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# Investigation of the effectiveness of dry needle therapy in pressure ulcers

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## ABSTRACT

**Aims:** This study aims to show whether dry needle therapy is effective in the treatment of pressure ulcers in patients who have developed ulcers anywhere on their body for any reason.

**Methods:** Thirty individuals (16 females, 14 males) with pressure ulcer were included in the study and a total of 6 sessions of dry needle therapy were applied to each individual with a one-day break. Before and after the application, circumference-diameter measurements of the wounds and staging according to the National Pressure Ulcer Advisory Panel scale were made and recorded with photographs.

**Results:** While the average wound diameter before the application was  $3.97 \pm 2.11$ , it was determined as  $3.21 \pm 1.77$  after the dry needle treatment ( $p < 0.001$ ). While the wound stage [med (IQR)] before application was 2 (1.75-3), it was determined as 2 (1-3) after application ( $p: 0.003$ ).

**Conclusion:** Dry needling treatment applied in pressure ulcers was effective in healing the wound and that studies should be conducted on wounds other than pressure sores.

**Keywords:** Pressure, ulcer, dry needle

## INTRODUCTION

Pressure ulcers, bed ulcers and decubitus ulcers are terms used to describe ischemic tissue loss due to pressure, especially on bony prominences.<sup>1</sup> It has been reported that 1.5-3 million people in the United States develop pressure ulcers every year for different reasons.<sup>2</sup> 63% of pressure ulcers develop in hospitalized patients,<sup>3</sup> the prevalence among hospitalized patients was found to vary between 10-20%.<sup>2</sup> It was observed that 10% of ambulatory patients, 37% of wheelchair-bound patients and 53% of bedridden patients developed pressure ulcers.<sup>3</sup> The economic burden of pressure sore treatment and care fees is considerable.<sup>4</sup> The amount of money spent on treating patients with pressure injuries in the UK is estimated to be between £1.4 and £2.1 billion.<sup>5</sup>

Pressure, the most important etiologic factor in the formation of pressure ulcers, was first described by Sir James Paget in 1873.<sup>3</sup> In cases where movement cannot be achieved, excessive pressure occurs in a part of the body. If this pressure is less than 45 mmHg, only capillary circulation is disrupted and erythema occurs in the tissue. However, when exposed to pressure higher than 45 mmHg, arterioles close, causing ischemia and tissue damage occurs.<sup>6</sup>

Pressure ulcers occur in patients requiring long-term care as a result of the contribution of two types of facilitating risk factors: intrinsic (cerebrovascular events, multiple sclerosis, spinal cord injuries, prolonged surgery, trauma, advanced musculoskeletal) and extrinsic (pressure, shear, friction and moisture).<sup>7</sup> It is most common in the sacrum, coccyx and heels in the supine position, in the hips and ankles in those who always lie on one side, and in the hips in the sitting position.<sup>8</sup>

Dry needling treatment (DNT) is the use of monofilament thick needles, known as acupuncture needles, on muscles, ligaments, tendons, subcutaneous fascia, scar tissue, peripheral nerves or tense neurovascular networks without the administration of any medication.<sup>9</sup> DNT creates an intense stimulation, activating muscle spindles and golgi tendon organs with the movement of the needle, creating long-lasting stimulation due to the minor injury it creates, unlike other physical stimuli. This stimulation reaches deep muscles, autonomic dysfunction responds to needle stimulation, resulting in smooth muscle relaxation, vasospasm and lymphoconstriction.<sup>10</sup>



A study in healthy subjects showed that blood flow and oxygen saturation volumes after needle removal in dry needling increased at the treated site compared to before the intervention.<sup>11</sup> As a result of our literature review, we could not find any study examining the effectiveness of dry needling therapy in patients with pressure ulcers. We think that determining the effectiveness of dry needling on pressure ulcers will be beneficial against pain, hospitalization, high costs and many complications. The aim of our study in this direction is to examine the effectiveness of dry needle therapy in patients with pressure ulcers.

## METHODS

### Ethics

The study was approved by the Gaziantep University Şahinbey Hospital Clinical Researches Ethics Committee (Date: 22.09.2014, Decision No: 2014/299). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. All patients signed the free and informed consent form.

### Design and Subjects

This study was conducted at Gaziantep University Şahinbey Hospital. At the beginning of the study, 52 patients with pressure ulcers were identified and followed up. The study was performed on 30 patients (14 males and 16 females) who met the inclusion and exclusion criteria (Figure 1).

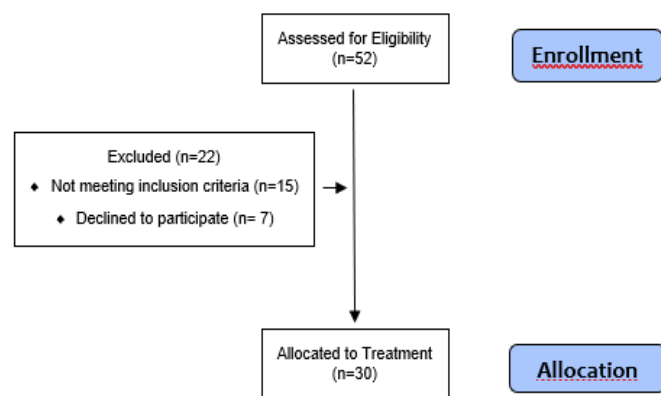


Figure 1. Flowchart of the study

Patients who received additional treatments such as debridement and grafting for pressure sores, patients with limb wounds and planned amputation, patients with a glasgow coma scale score of 3 points or less, patients who refused to participate in the study, and pregnant women were excluded from the study.

### Procedures

**Wound diameter and circumference:** The circumference and diameter measurements of the wounds were measured with a ruler before and after dry needle treatment (Figure 2).

**Pressure ulcer staging:** Pre-and post-treatment pressure injury staging was carried out in accordance with the National Pressure Ulcer Advisory Panel's (NPUAP) 2016 unified standards. Pressure injuries were classified as stage one, two, three, four, probable deep tissue damage, or unstageable.<sup>12</sup>



Figure 2. Taking measurements from a pressure ulcer

**Dry needle treatment:** Needles 25 mm long and 0.20 mm thick were used to wrap around the wound. The number of needles used was increased or decreased in direct proportion to the wound size. Each patient underwent a total of 6 needling sessions with a one-day break and the needles were kept for 20 minutes (Figure 3).



Figure 3. Dry needling application

### Statistical Analysis

Kolmogorov Smirnov test was used to check the conformity of continuous variables to normal distribution. In 2 dependent measure comparisons, paired t-test was used for normally distributed variables and Wilcoxon test was used for non-normally distributed variables. As descriptive statistics, mean±standart deviation, median (25%-75% values for numerical variables), number and % values for categorical variables are given. SPSS for Windows version 22.0 package program was used for statistical analysis and p<0.05 was considered statistically significant.

## RESULTS

Demographic information, initial wound stages, wound diameters and the distribution of the wound sites of all individuals are shown in [Table 1](#).

	Subjects (n:30)
Age (years)	61.20±20.92
Gender (female/male) (n)	16/14
<b>Ulcer stage</b>	
Evre 1 (n)	7
Evre 2 (n)	9
Evre 3 (n)	8
Evre 4 (n)	6
Ulcer (cm)	3.97±2.11
<b>Region</b>	
Foot (n)	6
Knee (n)	2
Hip (n)	17
Back (n)	5

\*Values are mean±SD, SD: Standart deviation

The average diameter measurement made on the ulcer before and after dry needle treatment (DNT) decreased from 3.97 cm to 3.21 cm, showing statistical significance (p: 001). When comparing the wound stage before and after treatment, the stage values of all cases decreased statistically (p: 003) ([Table 2](#)).

	Before Treatment (n: 30)	After Treatment (n: 30)	p
Ulcer diameter	3.97±2.11	3.21±1.77	0.001*
Ulcer stage	2 (1.75-3)	2 (1-3)	0.003**

\*: Paired sample t test, \*\*: Wilcoxon test, values are mean±SD and median (inter quartile range), SD: Standart deviation

## DISCUSSION

The data obtained from this study, which was carried out to examine the effect of dry needling technique on the healing of pressure ulcers, were discussed in the light of literature information.

When the pressure sore is approached as a soft tissue defect; Considering that DNT previously applied in moderate carpal tunnel syndrome gave satisfactory data,<sup>13</sup> a study on tendon healing reported that DNT contributed to healing by accelerating collagen proliferation,<sup>14</sup> DNT applied in wounds caused by burns produced high fibroblastic growth factor and increased wound healing rate<sup>15</sup> DNT's positive results in pressure ulcers would be in parallel with the literature information and was included in the study to be tested clinically.

Laser Doppler Flowmetry measurements performed after DNT, the blood flow in the region increases more than 2 times compared to before the application.<sup>16</sup> In the acute effects of DNT on osteoarthritis patients, it was found that microcirculation increased compared to the control group.<sup>17</sup>

In this direction, it has been supported by other researchers that DNT increases blood flow by local vasodilation.<sup>18</sup>

Statistically favourable results were found on the basis of diameter and NPUAP stage scale in the pre- and post-DNT data evaluation. From this perspective, the application of DNT in pressure ulcers statistically reduced the diameter of these ulcers. The effects we obtained locally from dry needling are similar to the literature.<sup>19,20</sup> A study with a control group to evaluate the specific efficacy of DNT applied on pressure ulcers would eliminate the doubts about the efficacy of DNT. Our study, in which DNT application was used on pressure ulcers, is one of the first studies on this subject. We think that DNT will pioneer the studies on ulcer in this context.

### Limitation

The patients included in the study were hospitalized both in the ward and intensive care unit. Since the care conditions in the ward and intensive care setting were not the same, it would have been more appropriate to select patients from the same type of intensive care unit or ward in order to eliminate other factors that may affect pressure sore healing. Since the care conditions in the ward and intensive care setting were not the same, it would have been more appropriate to select patients from the same type of intensive care unit or ward in order to eliminate other factors that may affect pressure sore healing. Some of the patients became mobile after prolonged hospitalization, while others were still immobile. A homogeneous study group, taking into account the mobilization status of the patients, would have been more effective in determining the efficacy of DNT in isolation. If a control group had been formed in addition to the DNT-treated patient group, the effect of DNT administration in isolation could have been better observed.

## CONCLUSION

When the effectiveness of DNT in pressure ulcers is examined, the results obtained are positive and significant both clinically and statistically. Ulcers improved according to ulcer diameter and staging scale before and after DNT. It is thought that the general health status of the patient and the prevention of contamination in open ulcers may affect the rate of ulcer closure. In this context, a study that can be conducted with patients who have equal care conditions and whose general health status is close to each other will provide clearer results.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

The study was approved by the Gaziantep University Şahinbey Hospital Clinical Researches Ethics Committee (Date: 22.09.2014, Decision No: 2014/299).

### 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

There was no external funding for the study.

### 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.

## REFERENCES

- Haesler E, National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: quick reference guide. [Internet], 2014.
- Jacquot JM, Pelissier J, Finels H, Strubel D. Epidémiologie et coût des escarres en gériatrie [Epidemiology and cost of pressure sores in the aged]. *Presse Med.* 1999;28(33):1854-1860.
- Petersen NC, Bittmann S. The epidemiology of pressure sores. *Scand J Plast Reconstr Surg.* 1971;5(1):62-66. doi: 10.3109/02844317109042939
- Jackson D, Durrant L, Bishop E, et al. Health service provision and the use of pressure-redistributing devices: mixed methods study of community dwelling individuals with pressure injuries. *Contemp Nurse.* 2017;53(3):378-389. doi: 10.1080/10376178.2017.1364973
- Bennett G, Dealey C, Posnett J. The cost of pressure ulcers in the UK. *Age Ageing.* 2004;33(3):230-235. doi: 10.1093/ageing/afh086
- Lyon NJP. Dermatology. *Skin Aging.* 1993.
- Allman RM. Pressure ulcer prevalence, incidence, risk factors, and impact. *Clin Geriatr Med.* 1997;13(3):421-436.
- Duthie EH, Katz PR. Practice of geriatrics. *WB Saunders Company.* 1998.
- Casanueva B, Rivas P, Rodero B, Quintal C, Llorca J, González-Gay MA. Short-term improvement following dry needle stimulation of tender points in fibromyalgia. *Rheumatol Int.* 2014;34(6):861-8666. doi: 10.1007/s00296-013-2759-3
- Alltree, J. The gunn approach to the treatment of pain: intramuscular stimulation for myofascial pain of radiculopathic origin. C. Chan Gunn. Churchill Livingstone (1996), Price:£ 25. 165pp., ISBN: 0443054223. 1998, Churchill Livingstone.
- Cagnie B, Barbe T, De Ridder E, Van Oosterwijck J, Cools A, Danneels L. The influence of dry needling of the trapezius muscle on muscle blood flow and oxygenation. *J Manipulative Physiol Ther.* 2012;35(9):685-691. doi: 10.1016/j.jmpt.2012.10.005
- Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System: Revised Pressure Injury Staging System. *J Wound Ostomy Continence Nurs.* 2016;43(6):585-597. doi: 10.1097/WON.0000000000000281
- Khosrawi S, Moghtaderi A, Haghghat S. Acupuncture in treatment of carpal tunnel syndrome: A randomized controlled trial study. *J Res Med Sci.* 2012;17(1):1-7
- Langevin HM, Bouffard NA, Churchill DL, Badger GJ. Connective tissue fibroblast response to acupuncture: dose-dependent effect of bidirectional needle rotation. *J Altern Complement Med.* 2007;13(3):355-360. doi: 10.1089/acm.2007.6351
- Lee JA, Jeong HJ, Park HJ, Jeon S, Hong SU. Acupuncture accelerates wound healing in burn-injured mice. *Burns.* 2011;37(1):117-125. doi: 10.1016/j.burns.2010.07.005
- Larsson R, Cai H, Zhang Q, Oberg PA, Larsson SE. Visualization of chronic neck-shoulder pain: impaired microcirculation in the upper trapezius muscle in chronic cervico-brachial pain. *Occup Med (Lond).* 1998;48(3):189-194. doi: 10.1093/occmed/48.3.189
- Foster NE, Thomas E, Barlas P, Hill JC, Young J, Mason E, Hay EM. Acupuncture as an adjunct to exercise based physiotherapy for osteoarthritis of the knee: randomised controlled trial. *BMJ.* 2007; 1(335-7617):436. doi: 10.1136/bmj.39280.509803.BE
- Kubo K, Yajima H, Takayama M, Ikebukuro T, Mizoguchi H, Takakura N. Effects of acupuncture and heating on blood volume and oxygen saturation of human Achilles tendon in vivo. *Eur J Appl Physiol.* 2010;109(3):545-550. doi: 10.1007/s00421-010-1368-z
- Wang Y, Deng L, Bian C, et al. Efficacies of different diameters of fire needle therapy on stage II and III pressure ulcer: a comparative study. *Int J Clin Exp Med.* 2018;11(8):8460-8466.
- Wang H, Gu Y, Huang L, et al. Effectiveness of fire needle combining with moist healing dressing to promote the growth of granulation tissue in chronic wounds: a case report. *Inter J Nurs Sci.* 2020;7(3):386-390.

# Does scapular asymmetry affect shoulder joint position sense and muscle strength in adolescent idiopathic scoliosis? A pilot study

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## ABSTRACT

**Aims:** The aim of this pilot study was to compare shoulder joint position sense (JPS) and shoulder muscle strength in individuals with adolescent idiopathic scoliosis (AIS) with and without scapular asymmetry and to analyze the results obtained in both groups in terms of convex and concave sides of the curve.

**Methods:** Individuals with AIS with primary right thoracic curvature and right dominant upper extremity were included in the study. The presence of scapular asymmetry was judged by Kibler's lateral scapular slide test. The study was completed with a total of 21 individuals with AIS, 10 with scapular asymmetry (asymmetrical group) and 11 without scapular asymmetry (symmetrical group). After the demographic and Cobb angle data of the individuals were obtained, other measurements were taken. JPS was evaluated by digital inclinometer at 60° shoulder flexion and 60° shoulder abduction positions. Shoulder flexion and abduction muscle strengths were evaluated with a handheld dynamometer. All measurements performed at of both extremities.

**Results:** There was no significant difference between the groups in terms of age, gender, body weight, height, body-mass index and Cobb angle ( $p>0.05$ ). JPS of the concave side shoulder joint at 60 degrees of flexion had a statistically significant high in the asymmetrical group ( $p=0.029$ ). In contrast, the angular deviation values of flexion and abduction motion were similar on the concave and convex sides in both groups ( $p>0.05$ ). Shoulder muscle strength was similar between the asymmetrical and symmetrical groups ( $p>0.05$ ). In the intra-group comparison of concave and convex side shoulder flexor and abductor muscle strengths in the asymmetrical group no difference was found ( $p>0.05$ ); it was found that there was a significant low in the convex side shoulder abductor muscle strength within the symmetrical group ( $p=0.023$ ).

**Conclusion:** The results of our study revealed that scapular asymmetry affects shoulder JPS in individuals with AIS but has no effect on muscle strength. Further studies with a higher number of subjects and objective measurement methods are needed for a more detailed evaluation of scapular kinematics, which directly affects soft tissues, in individuals with AIS.

**Keywords:** Kinematics, muscle strength, position sense, scapula, scoliosis, shoulder

## INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a 3-dimensional deformity of the spine seen in 1-3% of the adolescent population, affecting girls more frequently and of unknown etiology.<sup>1,2</sup> This deformity not only causes progressive rotational deformation of the spine, but also affects the biomechanics of the upper and lower body segments for the affected areas.<sup>3</sup>

Pathologic changes in the thoracic region are common in spinal deformity.<sup>4</sup> Considering the close anatomical relationship between the thorax and the scapula, scapular asymmetry occurs in individuals with AIS due to pathologic

displacement of the spine, disruption of the scapulothoracic rhythm, altered shoulder balance and compensation strategies. In a study examining the scapular kinematics of individuals with AIS, it was shown that the scapula on the convex side had more internal rotation and anterior tilt, while the scapula on the concave side had more external rotation, downward rotation and posterior tilt.<sup>5</sup> This proximal malalignment can negatively affect upper limb function by altering the kinetic chain and force transfer of the upper limb.<sup>6</sup>

Although the etiopathogenesis is still unclear, AIS is reported to be a multifactorial pathology.<sup>7</sup> Recent studies have shown

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that proprioceptive defects caused by mutations in certain genes responsible for proprioception (Runx3 and Piezo2) are associated with the development of AIS.<sup>8,9</sup> In some studies in which individuals with idiopathic scoliosis were compared with healthy controls, proprioceptive deficits were reported in the scoliosis group in the elbow, knee and neck regions.<sup>10-12</sup> Although clinical and laboratory studies have proven that individuals with AIS have impaired proprioception sensation of the elbow, knee and neck joints, the cause or effect of shoulder proprioception deficit is still unclear.<sup>13,14</sup>

Proprioception, the ability to perceive the position/movement of body segments, depends on feedback from mechanoreceptors (muscle spindles and golgi tendon organs) that respond to changes in muscle length and tone. In scoliosis, scapular disorientation, changes in scapular kinematics and periscapular muscle activity on both the convex and concave sides are known to be associated with spinal deformity.<sup>15</sup> Changes in the scapulothoracic joint and surrounding muscular tissue in individuals with AIS may affect the functional integrity and musculoskeletal alignment of the thorax-scapula-shoulder joint complex, resulting in differences in proprioceptive and muscular performance. Although scapular asymmetry and periscapular changes have been investigated in individuals with AIS, no study has been found to investigate the effect of these changes on shoulder joint proprioception and muscle strength. The aims of this pilot study were to investigate joint position sense (JPS), which is a sub-parameter of proprioception, and shoulder muscle strength in individuals with AIS with and without scapular asymmetry and to compare the results obtained in each group in terms of convex and concave sides of the curve.

As the hypothesis of this study, it was predicted that AIS patients with scapular asymmetry have poorer shoulder JPS and muscle strength and that this deficiency is more pronounced for the limb on the concave side of the curve.

## METHODS

This cross-sectional study was conducted with patients who were referred to our clinic with a diagnosis of AIS who met the inclusion criteria. The study was carried out with the permission of Lokman Hekim University Scientific Researches Ethics Committee (Date: 30.01.2024, Decision No: 2024/8). The study was conducted in accordance with the Declaration of Helsinki. All individuals who volunteered to participate in the study were informed about the study and written informed consent was obtained.

### Participants

Volunteers diagnosed with AIS, aged 10-18 years, with primary right thoracic curvature and right dominant upper extremity were included in the study. Individuals who had undergone any surgery on the spine or upper extremity, had pain or any injury to the shoulder joint, had any cervical lesion (disc herniation, thoracic outlet syndrome, etc.), had systemic or neurologic disorders, used a brace, and had problems with cooperation were excluded. Individuals with AIS who met the inclusion criteria were grouped according to the presence of scapular asymmetry using Kibler's lateral scapular slide test (LSST). The group of 21 subjects has been divided into two groups, 10 of which demonstrating the presence of scapular

asymmetry and the remaining 11 demonstrating the absence of scapular asymmetry, whom we call symmetrical group.

### Procedures

All participants were evaluated by a research physiotherapist (MS) at the same time of the day in a quiet and well-lit room. Age, gender, body weight and height were recorded as demographic information. Body-mass index (BMI) values were calculated. Cobb angles were measured and recorded on AP scoliosis radiographs to determine the angular severity of scoliosis.

### Assessment of Scapular Asymmetry

Kibler's LSST was used to assess scapular asymmetry. The test was performed bilaterally in the standing position at three different shoulder abduction angles measured goniometrically (0°, 45°, and 90°, respectively). The measurements were performed first with the arms in a neutral position (0°) next to the trunk on both sides, then with the shoulders in 45° abduction, hands on the waist and thumbs pointing backwards, and finally with the shoulders in 90° abduction and maximum internal rotation (Figure 1).<sup>16</sup>

Scapular position was assessed by measuring the distance between the distal end of the scapula and the spinous process of the aligned thoracic vertebra. A difference of 1.5 cm or more between the two sides in any of the three test positions was considered scapular asymmetry.<sup>17</sup>

### Assessment of JPS

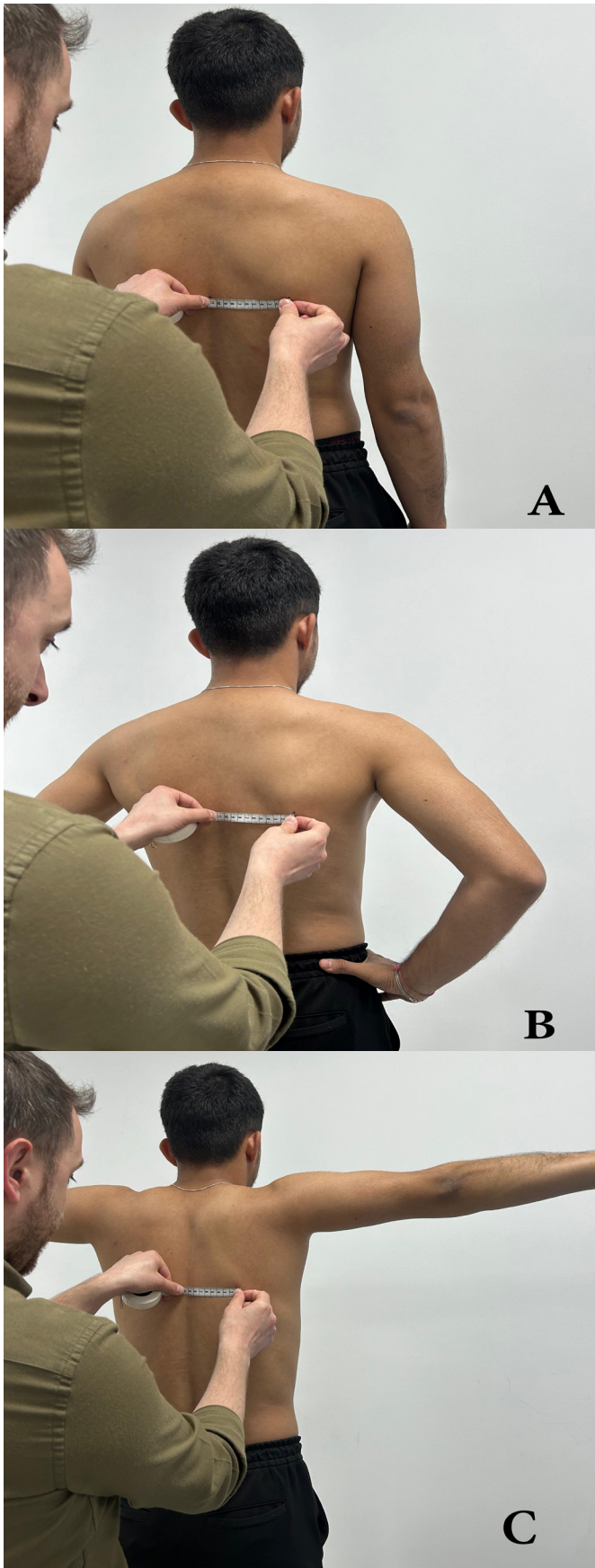
Shoulder JPS was evaluated by active reposition test using a digital inclinometer. Measurements were performed at 60° flexion and 60° abduction positions of both extremities. Participants were asked to sit on a chair without armrests with their feet in full contact with the floor and knees in 90° flexion. The digital inclinometer was placed at the attachment point of the anterior part of the Deltoid muscle to the humerus (Figure 2). The arm of the participants was flexed by the physiotherapist performing the test from the starting position of 0° to the target angle of 60° flexion, and after waiting in this position for 5 seconds, it was brought back to the starting position. The participant was then asked to close his/her eyes and actively use his/her arm to find this taught target angle. Participants verbalized the point at which they felt that they reached the target angle and maintained their position. The absolute difference between the target angle and the observed angle was measured and the absolute error score was calculated by averaging the three trials. The same measurements were repeated for the 60° abduction position of the shoulder. All measurements were performed bilaterally in both extremities.<sup>18,19</sup>

### Assessment of Muscle Strength

Strength assessments were performed for the shoulder muscles responsible for flexion and abduction movements in which JPS tests were performed. Shoulder flexion and abduction muscle strength measurements were evaluated using a digital hand-hold dynamometer. Participants were asked to perform 90° flexion and 90° abduction of the shoulder joint in a sitting position with the elbow in extension and the palm pointing downwards. The dynamometer was placed 1-2 cm above the elbow joint and the participants were



asked to maintain their current position against the given resistance (Figure 3). Resistance was applied by the evaluator until the arm position was broken and the maximum strength obtained was noted in kg. Three measurements were taken for both dominant and non-dominant extremities and the average was recorded as the final score.<sup>20</sup>



**Figure 1.** Lateral scapular slide test: A) neutral position, B) 45° abduction, C) 90° abduction



**Figure 2.** Assessment of joint position sense



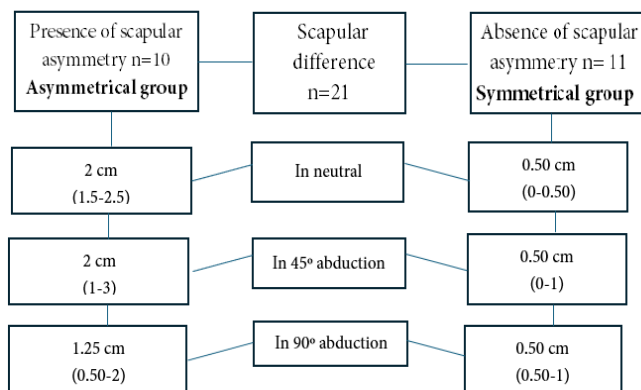
**Figure 3.** Assessment of muscle strength

### Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics 22.0 (SPSS Inc, Chicago, USA). All data were checked for normal distribution using the Shapiro-wilk test. Descriptive statistics were calculated for all variables and non-normal distributions were expressed as median and interquartile range (25-75), and ordinal variables were expressed as frequency and percentage. Mann Whitney u test and Chi-square test were used for intergroup comparisons and Wilcoxon signed-rank test was used for intragroup comparisons. Statistical significance value was accepted as  $p < 0.05$ .

## RESULTS

The pilot study was completed with 21 volunteer individuals with AIS (15 girls and 6 boys). The presence of scapular asymmetry determined by Kibler's LSST is shown in Figure 4.



**Figure 4.** Evaluations of the presence of scapular asymmetry in individuals with AIS included in the study and LSST results of the groups [Median IQR (25-75)]

When the LSST results of the patients forming the groups were analyzed, a statistical difference was found between the asymmetry values in the neutral and 45 degrees abduction position ( $p < 0.001$ ). There was no significant difference between the groups in terms of age, gender, body weight, height, BMI and Cobb angle ( $p > 0.05$ ) (Table 1). When the groups were analyzed in terms of Cobb Angle values, although there was no statistical difference, it was observed that the angular severity of scoliosis was slightly higher in the group with scapular asymmetry.

**Table 1. Comparison of demographic characteristics and Cobb angles of the groups**

	Asymmetrical group (n=10) median IQR (25-75)	Symmetrical group (n=11) median IQR (25-75)	P
Age (year)	14 (13-15)	15 (13-18)	0.255 <sup>a</sup>
Gender [n (%)]	Female 7 (70)	8 (72.7)	0.890 <sup>b</sup>
	Male 3 (30)	3 (27.3)	
Body weight (kg)	53.50 (49-61)	50 (47-65)	1.000 <sup>a</sup>
Height (cm)	167.50 (163-174)	167 (163-174)	0.724 <sup>a</sup>
BMI (kg/m <sup>2</sup> )	18.72 (18.04-20.81)	20.20 (17.21-21.80)	0.778 <sup>a</sup>
Cobb angle (°)	20.02 (16-30)	18.97 (15-28)	0.642 <sup>a</sup>

<sup>a</sup> $p < 0.05$ , <sup>b</sup>Mann Whitney's u test, <sup>c</sup>Chi-squared test, IQR: Interquartile range, BMI: Body mass index

Since the type of scoliosis was similar in all participants and the dominant upper extremity was right, the concave direction of the scoliotic curve was the non-dominant left upper extremity in all cases. In Table 2, statistical comparisons in terms of JPS and muscle strength were made both between groups using Mann-Whitney's u test ( $p^a$ ) and within groups using Wilcoxon signed-rank test comparing the concave-convex side (dominant-nondominant side respectively) ( $p^b$ ).

The shoulder joint movement deviation of the concave (non-dominant) side at 60 degrees of flexion of shoulder had a statistically significant high in the asymmetrical group ( $p = 0.029$ ). In contrast, the angular deviation values of flexion and abduction motion were similar on the concave and convex sides in both groups ( $p > 0.05$ ) (Table 2).

**Table 2. Comparison of muscle strength and joint position sense of the within and between groups**

Outcome measures	Asymmetrical group (n=10) median IQR (25-75)	Symmetrical group (n=11) median IQR (25-75)	$p^a$	
Joint position sense (°)	60° flexion (convex)	4.17 (2.33-10.33)	5.66 (2-8.33)	1.000
	60° flexion (concave)	10.16 (4.66-13.33)	4.33 (2.33-8)	0.029*
	$p^b$	0.092	1.000	
	60° abduction (convex)	6.33 (3-10.33)	4.66 (3.66-11)	0.751
	60° abduction (concave)	6.50 (2.66-10.33)	11.66 (3-12.66)	0.572
	$p^b$	0.878	0.398	
Muscle strength (kg)	Flexion (convex)	11.38 (10.13-17.83)	11 (9.90-11.63)	0.805
	Flexion (concave)	11.46 (8.66-13.56)	11.26 (9.80-12.60)	0.888
	$p^b$	0.508	0.656	
	Abduction (convex)	8.75 (8.30-12.43)	10.46 (8.16-10.63)	0.549
	Abduction (concave)	10.35 (7.46-14.10)	10.96 (10.43-12.40)	0.439
	$p^b$	0.386	0.023*	

\* $p < 0.05$ , a: Mann Whitney's u test; b: Wilcoxon signed-rank test, IQR: Interquartile range

Shoulder muscle strength was similar between the asymmetrical and symmetrical groups ( $p > 0.05$ ). In the intra-group comparison of concave and convex side shoulder flexor and abductor muscle strengths in the asymmetrical group, no difference was found ( $p > 0.05$ ); it was found that there was a significant low in the convex side shoulder abductor muscle strength within the symmetrical group ( $p = 0.023$ ) (Table 2).

## DISCUSSION

In the study in which we evaluated the flexor and abductor muscle strength as well as the shoulder JPS in 60° flexion and abduction positions by grouping individuals with primary right thoracic scoliotic curve and dominant right upper extremity diagnosed with AIS between the ages of 10-18, according to the presence of scapular asymmetry, it was concluded that our hypotheses were partially confirmed. As a result of the study, the angle error values of the concave (non-dominant) side shoulder flexion movement were found to be higher in individuals with AIS who had only scapular asymmetry compared to those with symmetrical scapular alignment. In intragroup comparisons of the concave and convex sides of the subjects in both groups, only the concave side shoulder abductor muscle strength of the symmetrical subjects was statistically higher.

The scapula has a very important role in normal shoulder-arm biomechanics. Differences in the kinematics of the scapula can cause asymmetry and changes in periscapular muscle activation, affecting the position sense and muscle strength of the shoulder joint.<sup>21</sup> Reyhani et al.<sup>6</sup> compared shoulder proprioception in asymptomatic athletes with and without scapular dyskinesia and reported that the group with scapular dyskinesia had JPS deficits and that these differences were due to changes in muscle activity and scapular kinematics. Studies have shown that individuals with AIS also have changes in scapular kinematics and muscle activity.<sup>5,22</sup> The results of our study are consistent with the results of these studies in terms of showing that individuals with AIS with scapular asymmetry have a loss of shoulder JPS. In addition, since there is no study in the literature that



examines shoulder muscle strength and JPS in individuals with AIS taking scapular asymmetry into account, this pilot study is the first of its kind.

Proprioception is known as the afferent signal originating from joint, muscle, tendon and related deep tissue mechanoreceptors, and an intact proprioceptive function is essential for the control of normal movement.<sup>23</sup> Cook et al.<sup>10</sup> compared the elbow joint proprioception of healthy individuals and individuals with AIS and reported that individuals with AIS had higher scores in both threshold and angle repetition tests compared to healthy individuals. Similarly, Keessen et al.<sup>24</sup> reported that individuals with AIS have proprioceptive dysfunction compared to healthy individuals and this may be an important factor in the development of spinal asymmetry. It is seen that the scapula position was ignored in these studies comparing the upper extremity JPS of individuals with AIS and healthy individuals. Unlike the studies in the literature, our current study was performed only in individuals with AIS considering the presence of scapular asymmetry, and a significant difference was found between individuals with and without asymmetry in terms of concave side shoulder flexion JPS. This may be explained by the fact that scapular asymmetry affects the structures responsible for sagittal plane movements more than the frontal plane.

Gupta and Shukla compared the proprioception of the elbow joint between healthy individuals and individuals with AIS and reported that there was a significant difference between the groups, but there was no difference between the dominant and non-dominant side within both groups.<sup>25</sup> The finding that the convex and concave side shoulder JPS of individuals with AIS were similar in the present study is in parallel with the results of previous studies. Yağcı et al.<sup>26</sup> examined the curve pattern and upper extremity function changes in individuals with AIS and reported that concave side dexterity and hand reaction time decreased in individuals with main thoracic curvature. This may have been caused by asymmetry in the scapula affecting the concave side JPS. We believe that the asymmetry in the scapula may affect the concave side JPS in individuals with AIS with main thoracic curvature, further negatively affecting dexterity and hand reaction time.

The scapula is an important part of the kinetic chain that allows the sequential transfer of forces, and inadequate muscle strength and muscle activation in the kinetic chain can lead to dysfunction.<sup>27</sup> Many studies have reported that altered muscle length-tension relationships in individuals with scapular asymmetry may lead to a decrease in shoulder girdle muscle strength.<sup>28,29</sup> However, Barbosa et al.<sup>30</sup> compared the physical performance of the upper limb in asymptomatic healthy adults with and without dyskinesia and reported that both groups had similar results and that the presence of scapular dyskinesia was not the only factor associated with poor scores on the upper limb performance test. Similarly, Akınoğlu et al.<sup>15</sup> reported similar horizontal abduction and horizontal adduction muscle strength results in athletes with and without scapular asymmetry. As a result of the present study, it was observed that there was no difference between the groups in terms of the presence of scapular asymmetry in shoulder flexion and abduction muscle strength of individuals with AIS. This is in line with the results of previous studies.

Seitz et al.<sup>28</sup> reported that athletes with dyskinesia had less lower trapezius and serratus anterior muscle strength

compared to those without dyskinesia and that this was due to decreased upward rotation of the scapula. Lin et al.<sup>22</sup> examined the relationship between scapular kinematics and muscle activity in individuals with AIS and found that there was decreased lower trapezius and serratus anterior muscle activity on the concave side, while there was an increase in upward rotation of the scapula. They also reported that shoulder dysfunction did not occur on the concave side, whereas it may occur on the convex side. In the light of this information, the reason why the shoulder abduction muscle strength of individuals without scapular asymmetry was significantly higher on the concave side may be due to the relationship between the upward rotation movement of the scapula and muscle activation.

Considering the presence of scapular asymmetry in individuals with AIS in shoulder JPS and muscle strength assessments is a strength of this study. The evaluation of scapular asymmetry with LSTT and the relatively small sample size can be considered as limitations of this pilot study.

## CONCLUSION

As a result of our study, there was a difference between individuals with AIS with and without scapular asymmetry in terms of shoulder flexion JPS on the concave side, while other position sensations and muscle strengths were similar. When the convex and concave sides were compared within the groups, only the symmetrical scapula group had significantly better concave side shoulder abductor strength. The results of our study revealed that scapular asymmetry affects shoulder JPS in individuals with AIS but has no effect on muscle strength. Further studies with a higher number of subjects and objective measurement methods are needed for a more detailed evaluation of scapular kinematics, which directly affects soft tissues, in individuals with AIS.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

The study was carried out with the permission of Lokman Hekim University Scientific Researches Ethics Committee (Date: 30.01.2024, Decision No: 2024/8).

### 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.



## REFERENCES

- Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. *J Child Orthop*. 2013;7(1):3-9.
- Weinstein SL, Dolan LA, Cheng JC, Danielsson A, Morcuende JA. Adolescent idiopathic scoliosis. *Lancet*. 2008;371(9623):1527-1537.
- Raso VJ, Lou E, Hill DL, Mahood JK, Moreau MJ, Durdle NG. Trunk distortion in adolescent idiopathic scoliosis. *J Pediatr Orthop*. 1998;18(2):222-226.
- LeBlanc R, Labelle H, Rivard CH, Poitras B. Relation between adolescent idiopathic scoliosis and morphologic somatotypes. *Spine*. 1997;22(21):2532-2536.
- Turgut E, Gur G, Ayhan C, Yakut Y, Baltaci G. Scapular kinematics in adolescent idiopathic scoliosis: A three-dimensional motion analysis during multiplanar humeral elevation. *J Biomech*. 2017;61:224-231.
- Reyhani F, Meftahi N, Rohjani-Shirazi Z. Comparing shoulder proprioception, upper extremity dynamic stability, and hand grip strength in overhead athletes with and without scapular dyskinesis. *J Bodyw Mov Ther*. 2024;39:304-310.
- Cheng JC, Castelein RM, Chu WC, et al. Adolescent idiopathic scoliosis. *Nat Rev Dis Primers*. 2015;1(1):1-21.
- Blecher R, Krief S, Galili T, et al. The proprioceptive system masterminds spinal alignment: insight into the mechanism of scoliosis. *Dev Cell*. 2017;42(4):388-399.
- Chesler AT, Szczot M, Bharucha-Goebel D, et al. The role of PIEZO2 in human mechanosensation. *N Engl J Med*. 2016;375(14):1355-1364.
- Cook SD, Harding AF, Burke SW, Whitecloud TS, Barrack RL, Leinhardt TM. Upper extremity proprioception in idiopathic scoliosis. *Clin Orthop Relat Res*. 1986;213:118-124.
- Barrack RL, Whitecloud TS, Burke SW, Cook SD, Harding AF. Proprioception in idiopathic scoliosis. *Spine*. 1984;9(7):681-685.
- Guyot MA, Agnani O, Peyrodie L, Samantha D, Donze C, Catanzariti JF. Cervicocephalic relocation test to evaluate cervical proprioception in adolescent idiopathic scoliosis. *Eur Spine J*. 2016;25:3130-3136.
- Le Berre M, Guyot MA, Agnani O, et al. Clinical balance tests, proprioceptive system and adolescent idiopathic scoliosis. *Eur Spine J*. 2017;26:1638-1644.
- Lau KK, Law KK, Kwan KY, Cheung JP, Cheung KM, Wong AY. Timely revisit of proprioceptive deficits in adolescent idiopathic scoliosis: a systematic review and meta-analysis. *Global Spine J*. 2022;12(8):1852-1861.
- Akınoğlu B, Kabak B, Balci A, Kocahan T, Hasanoglu A. A comparative study of shoulder muscle strength, sense of proprioception and internal/external rotation flexibility between adolescent athletes with and without scapular asymmetry. *Adv Rehab*. 2020;34(3):1-7.
- Ben Kibler W. The role of the scapula in athletic shoulder function. *Am J Sports Med*. 1998;26(2):325-337.
- Curtis T, Roush JR. The lateral scapular slide test: a reliability study of males with and without shoulder pathology. *N Am J Sports Phys Ther*. 2006;1(3):140-146.
- Dover G, Powers ME. Reliability of joint position sense and force-reproduction measures during internal and external rotation of the shoulder. *J Athl Train*. 2003;38(4):304-310.
- Yang JL, Chen S, Jan MH, Lin YF, Lin JJ. Proprioception assessment in subjects with idiopathic loss of shoulder range of motion: joint position sense and a novel proprioceptive feedback index. *J Orthop Res*. 2008;26(9):1218-1224.
- Beshay N, Lam PH, Murrell GA. Assessing the reliability of shoulder strength measurement: hand-held versus fixed dynamometry. *Shoulder Elbow*. 2011;3(4):244-251.
- Karagiannakis D, Athanasopoulos S, Mandalidis D. Scapular muscles' activity in female volleyball players with scapular asymmetry in the resting position. *J Bodyw Mov Ther*. 2018;22(3):580-585.
- Lin JJ, Chen WH, Chen PQ, Tsao JY. Alteration in shoulder kinematics and associated muscle activity in people with idiopathic scoliosis. *Spine*. 2010;35(11):1151-1157.
- Chen N, Chen C, Mo X, Du Q, Liu Y. Joint proprioception of adolescent idiopathic scoliosis: a mini review. *Biomed J Sci Tech Res*. 2019;15(5):11601-11603.
- Keessen W, Crowe A, Hearn M. Proprioceptive accuracy in idiopathic scoliosis. *J Pediatr Orthop*. 1992;12(4):149-155.
- Gupta RR, Shukla Y. To study the upper extremity proprioception in juvenile idiopathic scoliosis-an observational study. *Indian J Physic Therapy*. 2014;2(2):66-69.
- Yagci G, Aydin Ozcan D, Ayhan C, Demirkiran G, Yakut Y, Yazici M. Evaluation of upper extremity function and its relation to curve pattern in female adolescents with idiopathic scoliosis: a pilot study. *Spine Deform*. 2020;8:1175-1183.
- Sciascia A, Cromwell R. Kinetic chain rehabilitation: a theoretical framework. *Rehabil Res Pract*. 2012;2012:1-9.
- Seitz AL, McClelland RI, Jones WJ, Jean RA, Kardouni JR. A comparison of change in 3D scapular kinematics with maximal contractions and force production with scapular muscle tests between asymptomatic overhead athletes with and without scapular dyskinesis. *Int J Sports Phys Ther*. 2015;10(3):309-318.
- Merolla G, De Santis E, Campi F, Paladini P, Porcellini G. Supraspinatus and infraspinatus weakness in overhead athletes with scapular dyskinesis: strength assessment before and after restoration of scapular musculature balance. *Musculoskelet Surg*. 2010;94:119-125.
- Barbosa GMP, Matheus JPC, Lemos TV, Barbosa GMP, Souza Júnior JRD. Comparison of the upper extremity physical performance tests between asymptomatic adults with and without scapular dyskinesis. *Fisioter. Mov*. 2023;36:e36121.

# Bibliometric analysis of articles on meniscal transplantation

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## ABSTRACT

**Aims:** The aims of this study is to contribute to the literature by performing a bibliometric analysis of the articles written about meniscal transplantation worldwide.

**Methods:** Studies indexed in the Science Citation Index Expanded and Emerging Sources Citation Index of the Web of Science database from 1986 to 2024 have been examined. The analysis included the number of articles by year, country, publisher, citation count, and journal of publication.

**Results:** A total of 577 articles indexed as SCI-E and ESCI were identified in the WoS database. These articles were contributed from a diverse range of countries, with the number of articles increasing over time.

**Conclusion:** Meniscus transplantation is a topic that has become popular over time. It is reasonable to posit that this trend will continue in the near future.

**Keywords:** Bibliometric analysis, meniscus, transplantation, allograft, publications

## INTRODUCTION

It is known that the meniscus is one of the most significant tissues of the knee joint. The menisci perform a number of crucial functions, including distributing the load on the tibiofemoral joint, adapting the femur and tibia bones in the knee joint, nutritional and lubrication support for the cartilages.<sup>1-4</sup> The meniscus tissue is an indispensable component of the knee joint, as it possesses a unique structure that is not found in any other part of the body. Consequently, it cannot be replaced by another tissue in the event of injury. In the extended position of the knee, the medial meniscus bears 50% of the load of the medial compartment, while the lateral meniscus bears 70% of the load of the lateral compartment. When the knee is flexed, the aforementioned 70% ratio increases to 85%.<sup>5</sup> Given that the lateral meniscus is subjected to greater forces, the contact area between the opposing surfaces is reduced by 40-50% following total lateral meniscectomy, resulting in a contact force of 200-300% on the articular surfaces. Meniscectomies are a common surgical procedure. In the majority of cases, less than 50% of the meniscus is removed. However, in the case of bucket handle-type tears, in which more than 50% of the meniscus is removed, the use of meniscal allograft transplants (MAT) becomes a viable option.<sup>6,7</sup>

The initial MAT surgery in humans was conducted by Milachowski et al.<sup>8</sup> in 1984, with the results of experimental and clinical studies on this case and subsequent cases published in 1989. In their experimental studies, they transplanted lyophilised gamma-sterilised allogenic menisci to the first group of 15 sheep and deep-frozen menisci to the other group. While complete remodelling was obtained in the first group, they reported that they obtained non-remodelled but functionally complete menisci in the second group. In their clinical studies, better results were generally obtained with deep-frozen allografts. Subsequently, numerous experimental and clinical studies have been conducted on indications, graft preservation methods, surgical technique and approach in the case of concomitant chondral and ligamentous injuries.<sup>2,3,7</sup>

MAT is indicated in patients with a stable knee joint, cartilage damage of less than grade 3 according to ICRS, no malalignment and pain in the knee compartment affected by the meniscal defect. MAT is an evolving surgical option for symptomatic meniscal deficiency with good overall clinical outcomes and high rates of patient satisfaction.<sup>7</sup>

Bibliometric analyses are an effective method for tracking long-term research trends in a field.<sup>9-12</sup> This method enables

objective evaluation of research contributions by different countries, institutions, journals, and authors in the scientific field. It further facilitates analysis of research trends and identification of current perspectives.

## METHODS

A bibliometric study is an open data study. It does not contain any personal data. Ethics committee approval is not required. All procedures were carried out in accordance with the ethical rules and the principles.

Numerous online databases are available for bibliometric analysis. This study chose Web of Science (WoS), Science Citation Index Expanded (SCI-E), and Emerging Sources Citation Index (ESCI) for their high scientific quality and reliability. For the document type, ‘article’ was selected. The WoS database was accessed on 1 June 2024, retrieving articles related to meniscus transplantation from around the world between 1986 and June 2024.

Search terms, selected from the MESH library, were: “meniscus transplantation” (all fields) OR “menisci transplantation” (all fields) OR “meniscal transplantation” (all fields) OR “meniscus allograft transplantation” (all fields) OR “menisci allograft transplantation” (all fields) OR “meniscal allograft transplantation” (all fields). The literature, filtered using exclusion criteria from the study plan, was downloaded in Word and Excel file formats. The data obtained were then analyzed. Bibliometric parameters such as publication year, language used, first author’s name, country of publication, total citations, journal title, and affiliated institutions were considered in the evaluation.

Excel files were utilized to create graphs and tables, employing percentage and frequency values for table creation. In addition to Scopus and WoS database’s own graphs, the VOSviewer tool (Leiden University, The Netherlands) was used to produce bibliometric networks and visualizations.<sup>13,14</sup>

## RESULTS

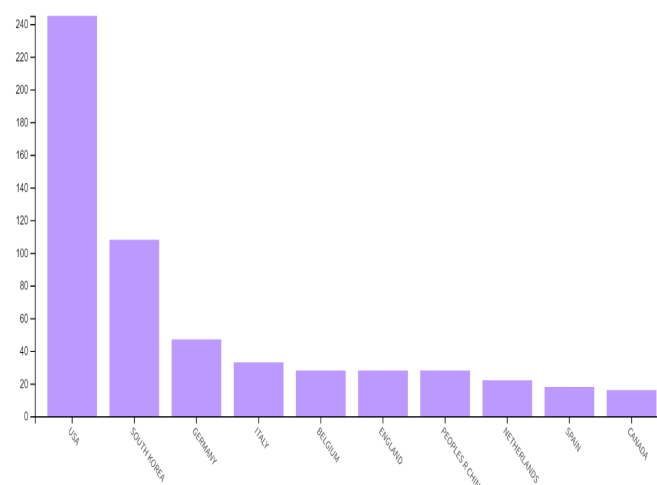
A total of 577 articles indexed as SCI-E and ESCI were identified in the WoS database. The first of these articles was published in 1986. The first year in which the number of publications exceeded 20 was 2012. A total of 16 articles were published until June 2024. The number of publications according to years is presented in **Table 1**.

A total of 52 countries contributed to the literature. The USA, South Korea and Germany were the largest contributors (**Figure 1**). It was observed that five languages were used in the articles: English, German, French, Portuguese and Czech. The data on the languages of the articles are presented in **Table 2**. 505 (87.52%) of the articles were indexed in SCI-E and 72 (12.48%) in ESCI.

A total of 122 different journals published the articles. The American Journal of Sports Medicine (92 articles), Knee Surgery Sports Traumatology Arthroscopy (86 articles), and Arthroscopy: The Journal of Arthroscopic and Related Surgery (75 articles) were the journals where the most articles were published. **Table 3** shows the journals with 10 or more articles. The publishers with the greatest number of articles were Elsevier (180 articles), Springer Nature (143 articles), and Sage (113 articles). The top 10 publishers with the greatest number of articles are shown in **Table 4**.

**Table 1. Distribution of the number of articles by years**

Publication years	Record count	% of 577
2024	16	2.773
2023	35	6.066
2022	37	6.412
2021	33	5.719
2020	39	6.759
2019	37	6.412
2018	28	4.853
2017	34	5.893
2016	31	5.373
2015	36	6.239
2014	26	4.506
2013	13	2.253
2012	26	4.506
2011	18	3.120
2010	16	2.773
2009	9	1.560
2008	14	2.426
2007	16	2.773
2006	18	3.120
2005	6	1.040
2004	10	1.733
2003	15	2.600
2002	13	2.253
2001	3	0.520
2000	8	1.386
1999	11	1.906
1998	1	0.173
1997	7	1.213
1996	3	0.520
1995	5	0.867
1994	6	1.040
1993	3	0.520
1992	1	0.173
1989	1	0.173
1988	1	0.173
1986	1	0.173



**Figure 1. Top 10 countries with the most articles published**

**Table 2. Distribution of articles according to language of writing**

Languages	Record count	% of 577
English	553	95.841
German	19	3.293
French	2	0.347
Portuguese	2	0.347
Czech	1	0.173

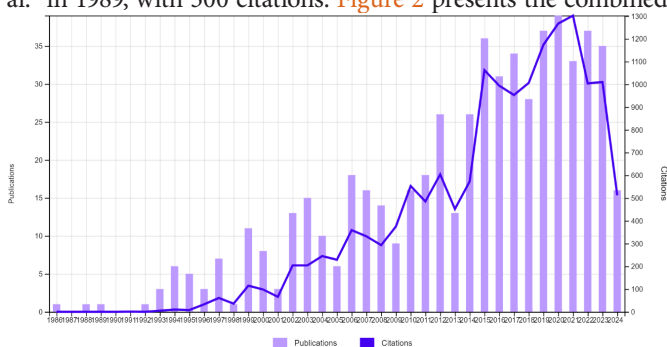
**Table 3. Journals publishing more than 10 articles**

Publication titles	Record count	% of 577
American Journal of Sports Medicine	92	15.945
Knee Surgery Sports Traumatology Arthroscopy	86	14.905
Arthroscopy the Journal of Arthroscopic and Related Surgery	75	12.998
Arthroscopy Techniques	29	5.026
Orthopaedic Journal of Sports Medicine	19	3.293
Knee	15	2.600
Operative Techniques in Sports Medicine	15	2.600
Journal of Knee Surgery	12	2.080

**Table 4. Top 10 publishers publishing the most articles**

Publishers	Record count	% of 577
Elsevier	180	31.196
Springer Nature	143	24.783
Sage	113	19.584
Lippincott Williams & Wilkins	30	5.199
Wiley	17	2.946
Thieme Medical Publishers	16	2.773
Amer Orthopaedic Soc Sport Med	7	1.213
MDPI	7	1.213
British Editorial Soc Bone Joint Surgery	6	1.040
Taylor & Francis	4	0.693

The total number of citations received by 577 articles was 15,625. The average number of citations per article was 27.08. The most cited article was that published by Milachowski et al.<sup>8</sup> in 1989, with 300 citations. Figure 2 presents the combined

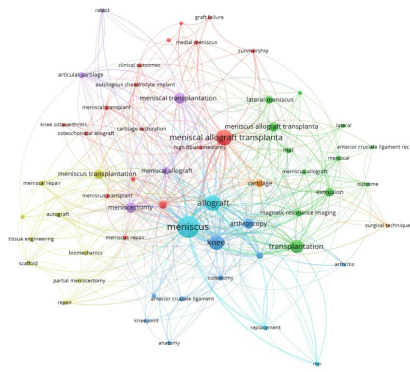


**Figure 2.** Distribution of the number of articles and citations by year

change in the number of articles and citations by year.

### Results of Analyzing the WoS Database with the VOSviewer

**Keyword analysis:** The WoS database was examined using the VOSviewer application to identify and analyse frequently occurring keywords. A total of 766 unique keywords were identified that occurred at least once. The size of each node represents the frequency of each keyword, while the lines connecting the nodes show co-occurrence relationships (Figure 3). The most frequently occurring keywords were



**Figure 3.** VOSviewer results of keyword analysis

meniscus (162 occurrences), allograft (86 occurrences), knee (76 occurrences) and transplantation (61 occurrences).

## DISCUSSION

The initial publication on MAT was a study on animals in 1986, and the first study on humans was published in 1989. Over the following two decades, a mere 19.4% of all articles on MAT were published. In contrast, 27.7% of all published articles on MAT have been produced in the past five years. This demonstrates that there has been a rapid increase in the interest in meniscal transplantation, which is a topic of great current interest. Similarly, it can be anticipated that this trend will continue in the coming years. The relatively low number of articles published over the 20-year period following the initial publication may be attributed to the fact that a novel and challenging surgical technique had only recently been introduced and was just beginning to be applied by surgeons, in addition to the potential inadequacies in equipment and graft supply.

The contributions and impact of countries in the field of science can be quantified through bibliometric studies. Upon analysis of the WOS database, the results indicated a pronounced dominance of the USA. Upon analysis of the top-ranked countries, it becomes evident that there is a discernible correlation between their financial development and their contribution to science.

English is the dominant language of publication in the WOS database, with a rate of 87.52%. It can therefore be concluded that English is the most widely used language for scientific literature.

One of the most significant challenges for authors is identifying suitable journals for their articles. Bibliometric studies can provide valuable insights in this regard. In this regard, bibliometric studies provide valuable insights. Upon examination of the publishers and journals that have published the most articles on MAT, it becomes evident that these are highly regarded and well-established publishers (e.g., Elsevier, Springer Nature, Sage) and journals (e.g., The American Journal of Sports Medicine, Knee Surgery Sports Traumatology Arthroscopy, Arthroscopy: The Journal of Arthroscopic and Related Surgery). This information serves as a valuable guide for researchers in terms of publishing subsequent studies.

Keywords are important for understanding what readers are looking for and what information you need to provide to



meet their needs. The most frequently occurring keywords in the field of meniscus allograft transplantation are meniscus, allograft, knee and transplantation. The terms in question exhibit a general expression. As more articles are incorporated, it is anticipated that keyword frequencies will cluster around more specific words.

## CONCLUSION

The findings of this study will assist in the review and evaluation of the existing literature on meniscal transplantation. This subject, which has gained considerable momentum in recent times, will continue to gain importance as surgical experience increases and the influence of biomedical and material engineering grows.

## ETHICAL DECLARATIONS

### Ethics Committee Approval

A bibliometric study is an open data study. It does not contain any personal data. Ethics committee approval is not required.

### Informed Consent

A bibliometric study is an open data study. It does not contain any personal data. Informed consent is not required.

### Referee Evaluation Process

Externally peer-reviewed.

### Conflict of Interest Statement

The authors have no conflicts of interest to declare.

### Financial Disclosure

There was no external funding for the study.

### 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.

## REFERENCES

- Haklar U, Aykut S. Lateral menisküs allogreft transplantasyonu. *TOTBID Derg.* 2018;17. doi: 10.14292/totbid.dergisi.2018.30
- Smith NA, Costa ML, Spalding T. Meniscal allograft transplantation: rationale for treatment. *Bone Joint J.* 2015;97-B(5):590-594. doi:10.1302/0301-620X.97B5.35152
- Frank RM, Cole BJ. Meniscus transplantation. *Curr Rev Musculoskelet Med.* 2015;8(4):443-450. doi:10.1007/s12178-015-9309-4
- Fox AJ, Wanivenhaus F, Burge AJ, Warren RF, Rodeo SA. The human meniscus: a review of anatomy, function, injury, and advances in treatment. *Clin Anat.* 2015;28(2):269-287. doi:10.1002/ca.22456
- Ahmed AM, Burke DL. In-vitro measurement of static pressure distribution in synovial joints-Part I: Tibial surface of the knee. *J Biomech Eng.* 1983;105(3):216-225. doi:10.1115/1.3138409
- Lubowitz JH, Verdonk PC, Reid JB 3rd, Verdonk R. Meniscus allograft transplantation: a current concepts review. *Knee Surg Sports Traumatol Arthrosc.* 2007;15(5):476-492. doi:10.1007/s00167-006-0216-5
- Sherman SL, Thomas DM, Gulbrandsen TR, Farr J. Meniscus allograft transplantation. *Oper Tech Sports Med.* 2018;26(3):189-204. doi: 10.1053/j.otsm.2018.06.010
- Milachowski KA, Weismeier K, Wirth CJ. Homologous meniscus transplantation. Experimental and clinical results. *Int Orthop.* 1989; 13(1):1-11. doi:10.1007/BF00266715
- Üzümcügil A, Kurt M, Yılmaz S. Bibliometric approach to total hip arthroplasty literature originating from Turkey. *J Contemporary Med.* 2023;13(4):711-719. doi: 10.16899/jcm.1312501
- Uyar C, Alkan S, Tahmaz A. Research trends and hotspots of osteoarticular involvement in brucellosis. *J Zoonotic Diseases.* 2022; 6(2):69-77. doi: 10.22034/jzd.2022.14656
- Seetharam A, Ali MT, Wang CY, et al. Authorship trends in the Journal of Orthopaedic Research: a bibliometric analysis. *J Orthop Res.* 2018; 36(11):3071-3080. doi:10.1002/jor.24054
- Lazarides MK, Lazaridou IZ, Papanas N. Bibliometric analysis: bridging informatics with science. *Int J Low Extrem Wounds.* Published online 2023. doi:10.1177/15347346231153538
- van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics.* 2010;84(2):523-538. doi:10.1007/s11192-009-0146-3
- van Eck NJ, Waltman L. Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics.* 2017;111(2):1053-1070.

# Exercise in head and neck cancer: review of the last 5 years

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## ABSTRACT

Head and neck cancers (HNC) is a significant global health issue with increasing incidence and mortality rates. Physiotherapy in HNC is crucial for managing post-treatment challenges, reducing functional limitations, improving quality of life, and achieving maximum physical independence. This review examined full-text articles published between 2019 and 2024 on PubMed using keywords related to head and neck neoplasms, exercise, and rehabilitation. Out of sixteen accessed articles, eleven met the inclusion criteria. The reviewed studies primarily focused on supervised aerobic, and resistance exercises post-surgery. Aerobic exercise training did not change heart rate or aerobic endurance in participants before and after treatment. However, the control group in studies showed significant decreases in these parameters. This highlights the importance of aerobic exercise during chemotherapy. Muscle strength exercises reported significant increases in overall muscle strength and positive changes in fatigue levels and quality of life in the exercise groups. Stretching exercises were performed in studies, replacing warm-up and cool-down periods. Qi-gong exercises administered to HNC patients resulted in significant improvements in quality of life, sleep quality, and cancer-related fatigue. The limited number of exercise studies in HNC highlights the need for more research. The reviewed studies demonstrate the importance of incorporating supervised exercise in the rehabilitation of HNC patients, particularly to mitigate the side effects of chemotherapy. Future research should explore home exercise programs and telerehabilitation to accommodate patients unable to participate in supervised exercise programs. Exercise plays a critical role in the rehabilitation of HNC patients, improving physical function, reducing fatigue, and enhancing quality of life, thus emphasizing the need to incorporate structured exercise programs into HNC treatment plans to optimize patient outcomes.

**Keywords:** Head and neck neoplasms, rehabilitation, exercise

## INTRODUCTION

Head and neck cancers (HNC) encompass a group of cancers that include the larynx, oral cavity, oropharynx, hypopharynx, nasopharynx, maxillary antrum, other paranasal sinuses, nasal cavity, salivary glands, and middle ear cancers, as well as their subtypes. In Türkiye, HNC is the 6th most common cancer in men and 11<sup>th</sup> in women. According to the Global Cancer Observatory (GLOBOCAN) 2020 data, 870,000 new cases of HNC are diagnosed annually, with 440,000 deaths reported. The incidence of HNC is increasing, with projections estimating 1.08 million new cases per year by 2030.<sup>1</sup>

Etiologically, tobacco and alcohol use, occupational, ionizing radiation, and viral exposures are significant risk factors. Tobacco-derived carcinogens and chronic heavy alcohol consumption are major global risk factors for HNC. In recent years, Human papilloma virus (HPV) is the most common cause of oropharyngeal cancer in Western countries, while Epstein-barr virus stands out as another factor playing a role in nasopharyngeal carcinomas.<sup>2</sup>

Treatment options for HNC vary based on the cancer type and stage, including surgery, radiotherapy, and chemotherapy, either alone or in combination<sup>3</sup>. Recently, targeted therapy,<sup>4</sup> immunotherapy,<sup>5</sup> and photodynamic therapy<sup>6</sup> have been introduced. Treatment choices consider tumor size, location, stage, pathology, patient's life expectancy, functionality, and cosmetic factors.<sup>7</sup> Each treatment modality affects patients' functional and aesthetic capacities, highlighting the importance of rehabilitation.

In many HNC cases, surgery is the primary treatment. Modified radical neck dissection is the gold standard when neck lymph nodes are involved. Although radiotherapy is a complementary treatment modality, studies show that with advancing technology, radiotherapy can control tumor growth and spread, and in specific tumors, it can be used as a standalone medical agent. The role of chemotherapy alone in HNC is uncertain; however, when combined with radiotherapy for advanced tumors, it effectively controls the tumor. While other treatments usually have localized



effects, chemotherapy’s systemic effects also reduce its frequency of use.<sup>8</sup>

### Physiotherapy in Head and Neck Cancers

Physiotherapy in HNC is crucial in managing post-treatment challenges, reducing functional limitations, improving quality of life, and achieving maximum physical independence. HNC treatments can cause complications that necessitate physiotherapy and rehabilitation, including posture disorders, limited joint range of motion, trismus, respiratory problems, swallowing difficulties, dry mouth, facial paralysis, hearing problems, lymphedema, cosmetic issues, pain, fatigue, sleep disorders, and psychological problems.<sup>9</sup>

Rehabilitation focuses on neck joint range of motion, shoulder functions, posture, and respiratory mechanics. Interventions in these areas can significantly improve patients’ quality of life. Common post-treatment complications like shoulder movement restrictions negatively impact daily activities. Postural deformities and reduced respiratory functions can adversely affect both physical and psychological health. Specific interventions, such as improving shoulder mobility, correcting posture, and increasing respiratory capacity, are essential. The broad application range of physiotherapy includes special exercise programs, lymphedema management, and facial paralysis rehabilitation. However, more knowledge and awareness are needed regarding the effectiveness and standard application methods of these rehabilitation techniques.<sup>10</sup>

Aerobic, resistance, stretching and Qi-gong exercises are utilized in HNC patients. This review was conducted to emphasize the critical need for including exercise in the rehabilitation process for HNC patients by highlighting recent advancements and findings in current literature.

### METHODS

Using keywords “head and neck neoplasms or neck dissection and exercise or rehabilitation,” full-text articles published between 2019-2024 in PubMed were reviewed. Keywords were selected from the medical subject headings (MeSH) database. Sixteen articles were accessed and reviewed in detail.

Of the reviewed articles, two focused on swallowing, one on trismus-related devices, one lacked exercise, and one was a study design, and 11 articles<sup>11-21</sup> focusing on exercise interventions and its effectiveness included in the review.

### RESULTS

Most exercise interventions in HNC focus on supervised aerobic<sup>11,15,18,20,21</sup> and resistance<sup>11,12,15-21</sup> exercises post-surgery. Ten studies<sup>11-13,15-21</sup> involved supervised exercise interventions, primarily aiming to increase aerobic capacity and muscle strength. One study<sup>12</sup> recommended maintaining physical activity levels above 150 minutes weekly, another<sup>19</sup> included range of motion exercises and NMES. **Table.**

#### Aerobic Exercises

In five studies where aerobic exercise training was conducted,<sup>14,15,18,20,21</sup> it was noted that there was no reduction in the pre-treatment/post-treatment values of heart rate and aerobic endurance parameters among participants who underwent exercise training. However, a significant decrease was observed in the control group. These studies particularly emphasized the necessity of providing aerobic exercise in cases where chemotherapy is administered. In a study by Van Vulpen et al.,<sup>11</sup> instead of cardiopulmonary outcomes, exercise barriers encountered during aerobic and resistance exercises were investigated, and participants reported facing the most difficulties due to lack of physical fitness and transportation issues.

It has been determined that studies involving aerobic exercise training typically span between 8 to 15 weeks (average of 11 weeks), with 2 to 5 sessions per week (average of 3 sessions), and each session lasting 20 to 50 minutes (average of 28.33 minutes) of aerobic exercise.

#### Exercises to Increase Muscle Strength

In nine studies,<sup>11,12,14-16,18-21</sup> interventions were implemented to enhance muscle strength. Although results focusing on different muscle groups were published, a significant increase in overall muscle strength was reported. Additionally, it was emphasized that there were positive

**Table. Included studies**

Author (year)	Number of participants (intervention/control)	Exercise modality	Intervention time	Supervised	Duration	CT	RT
van Vulpen Jonna K. (2023) <sup>11</sup>	120 (61/59)	Aerobic+resistance	Post-surgery	Supervised	12 weeks	-	-
Anandavadivelan P. (2023) <sup>12</sup>	134 (64/70)	Physical activity+strengthening	Post-surgery	Home program	12 weeks	Yes	Yes
Wen L. (2023) <sup>13</sup>	75 (36/39)	Baduanjin (Qigong)	Post-surgery	Supervised	12 weeks	Yes	-
Allen SK. (2022) <sup>14</sup>	54 (26/28)	Aerobic+resistance+stretching	During chemotherapy	Supervised+home program	15 weeks	Yes	-
Yin Lin K. (2021) <sup>15</sup>	40 (20/20)	Aerobic+resistance+stretching	Post-surgery	Supervised	8 weeks	Yes	-
Hu Q. (2020) <sup>16</sup>	132 (67/65)	Resistance	Post-surgery	Supervised	12 weeks	Yes	Yes
Thomas A. (2020) <sup>17</sup>	46 (21/25)	ROM+NMES	Post-surgery	Supervised	10 days	No	No
Simonsen C. (2020) <sup>18</sup>	26 (12/14)	Aerobic+resistance	Post-surgery	Supervised	12 weeks	-	-
Lavigne C. (2020) <sup>19</sup>	22 (11/11)	Resistance+NMES	Post-surgery	Supervised	12 weeks	-	-
Jui Yen C. (2019) <sup>20</sup>	72 (38/34)	Aerobic+resistance (NMES)	Post-surgery	Supervised	8 weeks	Yes	-
Samuel SR. (2019) <sup>21</sup>	120 (62/58)	Aerobic+resistance	Post-surgery	Supervised	11 weeks	-	Yes

CT: Chemotherapy, RT: Radiotherapy, -: There is no information, ROM: Range of motion, NMES: Neuro-muscular electrical stimulation

changes in fatigue levels and overall quality of life in the exercise group.

In a study conducted by Lavigne et al.,<sup>19</sup> only resistance exercise programs aided by NMES were performed, and the results were analyzed. In other studies, a portion of the exercise program was dedicated to resistance exercises. The exercise programs were conducted 2 to 5 days per week (average 2.75 days), with each session consisting of 1 to 3 sets (average 2.22 sets) and 8 to 20 repetitions (average 11.89 repetitions). In one study,<sup>11</sup> resistance was based on 15 repetition maximum, in four studies<sup>12,14,15,20</sup> exercise bands were used, in one study<sup>16</sup> an exercise station was utilized, and in two studies<sup>17,19</sup> NMES was used.

### Stretching Exercises

In two studies, it was noted that stretching exercises were performed before resistance exercises.<sup>14,15</sup> Although the exact type and intensity of the exercises were not specified, it was reported that stretching exercises were done in place of warm-up and cool-down periods. In other studies, stretching exercises were either not mentioned or were used in cases of reduced range of motion.

### Qi-gong Exercises

In a study conducted by Wen L. et al.,<sup>13</sup> Qi-gong exercises were administered to patients with HNC, and the results were examined. In the 12-week exercise training program, participants were given an exercise regimen for 5 days a week, with each session lasting a total of 40 minutes. The program was followed up as a home exercise program via video conference. At the end of the study, significant improvements were noted in the quality of life, sleep quality, and cancer-related fatigue of the HNC patients.

## DISCUSSION

It is noted that there are a limited number of exercise studies in HNC. Aerobic and resistance exercises have been most frequently applied. The majority of these studies focus on chemotherapy, effectively demonstrating the role of exercise in reducing the side effects of chemotherapy. In the last five years, studies involving exercise applications in HNC have generally focused on esophageal cancer. This is thought to be due to the frequent use of chemotherapy in this patient group and the significant systemic challenges it poses, increasing the need for physiotherapy.

In addition to physical benefits, exercise-based rehabilitation programs have been shown to enhance the overall quality of life for HNC patients. Structured exercise programs, such as those including aerobic and resistance exercises,<sup>14,15,18,20,21</sup> have been effective in preventing the deterioration of fatigue and significantly improving quality of life.

The duration of these interventions varied from 8 to 15 weeks, with sessions conducted 2 to 5 times per week, indicating a structured and intensive approach to rehabilitation. This structured approach ensures that patients receive consistent and frequent exercise sessions, which are critical for maximizing the benefits of the rehabilitation process. Interventions lasting 8 weeks might be more suitable for patients who require shorter,

high-intensity programs, possibly due to the severity of their symptoms or the need for quick recovery. On the other hand, interventions extending to 15 weeks provide patients with prolonged and steady rehabilitation, helping them gradually rebuild strength and endurance without overwhelming their systems.

The frequency of 2 to 5 sessions per week offers scheduling flexibility, accommodating patients' other treatment plans and personal commitments. Conducting sessions regularly, with moderate to high frequency, ensures ongoing progress and adaptation, which are crucial for enhancing physical function and alleviating the side effects of cancer treatments. The variation in both duration and frequency allows for personalization according to individual patient needs and capacities, achieving a balance between intensity and recovery.

The concentration of studies after surgery emphasizes the importance of exercise therapy in the recovery process. All studies indicate that exercise should be included in the treatment program of patients diagnosed with HNC. To avoid incorrect applications, most studies have utilized supervised exercise. This has led to more effective implementation of exercise training and more striking results. However, to determine changes in groups where supervised exercise cannot be performed, there is a need for studies involving exercise groups followed by home programs and telerehabilitation, with results compared to those of supervised exercise groups.

## CONCLUSION

This review clearly demonstrates the significant role of exercise in the rehabilitation of HNC patients. The reviewed studies highlight that supervised aerobic and resistance exercises, particularly during chemotherapy, are effective in reducing side effects and improving overall quality of life. However, HNC encompass a variety of cancer groups, resulting in differences in the applied medical treatments. Future studies should include exercise interventions post-surgery acute phase and radiotherapy. In conclusion, enhancing the treatment programs of HNC patients with exercise interventions is crucial to improving their recovery.

## ETHICAL DECLARATIONS

### 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.

## REFERENCES

1. Sung H, Ferlay J, Siegel RL, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin.* 2021;71(3):209-249.
2. Smith CDL, McMahon AD, Lyall DM, et al. Development and external validation of a head and neck cancer risk prediction model. *Head Neck.* 2024. doi:10.1002/hed.27834
3. Mendenhall WM, Hinerman RW, Amdur RJ, et al. Postoperative radiotherapy for squamous cell carcinoma of the head and neck. *Clin Med Res.* 2006;4(3):200-208.
4. Tsimberidou AM. Targeted therapy in cancer. *Cancer Chemo Pharma.* 2015;76:1113-1132.
5. Schuster M, Nechansky A, Kircheis R. Cancer immunotherapy. *Biotech J Healthcare Nutri Techno.* 2006;1(2):138-147.
6. Agostinis P, Berg K, Cengel KA, et al. Photodynamic therapy of cancer: an update. *CA Cancer J Clin.* 2011;61(4):250-281.
7. Schutte HW, Heutink F, Wellenstein DJ, et al. Impact of time to diagnosis and treatment in head and neck cancer: a systematic review. *Otolaryngo-head Neck Surg.* 2020;162(4):446-457.
8. Mody MD, Rocco JW, Yom SS, Haddad RI, Saba NF. Head and neck cancer. *The Lancet.* 2021;398(10318):2289-2299.
9. Schorn L, Lommen J, Sproll C, et al. Evaluation of patient specific care needs during treatment for head and neck cancer. *Oral Oncology.* 2020;110:104898.
10. Felsler S, Behrens M, Liese J, et al. Feasibility and effects of a supervised exercise program suitable for independent training at home on physical function and quality of life in head and neck cancer patients: a pilot study. *Integrat Cancer Therap.* 2020;19:1534735420918935.
11. van Vulpen JK, Witlox L, Methorst-de Haan AC, et al. Perceived facilitators and barriers by esophageal cancer survivors participating in a post-treatment exercise program. *Support Care Cancer.* 2023;31(6):320.
12. Anandavadivelan P, Malberg K, Vikstrom K, et al. Home-based physical activity after treatment for esophageal cancer-A randomized controlled trial. *Cancer Med.* 2023;12(3):3477-3487.
13. Wen L, Chen X, Cui Y, Zhang M, Bai X. Effects of Baduanjin exercise in nasopharyngeal carcinoma patients after chemoradiotherapy: a randomized controlled trial. *Support Care Cancer.* 2023;31(1):79.
14. Allen SK, Brown V, White D, et al. Multimodal prehabilitation during neoadjuvant therapy prior to esophagogastric cancer resection: effect on cardiopulmonary exercise test performance, muscle mass and quality of life-a pilot randomized clinical trial. *Annals Surg Oncology.* 2022:1-12.
15. Lin K-Y, Cheng H-C, Yen C-J, et al. Effects of exercise in patients undergoing chemotherapy for head and neck cancer: a pilot randomized controlled trial. *Inter J Environment Res Public Health.* 2021;18(3):1291.
16. Hu Q, Zhao D. Effects of resistance exercise on complications, cancer-related fatigue and quality of life in nasopharyngeal carcinoma patients undergoing chemoradiotherapy: a randomised controlled trial. *European J Cancer Care.* 2021;30(1):e13355.
17. Thomas A, D'Silva C, Mohandas L, Pais SM, Samuel SR. Effect of muscle energy techniques V/S active range of motion exercises on shoulder function post modified radical neck dissection in patients with head and neck cancer-a randomized clinical trial. *APJCP.* 2020;21(8):2389.
18. Simonsen C, Thorsen-Streit S, Sundberg A, et al. Effects of high-intensity exercise training on physical fitness, quality of life and treatment outcomes after oesophagectomy for cancer of the gastro-oesophageal junction: preset pilot study. *BJS Open.* 2020;4(5):855-864.
19. Lavigne C, Twomey R, Lau H, Francis G, Culos-Reed SN, Millet GY. Feasibility of eccentric overloading and neuromuscular electrical stimulation to improve muscle strength and muscle mass after treatment for head and neck cancer. *J Cancer Survivorship.* 2020;14:790-805.
20. Yen CJ, Hung CH, Kao CL, et al. Multimodal exercise ameliorates exercise responses and body composition in head and neck cancer patients receiving chemotherapy. *Support Care Cancer.* 2019;27(12):4687-4695. doi:10.1007/s00520-019-04786-1
21. Samuel SR, Maiya AG, Fernandes DJ, et al. Effectiveness of exercise-based rehabilitation on functional capacity and quality of life in head and neck cancer patients receiving chemo-radiotherapy. *Support Care Cancer.* 2019;27(10):3913-3920. doi:10.1007/s00520-019-04750-z

# Delayed presentation of hamate fractures: recognizing and addressing the hidden risks

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## ABSTRACT

Hamatum fractures are rare fractures among carpal bone fractures. It can easily be overlooked in the emergency room and daily outpatient clinic examination. It has been 8 days since our patient was a right hand dominant male patient. The joint range of motion was full at the 6<sup>th</sup> week after surgery. A delayed or missed patient's results can lead to disability and poor outcomes. We emphasize to clinicians that rare bone injuries may be encountered, especially wrist injuries, and that wrist injuries should be examined in detail, and we hope that this article will raise awareness.

**Keywords:** Hamate fracture, carpal injury, delayed

## INTRODUCTION

Isolated carpal bone fractures are uncommon, with hamatum fractures comprising 2-4% of these cases. Such fractures are infrequently documented in medical literature. Due to their unfamiliarity, they are often missed during initial examinations.<sup>1</sup> Undetected bone injuries of this type can result in non-union, progressive osteoarthritis, and chronic pain.<sup>2</sup>

The injury mechanism typically involves striking a hard object with a clenched fist, though it can also result from indirect trauma. These injuries are often overlooked in diagnosis because of unfamiliarity with the condition and the lack of clear physical and radiological signs.<sup>3</sup>

There is no definitive agreement on the best approach to managing acute CMC fracture-dislocations, as both conservative and surgical treatments have been shown to yield positive outcomes.<sup>4</sup> Nevertheless, most experts concur that delayed cases should be addressed with open reduction and internal fixation (ORIF) to restore anatomical structure, prevent secondary dislocation, and ensure full functional grip.<sup>4,5</sup>

We present the case of hamate fracture, which was treated with screw fixation of the hamate and KW fixation of the metacarpals.

## CASE

We present the case of a 36-year-old male patient who visited our emergency department with extensive swelling and bruising on the right dorsal side of his hand, experiencing pain with movement and painful wrist movements.

The patient had initially visited the emergency department eight days prior with complaints of a heavy object falling on his hand at work. He was told there was no fracture and was given medication and referred to the orthopedic clinic. During the clinical examination, swelling, bruising, and movement restriction were noted on the right dorsal hand, with severe pain upon palpation of the proximal 4.5 metacarpal. The X-ray taken in the emergency department was reviewed, revealing that the initial X-ray was not taken in the appropriate position. A new AP-Lateral wrist X-ray was requested. The new radiograph revealed a fracture in the hamate bone (Figure 1). Given the intra-articular nature of the fracture, a wrist CT was performed for a more objective evaluation of the pathology (Figure 2). The CT scan revealed a type 2A hamate body fracture according to the Milch classification, along with associated 4-5 metacarpal dislocation. After consulting with the patient, a decision was made to proceed with surgery. The next day, open reduction was performed by the author, with fixation of the hamate body using two internal screws. Percutaneous K-wires were used to stabilize the 4<sup>th</sup> and 5<sup>th</sup> metacarpals.

Perioperative and postoperative X-rays showed satisfactory reduction and alignment (Figure 3). The patient had no issues during postoperative examinations, and neurovascular evaluation was normal. He was discharged the next day after a dressing change. At the one-week follow-up, the wound was clean and healing satisfactorily, and sutures were removed at the two-week follow-up.

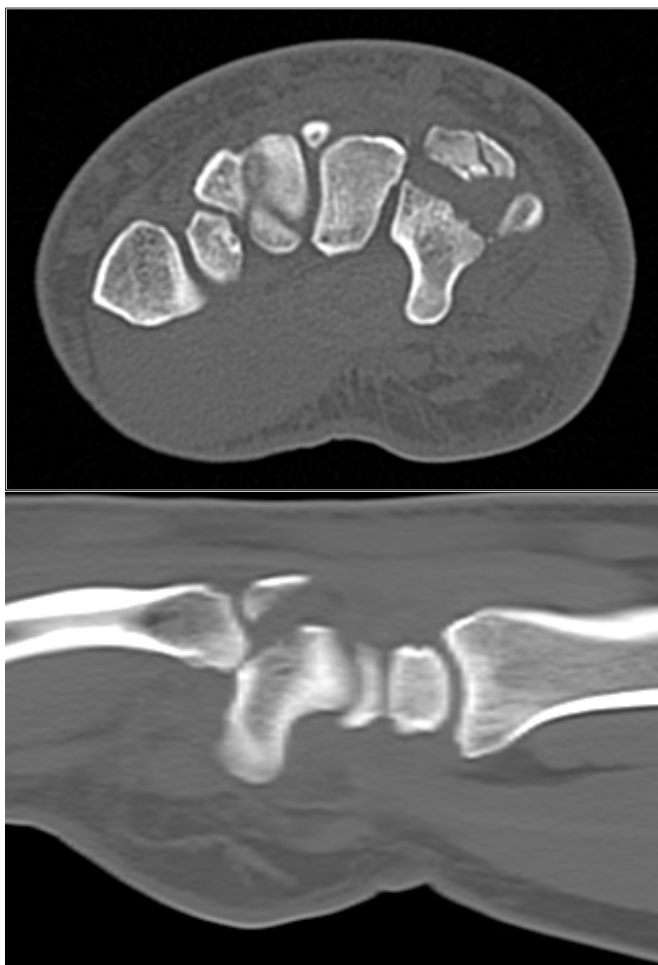
At the four-week follow-up, repeated X-rays showed stable fixation and alignment of the carpal arch, leading to the



removal of the K-wires from the 4<sup>th</sup> and 5<sup>th</sup> metacarpals. No pain or tenderness was detected during the examination. The patient, who was given hand rehabilitation, returned for a check-up two weeks later without any pain. Finger joint range of motion was complete, and there was no significant difference in wrist range of motion compared to the left wrist (Figure 4, 5).



**Figure 1.** Preoperative image demonstrating a displaced fracture of the Hamate (white arrow)



**Figure 2.** Preoperative CT scan illustrating a displaced fracture of the Hamate bone



**Figure 3.** Postoperative X-ray at 4 weeks



**Figure 4.** Postoperative X-ray at 6 weeks



**Figure 5.** Complete range of motion observed at the postoperative 6-week

## DISCUSSION

The hamate bone is located on the ulnar side of the distal carpal row. According to the Milch classification, its fractures are categorized into 2 main groups: hook (type 1) and body (type 2).<sup>6</sup> Type 1 fractures are commonly observed, with the hook forming the medial border of the carpal tunnel and the lateral aspect of the Guyon canal, starting from the palmar side. The hook serves as a pulley for the 4<sup>th</sup> and 5<sup>th</sup> flexor tendons.<sup>7</sup>

In cases like ours, hamate body fractures typically occur when a solid object impacts the hand in a clenched fist position, transmitting force through the 4<sup>th</sup> and 5<sup>th</sup> metacarpals to the hamate body, resulting in fracture. Another mechanism of injury involves mispositioning of equipment handles in sports like tennis, baseball, and golf, causing the force to pass through the hamate hook via the carpal arch and strain the 4<sup>th</sup> and 5<sup>th</sup> flexor tendons, leading to fracture.<sup>8</sup>

Delayed diagnosis of hamate bone fractures can result in nonunion, malunion, progressive osteoarthritis, and chronic pain. It may compress surrounding anatomical structures, leading to symptoms of compression in the ulnar and median nerves.<sup>9</sup> Avascular necrosis is rare in hamate fractures due to the triple vascular support.<sup>10,11</sup>

By reporting our experiences, we hope to increase awareness of hamate fractures, including their occurrence and potential mechanisms of injury. To facilitate timely diagnosis and appropriate treatment, we encourage other clinicians to report encounters with these unusual bone injuries when they occur.

## CONCLUSION

Hamate fractures, often occurring concomitantly with carpometacarpal dislocations, are fractures that can easily be overlooked during initial evaluation in the emergency department. The consequences of a delayed or missed diagnosis can lead to disability and poor outcomes. Therefore, we emphasize the need for thorough examination, especially of wrist injuries, to prevent overlooking rare bone injuries. We hope that our article will increase awareness of these injuries among clinicians.

## ETHICAL DECLARATIONS

### Informed Consent

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

## REFERENCES

1. Davis DL. Hook of the hamate: the spectrum of often missed pathologic findings. *AJR Am J Roentgenol.* 2017;209(5):1110-1118. doi:10.2214/AJR.17.18043
2. Snoap T, Habeck J, Ruitter T. Hamate fracture. *Eplasty.* 2015;15:ic28.
3. De Smet L. Fracture-dislocation of the hamatometacarpal joint: a case report. *Acta Orthop Belg.* 1993;59(1):106-108.
4. Zhang C, Wang H, Liang C, et al. The effect of timing on the treatment and outcome of combined fourth and fifth carpometacarpal fracture dislocations. *J Hand Surg Am.* 2015;40(11):2169-2175.e1. doi:10.1016/j.jhsa.2015.07.017
5. Syed AA, Agarwal M, Giannoudis PV, Matthews SJ. Dorsal hamatometacarpal fracture-dislocation in a gymnast. *Br J Sports Med.* 2002;36(5):380-382. doi:10.1136/bjsm.36.5.380
6. Hirano K, Inoue G. Classification and treatment of hamate fractures. *Hand Surg.* 2005;10(2-3):151-157. doi:10.1142/S0218810405002747
7. Boulas HJ, Milek MA. Hook of the hamate fractures. Diagnosis, treatment, and complications. *Orthop Rev.* 1990;19(6):518-529.
8. Amine HM, Reda L, Assouab O, et al. Hamatometacarpal fracture-dislocation: a case report. *Trauma Case Rep.* 2023;48:100966. doi:10.1016/j.tcr.2023.100966
9. Manske PR. Fracture of the hook of the hamate presenting as carpal tunnel syndrome. *Hand.* 1978;10(2):181-183. doi:10.1016/s0072-968x(78)80010-2
10. Van Demark RE, Parke WW. Avascular necrosis of the hamate: a case report with reference to the hamate blood supply. *J Hand Surg Am.* 1992;17(6):1086-1090. doi:10.1016/s0363-5023(09)91069-3
11. Grettve S. Arterial anatomy of the carpal bones. *Acta Anat (Basel).* 1955;25(2-4):331-345. doi:10.1159/000141080