as lumbar discopathy or peripheral nerve lesion. There may be many causes in the etiology of foot drop, which is rarely reported in upper motor nerve lesions. In this case report, a 59-year-old patient with lung cancer whose only symptom was drop foot was presented. In the patient's anamnesis, physical examination and imaging methods, we were guided by a central cause. As a result, it was concluded that although the etiology of foot drop is mostly due to peripheral lesions, central causes should not be ignored.

Keywords: Drop foot, brain metastasis, lung cancer

INTRODUCTION

Drop foot is severe weakness of ankle and big toe dorsiflexion. Drop foot is most commonly seen as a result of L4-5 radiculopathy or peroneal nerve entrapment at the head of the fibula.[1] Although it is usually seen in lesions of the peripheral nervous system, it has also been rarely reported in upper motor neuron lesions.[2] In this case report, we aimed to present a case with foot drop caused by non-small cell lung cancer with brain metastasis by reviewing the literature.

CASE

A 59-year-old male patient was admitted to our outpatient clinic with complaints of weakness in the right foot and difficulty in walking for a month. In the detailed anamnesis of the patient, who did not have a known systemic disease in his history, it was learned that he did not have low back pain, night sweats, weight loss and loss of appetite for about two months. There were no known features in her CV and family history. In the neuromuscular system examination of the patient with stepage gait, bilateral upper extremity, hip, knee and left ankle muscle strength were normal, right ankle dorsiflexion was 2/5, right toe extension was 2/5, right foot eversion was 2/5 muscle strength. Sensory examination was normal, deep tendon reflexes were hyperactive in the right lower extremity, and plantar response and clonus were positive in the right plantar reflex. In the electroneuromyography (ENMG) evaluation performed to explain the cause of foot drop of the patient whose hemogram, biochemistry, sedimentation and C-reactive protein values were normal; bilateral tibial-peroneal nerve amplitude and conduction velocities were within normal limits, and F response delay and thinning in the right tibialis anterior and gastrocnemus muscle were detected in the needle ENMG study. Lumbar, thoracic and cervical magnetic resonance imaging (MRI) did not reveal any additional pathology except mild degenerative changes. In the brain MRI examination of the patient who did not have a peripheral nervous system lesion, there was a mass lesion (metastasis) in the left posterior parietal region, in the paramedian midline, with a heterogeneous enhancement of 11*17*23 mm in size, with the effect of peripheral edema (**Figure 1**). The patient was transferred to the oncology department for further examination and treatment. In the examinations performed, a 48*41 mm mass lesion was detected in the vicinity of the segmental artery branch going to the lower lobe of the right lung in the thorax computed tomography (CT) examination of the patient. The biopsy result was compatible with non-small cell ca of the lung.

DISCUSSION

Drop foot is severe weakness of foot and ankle dorsiflexion. Tibialis anterior, extensor digitorum longus, extensor hallucis longus muscles provide dorsiflexion of the foot and ankle and are innervated from L4-L5-S1. These nerves are under control by the primary motor cortex (4th area of Broadma) located in the precentral gyrus. The primary motor cortex is the widest place on the dorsomedial surface of the hemisphere and continues as

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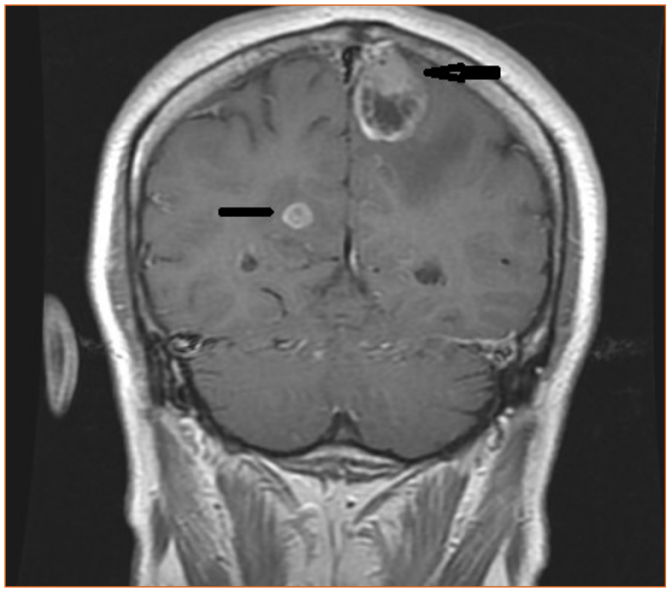

Figure 1: Paramedian midline metastatic lesion in the left posterior parietal region (brain MRI)

a thin band on the inferolateral surface of the precentral sulcus.[1-3] Although drop foot is usually seen as a result of L4-L5 disc herniation or fibular head peroneal nerve damage, it can also occur in upper motor neuron lesions.[4] Due to central causes, intensified upper motor neuron tracts, interhemispheric motor cortex homunculus area, corona radiata, internal capsule, cerebral peduncle, medulla and spinal cord pyramidal tract lesions are seen.[5,6] Upper motor neuron findings such as Babinski sign, hyperreflexia, and clonus in foot drop of central origin may accompany foot drop.[4] Baysefer et al.[7] reported a case of drop foot due to a parasagittal brain tumor. Eskandary et al.[8] reported that drop foot regressed after surgery in patients with parasagittal meningioma, brain abscess, astrocytoma, periventricular demyelinating plaque and depressed parietal fracture. In our case, weight loss, loss of appetite, night sweats in the patient's history, and Babinski's sign in the physical examination, vitality in deep tendon reflexes and clonus positivity directed us primarily to a central cause. The ENMG study and lumbar, thoracic and cervical MRI results supported our finding. The metastatic lesion detected in the brain MRI performed in our case who did not have peripheral pathology facilitated the diagnosis.

CONCLUSION

Although foot drop is usually seen as a result of L4-L5 disc herniation or fibular head peroneal nerve damage, it can also occur in upper motor neuron lesions. Detailed history, physical examination, ENMG and MRI methods taken from the patient are important methods to find the etiology of foot drop. Although the etiology of drop foot is mostly related to peripheral lesions, the causes of central origin should not be forgotten.

ETHICAL DECLARATIONS

Informed Consent: All patients signed the free and informed consent form.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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