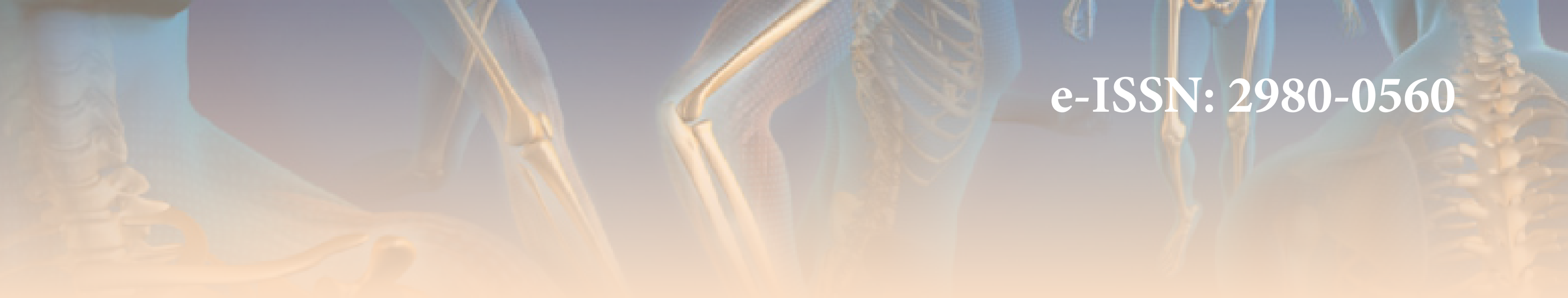

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Comparison of the immediate effects of different stretching methods for the pectoralis minor muscle in individuals with shoulder protraction

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ABSTRACT

Aims: This study aimed to compare the immediate effects of different stretching methods for the pectoralis minor (PM) muscle on acromial distance (AD), pectoralis minor length, Pectoralis Minor Index (PMI) and scapular upward rotation (SUR) in individuals with shoulder protraction.

Methods: The study included 12 individuals with shoulder protraction. Manual stretching, unilateral corner stretching and modified contract-relax proprioceptive neuromuscular facilitation (PNF) stretching were applied to the PM muscle in a single session randomly. Before and after stretching, AD, PM muscle length, PMI and SUR were recorded.

Results: It was determined that three stretching methods improved the AD, PM length and PMI values ($p<0.05$), modified contract-relax PNF stretching method was superior to unilateral corner stretching ($p<0.05$). In addition, it was determined that all three stretching methods had no effect on SUR values ($p>0.05$).

Conclusion: According to these results, adding any of the manual stretching, unilateral corner stretching or modified contract-relax PNF stretching methods for the PM muscle to the shoulder protraction treatment program may optimize the AD, PM length and PMI values affecting the scapular position. Especially, modified contract-relax PNF stretching technique is more effective than unilateral corner stretching. Therefore, it is recommended that the first preferred stretching method should be modified contract-relax PNF stretching for shoulder protraction treatment program.

Keywords: Pectoralis minor, PNF, rounded shoulder posture, stretching

INTRODUCTION

Shoulder protraction is one of the common postural deviations seen in approximately 73% of healthy individuals, known as anterior translation of the shoulder complex from the lateral midline of the body.[1] It is characterized by abduction of the scapula and anterior deviation of the acromial process, which changes the rotational axis of the glenoid fossa, causing internal and upward rotation and anterior tilt of the scapula.[2]

Shoulder protraction can be caused by many factors such as static posture, muscle strength imbalance, soft tissue injuries or repetitive movements.[3,4] Static, abnormal postural changes cause adaptive lengthening of the soft tissues and shortening of the opposite side soft tissues.[2,5] Muscles responsible for protraction of the scapula, such as the shortened pectoralis major and pectoralis minor, play a major role in shoulder protraction.[6] In particular, it has been reported that the adaptive shortening of the pectoralis minor (PM) muscle due to its attachment to the scapula and thorax restricts normal scapulothoracic movement and changes the position of the scapula.[2,6] In individuals with shoulder protraction, it has also been reported that lengthening of retractor muscles such as trapezius and rhomboid occurs.[2,5,7]

The PM muscle attaches to the 3rd, 4th, and 5th ribs and the coracoid process of the scapula. The fibril orientation of the PM allows internal rotation, downward rotation and anterior tilt of the scapula. It elongates during elevation, allowing upward rotation, external rotation and posterior tilt of the scapula.[8] Individuals with a short PM muscle have decreased scapular external rotation and posterior tilt during arm elevation compared to individuals with a long PM.[6]

In the physiotherapy program of shoulder protraction, approaches such as teaching the correct position,[9,10] strengthening exercises,[11,12] use of orthosis,[13,14] taping,[15] soft tissue mobilizations and stretching exercises for PM are used.[4,6,12,14,16]

Stretching is applied as static, dynamic, ballistic and PNF.[17] These applications aim to increase the flexibility and length of

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the soft tissue by creating tension.[18] With stretching, changes such as an increase in the viscoelasticity of the muscle and tendon and relaxation of the agonist muscle through autogenic inhibition by stimulation of the Golgi tendon organ.[19]

In the literature, the effects of PM muscle stretching on PM muscle length, pectoralis minor index (PMI) and scapular position have been investigated,[14,17,20-23] but no study has been found on which stretching method is more effective among manual stretching, unilateral corner stretching and modified contract-relax PNF stretching techniques applied to PM. The aim of our study was to compare the immediate effects of manual, unilateral corner and modified contract-relax PNF stretching methods for the PM muscle on acromial distance (AD), PM muscle length, PMI and scapular upward rotation (SUR) in individuals with shoulder protraction.

METHODS

Study Design

This study is a prospective, randomized, controlled, crossover, single-blind study planned to compare the immediate effects of different stretching methods for the PM muscle on AD, PM muscle length, PMI, and SUR in individuals with shoulder protraction. In order to conduct the study, ethical approval was obtained from the Gazi University Rectorate Ethics Committee (Date: 04.04.2023, Decision No: E639069). The study was registered on ClinicalTrials.gov (Gazi University). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Voluntary individuals who met the inclusion criteria for the study conducted at Gazi University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation and Gülhane Faculty University of Healt Sciences were asked for their consent to participate in the study with the 'Informed Voluntary Consent Form'.

The inclusion criteria were as follows: individuals were between 18-40 years of age, had a shoulder protraction posture, had a short PM muscle, and agreed to participate in the study. Individuals with cervical and shoulder pain, adhesive capsulitis, thoracic outlet syndrome, shoulder instability, history of shoulder surgery and numbness or tingling in the upper extremity were excluded from the study.

Firstly, demographic information and physical characteristics of the individuals who met the inclusion criteria were recorded, and manual stretching, unilateral corner stretching and modified contract-relax PNF stretching methods for the PM muscle were randomly applied to all individuals 2 days apart. All stretching methods were performed by an investigator blinded to the evaluations.

Randomization method: The order of manual stretching (Manual), unilateral corner stretching (unilateral) and modified contract-relax PNF stretching methods applied to the volunteers included in the study was assigned using simple randomization method with the "Research Randomizer" program (https://www.randomizer.org/).

Assessments

AD, PM length, PM index and SUR measurements were taken before and after stretching by a researcher blinded to the interventions. All assessments were performed on the dominant side of the individuals.

Determination of shoulder protraction posture (AD measurement): The distance between the posterolateral aspect of the acromion on the dominant side and the bed was measured in cm with a caliper in the supine position, with the arms free next to the trunk and the knees slightly flexed. A distance of 2.5 cm or more was recorded as shoulder protraction posture.[24] Additionally, AD measurement was taken before and after stretching.

Pectoralis minor length: While the individuals were in a comfortable position, standing with their arms at their sides, the distance between the caudal corner of the 4th rib and the inferomedial surface of the coracoid process was measured twice with a tape measure and recorded in cm.[25]

Pectoralis Minor Index: This measure was used to determine the PM shortness of individuals. PMI was calculated as the ratio of the length of the pectoralis minor to the height of the individuals multiplied by 100. A value below 7.44 was considered as PM shortness.[25]

Scapular upward rotation measurement: This measurement was evaluated with a digital inclinometer (Baseline® Digital Inclinometer 12-1057) in the resting position, 45º, 90º and 135º shoulder abduction position. Two inclinometers were used in the measurements. One of the inclinometers (Jtech, American Fork, UT) was fixed to the humerus with tape just above the lateral epicondyle for shoulder abduction angle. The second inclinometer was positioned on the spina scapula for SUR measurement. Individuals were asked to stand in a comfortable standing position with elbow extension. They were then asked to abduct the shoulder with the thumb pointing upwards and wait in that position for the measurement where the evaluator told them to stand. The SUR angles of the individuals in resting position, 45º, 90º and 135º shoulder abduction were read from the inclinometer and recorded. Three measurements were taken with a 30 s rest interval and the mean value was calculated.[26]

Interventions

A 48-hour interval was given between stretching methods due to the wash-out effect. All stretching methods were performed by a blinded researcher to assessments. Before stretching, individuals were instructed how to rate the discomfort felt during stretching to determine the severity of stretching (0: no discomfort, 10: severe discomfort). During stretching, individuals were asked to report discomfort at a score of 4 out of 10 points.

Manual stretching: Individuals were positioned supine with the shoulder in 90º abduction and external rotation, elbow in 90º flexion position, with the side to be stretched out of the bed. A towel was placed on the interscapular region of the individual to increase the effect of stretching. While the practitioner stabilized the trunk over the coracoid process of the contralateral side with one hand, the other hand passively abducted the individual's shoulder to horizontal abduction just proximal to the elbow on the side to be stretched. At the point where the individual reported a discomfort level of 4 out of 10 points, the horizantal abduction position was maintained for 30 s. This method was repeated 4 times with 30 s rest between repetitions.[20,27]

Unilateral corner stretching: Individuals were asked to stand with the elbow in 90° flexion and shoulder in 90°

abduction, placing the palm and forearm on the wall. Angles were determined with a digital inclinometer (Jtech, American Fork, UT). The contralateral leg of the side to be stretched was positioned anterior to the other leg. For stretching, individuals were asked to increase shoulder horizontal abduction by bringing the trunk anteriorly and in contralateral rotation until the discomfort level was 4 out of 10. Then, individuals held this position for 30 s and repeated 4 times with 30 s rest between repetitions.[17,20,23,27]

PNF stretching: The modified contract-relax technique was adapted to the PM muscle by Birinci et al.[27] and proved to increase both PM length and PMI values. Therefore, this technique was preferred in our study. The modified contract-relax PNF stretching technique was performed with the individual sitting on an unsupported chair with the hands clasped behind the head. The practitioner stabilized the trunk at the interscapular region with a knee while standing posterior to the individual. With the practitioner's hands placed anterior to the elbows, the PM muscle was stretched passively and slowly in the horizontal abduction direction until the individual reported a level of 4 out of 10 for discomfort. Passive stretching was maintained for 10 seconds. Then, without changing the position of the hands, the practitioner applied resistance in horizontal abduction and obliquely in the upward direction to achieve a maximum voluntary isometric contraction of the PM muscle for 6 seconds. Afterwards, the subjects rested for 4 seconds. The application was completed with passive stretching by maintaining the new position of the stretched PM muscle for 10 seconds with a discomfort level of 4 out of 10. This procedure was repeated four times with 30 seconds rest.[27]

Statistical Analysis

SPSS (Statistical Package for Social Sciences) version 22.0 was used to evaluate the data obtained from the study and to create tables. Shapiro-Wilk test was used to determine the distribution of the data. Descriptive statistics of normally distributed numerical variables were expressed as X±SD, descriptive statistics of non-normally distributed numerical variables were expressed as median and (IQR), and descriptive statistics of categorical variables were expressed as frequency and percentage (%). Paired sample T test was used for intra-group comparison of normally distributed data and Wilcoxon test was used for intra-group comparison of non-normally distributed data. Kruskal Wallis analysis was used to compare both the pre-application values of the three groups and the change difference values of all three groups before and after the application. Statistical significance level was set as $p<0.05$ and post-hoc multiple comparisons test with Bonferroni correction was performed.

RESULTS

Demographic and Physical Characteristics of Individuals

The study included 12 individuals, 5 females (41.7%) and 7 males (58.3%), with a median age of 22 (20/29) years. It was determined that 83.3% of the individuals were dominant on the right side, while 16.7% were on the left side. In addition, the individuals' PMI values were 6.98 (6.84/7.20), and they had pectoralis minor muscle shortness (Table 1).

Table 1. Demographic and physical characteristics

		n (%)
Gender	Female	5 (41.7)
	Male	7 (58.3)
Dominant side	Right	10 (83.3)
	Left	2 (16.7)
		Median (IQR 25/75)
Age (year)		22 (20/29)
Heighth (cm)		172 (160/182.50)
Weigth (kg)		69 (51/77)
BMI (kg/m²)		22.12 (19.88/25.69)
AD (cm)		6.75 (6.00/7.30)
PM (cm)		11.95 (11.37/12.36)
PMI		6.98 (6.84/7.20)

cm: Centimeter, IQR: Interquartile range, kg: Kilogram, BMI: Body-mass index, kg/m²: kilogram/meter², AD: Acromial distance, PM: Pectoralis minor, PMI: Pectoralis Minor Index

Comparison of Acromial Distance Values of Individuals

AD values before the application were similar between the groups ($p>0.05$), and decreased in all three groups after the application ($p<0.05$). While manual and unilateral corner stretching were similar ($p>0.05$), modified contract-relax PNF stretching method was more effective than unilateral stretching ($p<0.05$) (Table 2).

Comparison of Pectoralis Minor Length Values of Individuals

Before the applications, there was no significant difference in PM muscle length between the groups ($p>0.05$). Following the applications, PM length increased significantly in all three groups ($p<0.05$). No significant difference was observed between manual and unilateral corner stretching ($p>0.05$) but modified contract-relax PNF stretching was superior to unilateral corner stretching ($p<0.05$) (Table 3).

Table 2. Comparison of acromial distance values of individuals

Acromial distance (cm)	Before median (IQR 25/75)	After median (IQR 25/75)	p^a	Change difference ($\Delta_{before-after}$)	Post-hoc analysis: Groups	p^c
Manual	6.75 (6.00/7.35)	5.25 (4.93/6.43)	0.002	-1.15 (-1.52/-0.55)	Manuel-unilateral	0.448
Unilateral	6.65 (5.70/7.40)	5.45 (5.00/6.65)	0.002	-0.90 (-1.15/-0.60)	Unilateral-PNF	0.003
PNF	6.80 (6.13/7.60)	5.30 (4.48/6.08)	0.002	-1.75 (-1.95/-1.25)	Manuel-PNF	0.025
p^b	0.728			0.008		

cm: Centimeter, IQR: Interquartile range, PNF: Proprioceptive neuromuscular facilitation, a: Wilcoxon test, b: Kruskal-Wallis H test, c: Mann-Whitney U test

Table 3. Comparison of pectoralis minor length values of individuals

PM length (cm)	Before median (IQR 25/75)	After median (IQR 25/75)	p[a]	Change difference ($\Delta_{before-after}$)	Post-hoc analysis	
					Groups	p[c]
Manual	11.95 (11.25/12.37)	13.25 (12.40/13.80)	0.002	1.35 (1.05/1.47)	Manuel-unilateral	0.437
Unilateral	11.95 (11.33/12.67)	13.10 (12.40/13.97)	0.002	0.90 (0.65/1.75)	Unilateral-PNF	0.003
PNF	11.55 (11.25/12.20)	13.50 (13.32/14.17)	0.002	1.80 (1.42/2.17)	Manuel-PNF	0.026
p[b]	0.673			0.008		

PM: Pectoralis minor, cm: Centimeter, IQR: Interquartile range, PNF: Proprioceptive neuromuscular facilitation, a: Wilcoxon test, b: Kruskal-Wallis H test, c: Mann-Whitney U test

Comparison of Pectoralis Minor Index Values of Individuals

PMI values were similar among the three groups before the applications ($p>0.05$), and showed a significant increase in all groups following the application ($p<0.05$). In the comparison between the groups, PMI values after the manual and unilateral corner stretching applications were similar ($p>0.05$), and were more higher after PNF stretching compered to unilateral corner stretching ($p<0.05$) (**Table 4**).

Comparison of Scapular Upward Rotation Values of Individuals

The upward rotation of the scapula in the 0°, 45°, 90° and 135° abduction positions were similar in all three groups before ($p>0.05$). All three treatments were not effective on SUR after application compared to pre-application values. When the groups were compared, there was no superiority of any of the three groups over each other ($p>0.05$) (**Table 5**).

Table 4. Comparison of Pectoralis Minor Index values of individuals

PMI	Before median (IQR 25/75)	After median (IQR 25/75)	p[a]	Change difference ($\Delta_{before-after}$)	Post-hoc analysis	
					Groups	p[c]
Manual	6.98 (6.76/7.11)	7.64 (7.54/7.89)	0.002	0.76 (0.62/0.81)	Manuel-unilateral	0.456
Unilateral	7.04 (6.80/7.27)	7.59 (7.27/8.19)	0.002	0.51 (0.39/1.00)	Unilateral-PNF	0.003
PNF	7.03 (6.55/7.14)	7.89 (7.72/8.33)	0.002	1.06 (0.79/1.28)	Manuel-PNF	0.028
p[b]	0.622	0.193		0.009		

PMI: Pektoralis Minor Index, IQR: Inter quartile range, PNF: Proprioceptive neuromuscular facilitation, a: Wilcoxon test, b: Kruskal-Wallis H test, c: Mann-Whitney U test,

Table 5. Comparison of scapular upward rotation values of individuals

SUR (°)	Before median (IQR 25/75)	After median (IQR 25/75)	p[a]	Change difference ($\Delta_{before-after}$)
Rest position				
Manual	-2.10 (-3.30/-1.22)	-2.15 (-3.05/0.00)	0.556	0.87 (-1.37/2.07)
Unilateral	-1.95 (-2.15/-1.41)	-2.50 (-3.58/-0.30)	0.367	-1.37 (-2.16/1.40)
PNF	-2.03 (-2.33/-1.50)	-0.95 (-2.95/1.12)	0.136	0.92 (-1.01/2.32)
p[b]	0.660			0.204
45° abduction position				
Manual	6.75 (6.09/7.50)	6.05 (5.17/7.15)	0.182	-1.47 (-2.00/1.28)
Unilateral	6.13 (5.81/6.88)	6.40 (5.59/7.45)	0.480	0.20 (-0.84/0.90)
PNF	6.25 (6.03/6.98)	7.20 (5.50/8.15)	0.346	0.95 (-1.40/1.80)
p[b]	0.281			0.162
90° abduction position				
Manual	13.72 (12.55/15.26)	12.80 (12.12/15.11)	0.533	-0.20 (-2.80/1.99)
Unilateral	12.83 (11.39/15.22)	13.87 (12.53/15.28)	0.754	2.27 (-2.85/2.64)
PNF	12.90 (11.23/14.71)	14.71 (13.55/16.67)	0.077	2.54 (0.69/4.30)
p[b]	0.348			0.080
135° abduction position				
Manual	19.20 (18.43/20.38)	19.60 (18.47/20.75)	0.583	0.30 (-1.62/2.10)
Unilateral	20.50 (18.59/22.87)	22.35 (19.49/23.38)	0.433	0.90 (-1.62/2.97)
PNF	20.35 (19.63/22.60)	21.68 (20.06/22.83)	0.272	0.54 (-0.99/2.74)
p[b]	0.202			0.856

SUR: Scapular upward rotation, IQR: Interquartile range, PNF: Proprioceptive Neuromuscular Facilitation, a: Wilcoxon test, b: Kruskal-Wallis H test

DISCUSSION

The aim of this study was to compare the immediate effects of 3 different stretching techniques applied to the PM muscle on AD, PM muscle length, PMI and SUR. Briefly, manual stretching, unilateral corner stretching, and modified contract-relax PNF stretching methods applied to the PM muscle in individuals with shoulder protraction posture resulted in decreased AD values and increased PM length and PMI values. Additionally, the modified contract-relax PNF stretching method was found to be more effective than unilateral corner stretching. However, none of the three stretching methods had an effect on SUR.

Acromial Distance

Scapular anterior tilt, internal rotation and downward rotation are seen in shoulder protraction posture. Treatment focuses on correcting this changing position of the scapula. AD provides information about both the detection of shoulder protraction and the position of the scapula and provides feedback on the effect of treatment.[15,28] It has been recorded that exercise and stretching techniques are effective in correcting shoulder protraction posture.[14]

In our study, we observed that manual stretching, unilateral corner stretching and modified contract-relax PNF stretching methods for PM significantly reduced AD, and PNF stretching applications had superiority over unilateral corner stretching. It has been previously stated that the decrease in AD indicates an increase in the posterior tilt and external rotation of the scapula.[14] It can be concluded that all three stretching methods we used are effective in reducing the increase in the anterior tilt and internal rotation of the scapula seen in individuals with shoulder protraction posture and in correcting shoulder protraction. When the PM muscle is short, the scapula tends to tilt anteriorly.[6] With stretching, the muscle responds to the stretching by lengthening due to the viscoelastic properties of the muscle. With the lengthening of the muscle, its flexibility increases and the anterior tilt of the scapula decreases. Considering the effect mechanism of stretching, all three stretching methods we applied to the PM muscle may affect AD by causing biomechanical changes in the myotendinous unit of the muscle.[29] According to the results of our study, the reason why the modified contract-relax PNF stretching technique is the most effective method in reducing AD may be due to the neurophysiological mechanism of the PNF stretching technique. Autogenic inhibition mechanism is activated by PNF stretching. With increased inhibitory information from the Golgi tendon organ of the contracting muscle (PM), excitability in the same muscle decreases and the muscle relaxes. In this way, the extensibility of the muscle and the posterior tilt of the scapula increase.[30]

Pectoralis Minor Length and Pectoralis Minor Index

One of the determinants of shoulder protraction is the shortness and tightness of the PM muscle. Therefore, interventions aimed at increasing the length and flexibility of the PM muscle should be included in the treatment of shoulder protraction. One of these interventions is stretching applications.[16] In our study, we found that all three stretching methods applied to the PM muscle of individuals with shoulder protraction significantly increased the PM length and PMI values, and the PNF stretching method was found to be superior to the unilateral corner stretching method. Williams et al.,[20] in a study conducted on 29 healthy swimmers, reported that there was a significant increase in PM muscle length with the gross stretching method, while there was no change with focused PM stretching. The gross stretching applied in the mentioned study is very similar to the manual stretching method used in our study. We observed that PM length increased significantly with manual stretching in our study. Laudner et al.,[21] reported that the muscle energy technique applied twice a week for 6 weeks to the PM muscle in swimmers with shoulder protraction caused a significant increase in PM length compared to the control group. Methodologically, the muscle energy technique used in this study is similar to the modified contract-relax PNF technique applied in our study. Similar to the mentioned study, we found an increase in PM length with the PNF stretching method. Lee et al.[14] showed that there was a significant increase in PMI values in the stretching group applied in addition to scapular posterior tilt exercise, compared to scapular posterior tilt exercise group alone in individuals with shoulder protraction posture, immediately after the application. In another study, Lee et al.[22] noted that PMI values were higher after stretching in the scapular posterior tilt exercise additional stretching group in individuals with PM muscle shortness. Borstad et al.[17] stated that the stretching that produced the most lengthening in the PM muscle of healty individuals was unilateral corner stretching, followed by manual stretching in the supine position and manual stretching in the sitting position, respectively. In our study, we used unilateral corner stretching and manual stretching methods in the supine position. Unlike the mentioned study, in our study, we observed a significant increase in PM muscle length before and after stretching with both methods, and when we compared the two methods, we found that this increase was similar to each other. The stretching method applied in the mentioned study is very similar to the stretching method used in our study, and we found that manual stretching significantly increased the PMI value. The fact that all three stretching methods we applied showed an increase in both PM length and PMI values supports the mechanism of action of stretching. With stretching, the passive tension of the muscle decreases and its flexibility increases as a result of the viscoelastic response of the muscle-tendon unit, resulting in lengthening of the muscle.[29] Among the 3 stretching methods we applied, PNF stretching was more effective in increasing PM length and PMI values than unilateral corner stretching. The neurophysiological mechanism, which is one of the mechanisms of PNF stretching, may underlie this result. With PNF stretching, the Golgi tendon organ of the contracting muscle is stimulated and the muscle is inhibited, relaxed and its elongation increases.[30] As expected, with the lengthening of the PM, there is an increase in PMI. As a result, we recommend that any of the manual stretching, unilateral corner stretching and modified contract-relax PNF stretching applied to the PM muscle should be added to the program in the treatment of shoulder protraction posture. Since modified contract-relax PNF stretching is the most effective method, it is recommended that this method be the first choice.

Scapular Upward Rotation

Lee et al.[14] reported that the manual stretching did not change the SUR. On the other hand, Williams et al.,[20] in a study, they conducted on 29 healthy swimmers, did not perform any application to the control group, but applied gross stretching technique for the PM muscle to one group and focused stretching technique for the PM muscle to the other group, and stated that there was no statistically significant difference in SUR in all three groups. Similarly, Rosa et al.[23] observed that daily unilateral corner stretching of the PM muscle for 6 weeks in 25 individuals with shoulder pain and 25 individuals without shoulder pain with PM shortness did not change the SUR values in either group. In our study, we found that manual stretching, unilateral corner stretching and modified contract-relax PNF stretching methods applied to the PM muscle were not effective on SUR. The reason for not finding a significant difference in SUR in all 3 stretching applications may be that a single session of stretching may be insufficient and as Williams et al.[20] stated, weakness of periscapular muscles such as upper, middle, and lower trapezius, rhomboids, levator scapula and serratus anterior may also prevent the change in SUR. In future studies, it is recommended to examine the effect of repeated PM stretching on SUR and to compare all 3 stretching applications in individuals with PM muscle shortness with different shoulder pathologies.

Limitations

Since our study is a pilot study, the number of individuals is small. Therefore, a study with a sufficient sample size is needed. In addition, the effects of PM stretching methods after a single session were examined in our study. Long-term effects should be investigated in future studies.

CONCLUSION

While it was observed that manual stretching, unilateral corner stretching and modified contract-relax PNF stretching methods applied to the PM muscle in individuals with shoulder protraction posture decreased AD values and increased PM length and PMI values, it was determined that modified contract-relax PNF stretching method was superior to unilateral corner stretching. In addition, it was determined that all three stretching methods had no effect on SUR. According to the results, incorporating any of the manual stretching, unilateral corner stretching, or modified contract-relax PNF stretching techniques for the PM muscle into a shoulder protraction treatment program may optimize AD, PM muscle length, and the PMI, all of which influence scapular positioning. Among these methods, the modified contract-relax PNF stretching technique was found to be the most effective, particularly when compared to unilateral corner stretching. Therefore, it is recommended that the modified contract-relax PNF stretching method be the first choice in shoulder protraction treatment programs.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Gazi University Rectorate Ethics Committee (Date: 04.04.2023, Decision No: E639069).

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 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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REFERENCES

1. Griegel-Morris P, Larson K, Mueller-Klaus K, Oatis CA. Incidence of common postural abnormalities in the cervical, shoulder, and thoracic regions and their association with pain in two age groups of healthy subjects. *Physical Therapy.* 1992;72(6):425-431. doi:10.1093/ptj/72.6.425
2. Borstad JD. Resting position variables at the shoulder: evidence to support a posture-impairment association. *Physical Therapy.* 2006; 86(4):549-557. doi:10.1093/ptj/86.4.549
3. Ludewig PM, Cook TM, Nawoczenski DA. Three-dimensional scapular orientation and muscle activity at selected positions of humeral elevation. *J Orthopaed Sports Physic Therapy.* 1996;24(2):57-65. doi:10.2519/jospt.1996.24.2.57
4. Wang CH, McClure P, Pratt NE, Nobilini R. Stretching and strengthening exercises: their effect on three-dimensional scapular kinematics. *Arch Physic Med Rehabil.* 1999;80(8):923-929. doi:10.1016/s0003-9993(99)90084-9
5. Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA. Muscles: testing and function with posture and pain. vol 5. Lippincott Williams & Wilkins Baltimore, MD; 2005.
6. Borstad JD, Ludewig PM. The effect of long versus short pectoralis minor resting length on scapular kinematics in healthy individuals. *J Orthop Sports Physic Therapy.* 2005;35(4):227-238. doi:10.2519/jospt.2005.35.4.227
7. Sahrmann S, Azevedo DC, Van Dillen L. Diagnosis and treatment of movement system impairment syndromes. *Brazil J Physic Ther.* 2017; 21(6):391-399. doi:10.1016/j.bjpt.2017.08.001
8. McClure PW, Michener LA, Sennett BJ, Karduna AR. Direct 3-dimensional measurement of scapular kinematics during dynamic movements in vivo. *J Shoulder Elbow Surg.* 2001;10(3):269-277. doi:10.1067/mse.2001.112954
9. Braun BL. Postural differences between asymptomatic men and women and craniofacial pain patients. *Arch Physic Med Rehabil.* 1991;72(9):653-656.
10. Jain S, Janssen K, DeCelle S. Alexander technique and Feldenkrais method: a critical overview. *Physic Med Rehabil Clin.* 2004;15(4):811-825. doi:10.1016/j.pmr.2004.04.005
11. Ludewig PM, Hoff MS, Osowski EE, Meschke SA, Rundquist PJ. Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. *Am J Sports Med.* 2004;32(2):484-493. doi:10.1177/0363546503258911
12. Kluemper M, Uhl T, Hazelrigg H. Effect of stretching and strengthening shoulder muscles on forward shoulder posture in competitive swimmers. *J Sport Rehabil.* 2006;15(1):58. doi:10.1123/jsr.15.1.58
13. Cole AK, McGrath ML, Harrington SE, Padua DA, Rucinski TJ, Prentice WE. Scapular bracing and alteration of posture and muscle activity in overhead athletes with poor posture. *J Athlet Train.* 2013; 48(1):12-24. doi:10.4085/1062-6050-48.1.13
14. Lee JH, Cynn HS, Yoon TL, et al. The effect of scapular posterior tilt exercise, pectoralis minor stretching, and shoulder brace on scapular alignment and muscles activity in subjects with round-shoulder posture. *J Electromyograp Kinesiol.* 2015;25(1):107-114. doi:10.1016/j.jelekin.2014.10.010
15. Han JT, Lee JH, Yoon CH. The mechanical effect of kinesiology tape on rounded shoulder posture in seated male workers: a single-blinded randomized controlled pilot study. *Physiother Theory Pract.* 2015;31(2):120-125. doi:10.3109/09593985.2014.960054

16. Wong CK, Coleman D, Song J, Wright D. The effects of manual treatment on rounded-shoulder posture, and associated muscle strength. *J Bodywork Movement Ther.* 2010;14(4):326-333. doi:10.1016/j.jbmt.2009.05.001
17. Borstad JD, Ludewig PM. Comparison of three stretches for the pectoralis minor muscle. *J Shoulder Elbow Surg.* 2006;15(3):324-330. doi:10.1016/j.jse.2005.08.011
18. Harvey L, Herbert R, Crosbie J. Does stretching induce lasting increases in joint ROM? A systematic review. *Physiother Res Int.* 2002;7(1):1-13. doi:10.1002/pri.236
19. Cramer JT, Housh TJ, Johnson GO, Miller JM, Coburn JW, Beck TW. Acute effects of static stretching on peak torque in women. *J Strength Cond Res.* 2004;18(2):236-241. doi:10.1519/r-13303.1
20. Williams JG, Laudner KG, McLoda T. The acute effects of two passive stretch maneuvers on pectoralis minor length and scapular kinematics among collegiate swimmers. *Int J Sports Phys Ther.* 2013;8(1):25-33.
21. Laudner KG, Wenig M, Selkow NM, Williams J, Post E. Forward shoulder posture in collegiate swimmers: a comparative analysis of muscle-energy techniques. *J Athlet Train.* 2015;50(11):1133-1139. doi:10.4085/1062-6050-50.11.07
22. Lee JH, Cynn HS, Yoon TL, et al. Comparison of scapular posterior tilting exercise alone and scapular posterior tilting exercise after pectoralis minor stretching on scapular alignment and scapular upward rotators activity in subjects with short pectoralis minor. *Phys Ther Sport.* 2015;16(3):255-261. doi:10.1016/j.ptsp.2015.01.002
23. Rosa DP, Borstad JD, Pogetti LS, Camargo PR. Effects of a stretching protocol for the pectoralis minor on muscle length, function, and scapular kinematics in individuals with and without shoulder pain. *J Hand Ther.* 2017;30(1):20-29. doi:10.1016/j.jht.2016.06.006
24. Kim TW, An DI, Lee HY, Jeong HY, Kim DH, Sung YH. Effects of elastic band exercise on subjects with rounded shoulder posture and forward head posture. *J Phys Ther Sci.* 2016;28(6):1733-1737. doi:10.1589/jpts.28.1733
25. Borstad JD. Measurement of pectoralis minor muscle length: validation and clinical application. *J Orthop Sports Phys Ther.* 2008;38(4):169-174. doi:10.2519/jospt.2008.2723
26. Larsen CM, Søgaard K, Eshoj H, Ingwersen K, Juul-Kristensen B. Clinical assessment methods for scapular position and function. An inter-rater reliability study. *Physiother Theory Pract.* 2019;36(12):1399-1420. doi:10.1080/09593985.2019.1579284
27. Birinci T, Mustafaoglu R, Mutlu EK, Ozdincler AR. Stretching exercises combined with ischemic compression in pectoralis minor muscle with latent trigger points: a single-blind, randomized, controlled pilot trial. *Compl Ther Clini Pract.* 2020;38:101080. doi:10.1016/j.ctcp.2019.101080
28. Kim TW, An DI, Lee HY, Jeong HY, Kim DH, Sung YH. Effects of elastic band exercise on subjects with rounded shoulder posture and forward head posture. *J Phys Ther Sci.* 2016;28(6):1733-1737.
29. Klinge K, Magnusson SP, Simonsen EB, Aagaard P, Klausen K, Kjaer M. The effect of strength and flexibility training on skeletal muscle electromyographic activity, stiffness, and viscoelastic stress relaxation response. *Am J Sports Med.* 1997;25(5):710-716. doi:10.1177/036354659702500522
30. Laporte Y, Lloyd DP. Nature and significance of the reflex connections established by large afferent fibers of muscular origin. *Am J Physiol Legacy Content.* 1952;169(3):609-621. doi:10.1152/ajplegacy.1952.169.3.609

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Attentional focus strategies alter muscle activation during combined chin tuck and prone T exercise in individuals with forward head posture: a cross-over pilot study

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ABSTRACT

Aims: This pilot study aims to assess the feasibility and preliminary effects of external versus internal attentional focus cues on cervical muscle activation during combined chin tuck and prone T exercises.

Methods: This cross-over, prospective, and pilot study included 15 individuals with forward head posture (FHP). Photographic analysis using Kinovea software was performed to identify individuals with FHP. Surface EMG system (Noraxon, USA, Inc., Scottsdale, AZ) was used to assess the activation of the sternocleidomastoid (SCM), upper trapezius (UT), middle trapezius (MT), lower trapezius (LT), and serratus anterior (SA) during a combined chin tuck and prone T exercise. Exercises were performed under three attentional focus conditions: unguided, internal, and external. Friedman and Wilcoxon signed-rank tests with Bonferroni correction were used to analyse differences.

Results: Friedman analysis revealed significant differences in SCM ($p=0.008$), UT ($p=0.012$), MT ($p=0.013$), and LT ($p=0.017$) activation across focus conditions, but not for SA ($p>0.05$). Pairwise comparisons showed that internal and external focus both increased SCM activation compared to unguided ($p=0.004$ and $p=0.008$), while internal focus significantly increased UT and MT activation ($p=0.013$ and $p=0.002$). LT activation showed an upward trend under internal focus but did not reach Bonferroni-corrected significance ($p=0.02$). No significant changes were observed in UT/MT and UT/LT ratios, although a decreasing (favorable) trend was noted under guided conditions ($p>0.05$).

Conclusion: This pilot study provides preliminary evidence that internal attentional focus cues may selectively enhance cervical and scapular muscle activation, particularly for the SCM, UT, and MT, with a similar trend noted for the LT during combined chin tuck and prone T exercises. These findings could support the potential role of attentional cueing in postural rehabilitation and guide the development of more targeted exercise protocols.

Keywords: Attention, neck muscles, electromyography, exercise therapy, posture

INTRODUCTION

Forward head posture (FHP) is defined as the forward protrusion of the head in the sagittal plane and is a common postural deformity among adults.[1] FHP leads to excessive extension of the upper cervical spine and flexion of the lower cervical spine. It is also recognized as a potential risk factor for neck and shoulder pain and abnormal scapular movement.[2]

Prolonged forward displacement of the head-neck complex causes cervical and scapular muscle imbalance and weakness. In individuals with FHP, the forward displacement of the head leads to shortening and weakening of the deep neck flexor muscles.[3] A key issue in individuals with FHP is compensatory hyperactivation and shortening of the sternocleidomastoid (SCM) muscle, resulting from deep neck flexor weakness.[4] Similarly, individuals with FHP show increased upper trapezius (UT) activation to counteract the heightened tension in the levator scapulae and support the weight of the head.[3] In individuals with FHP, shoulder isometric flexion was accompanied by greater activation of the UT and lower trapezius (LT) compared to performing the same exercises in a neutral head position.[5] Several studies have also demonstrated decreased serratus anterior (SA) activation in FHP, which is important for muscle scapular movement control.[1,5]

Numerous corrective exercises have been proposed to address the abnormal sagittal alignment in FHP. Among these, scapular retraction and craniocervical flexion have strong

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evidence for effectiveness in individuals with FHP without underlying musculoskeletal disorders.[6] Particularly the prone T exercise are widely used to minimize mechanical stress from altered scapular and cervical kinematics. The prone T exercise effectively strengthens scapular retractors, particularly the middle trapezius (MT) and LT, while limiting UT activation, supporting better muscle balance in FHP.[6,7]

In clinical practice, combining the chin tuck position with the prone T exercise may maximize postural correction outcomes, as it reduces cervical protraction and addresses related muscle imbalances;[6,8] however, maintaining correct cervical alignment consistently throughout the exercise remains challenging. Verbal cues directing attention either toward specific body movements (internal focus) or external targets related to task performance (external focus) have been frequently used to enhance motor learning and enhance muscle imbalances, particularly in lower extremity exercises.[9] Evidence suggests that internal attentional focus promotes heightened conscious control, increasing activation of task-specific muscles. In contrast, external attentional focus facilitates automatic movement control, reducing unnecessary muscle recruitment, and enhancing motor learning and athletic performance, such as vertical jump performance.[9-11] Verbal cues are commonly recommended to facilitate correct alignment during therapeutic exercises;[10,11] however, the effectiveness of internal versus external attentional strategies on cervical and scapular muscle activation, specifically in individuals with FHP, remains unclear.[9] Investigating how different attentional focus cues influence muscle activation during the chin-tuck position may help clinicians determine more effective approaches, enhancing outcomes for postural correction. However, to date, no research has investigated how these different attentional focus strategies influence neck and scapular muscle activation during combined chin tuck and prone T exercises in individuals with FHP.

Therefore, this pilot study aims to assess the feasibility and preliminary effects of external versus internal attentional focus cues on cervical muscle activation during combined chin-tuck and prone T exercises. Results from this pilot study will inform the methodology and sample size for the larger project.

METHODS

Study Design

This cross-over, prospective, and pilot study was conducted at the Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Gazi University between August 2024 and February 2025. This pilot study was conducted as part of a larger research project approved by the Gazi University Rectorate Ethics Committee (Date: 06.08.2024, Decision No: 2024/1260) in accordance with the principles of the 2018 Helsinki Declaration. Written informed consent was obtained from each of the participants at the beginning of the study.

Participants

This pilot study included 15 individuals with FHP who had a craniovertebral angle of less than 50 degrees. The study included individuals aged 18-35 who agreed not to participate in any other treatment or evaluation during the study period, were able to perform the exercises appropriately, and voluntarily consented to participate.

Participants were excluded from the study if they met any of the following criteria; experiencing pain in the neck, spine, upper extremities, or lower extremities within the last three months; having a body-mass index (BMI) greater than 25 kg/m^2; a history of intervertebral disc herniation, spondylosis, or neck injuries such as whiplash, or having undergone surgical intervention in the cervical region; the presence of visual or auditory impairments; neurological and orthopedic symptoms; any condition affecting muscle control; dermatological issues at electrode placement sites; hypersensitivity to adhesives; a history of recent surgery involving the measured muscles that could impair EMG quality. A sample size of 15 participants was selected to assess feasibility and effect size for future sample size calculation, in line with methodological recommendations suggesting a minimum of 12 participants per group in pilot trials.[12] Participants with FHP were recruited via convenience sampling through social media and university email announcements.

Measurement of the Craniovertebral Angle

The craniovertebral angle (CVA) was measured using lateral digital photogrammetry, a reliable and valid method supported by Kinovea Video Analysis Software.[13,14] Participants were photographed from their dominant side while standing naturally with their feet shoulder-width apart. A smartphone mounted on a tripod, positioned 1.5 meters away and adjusted to shoulder height, was used for imaging. The tragus and C7 spinous process were marked with visible markers, and participants wore tight-fitting clothing to ensure accurate marker placement. Participants were asked to stand in a comfortable position with their feet shoulder-width apart and to look straight ahead. To capture natural posture, participants marched in place five times before a lateral photograph was taken within the first five seconds.[13] The captured images were then transferred to Kinovea Video Analysis Software (version 8.15).[14]

Electromyography Measurements

Surface electromyography (EMG), a non-invasive method for measuring muscle activity, was performed using an 8-channel Noraxon MiniDTS system (Noraxon, USA, Inc., Scottsdale, AZ). Muscle activation was assessed in SCM, UT, MT, LT, and SA muscles.

Surface EMG signals were recorded using disposable, self-adhesive Ag/AgCl electrodes (Noraxon Dual EMG Electrode, U.S.A). To minimize skin impedance (<5 kΩ), the skin was shaved, lightly abraded with fine sandpaper, and cleaned with 70% isopropyl alcohol. Electrodes were secured with double-sided tape to ensure stability during the session. Electrode placement followed the recommendations of the European Recommendations for Surface Electromyography (SENIAM), with electrodes positioned parallel to the muscle fibers.[4,7] Measurements were taken unilaterally from the dominant side of each participant. Following electrode placement, skin impedance was measured using an ohmmeter and ensured to be below 5 kΩ.[2]

Electrodes were placed as follows: SCM one-third of the distance between the sternal notch and the mastoid process;[15,16] UT midway between the acromion and the seventh cervical vertebra; MT midway between the medial scapular border and the third thoracic vertebra; LT twothirds along the line from the trigonum spinae to T8;[7] and SA at the level of the fifth rib.[15]

Measurement of maximal voluntary isometric contractions (MVICs): Participants performed MVICs for each of the five muscles. Based on established protocols, each muscle was tested in postures designed to elicit maximal isometric activity. After the familiarization trials, participants performed three repetitions of MVIC measurements, each lasting 5 seconds, with 30-second rest periods between individual measurements and 1-minute rest intervals between repetitions. All MVIC measurements were conducted by the same investigator, who provided strong verbal encouragement to ensure maximal effort.[2]

The positions for measuring MVIC are standardized as follows: (1) for SCM, the subject is in a supine position, performing cervical flexion and rotation;[15,16] (2) for UT, the shoulder is positioned at 90° of abduction, combined with lateral flexion of the head to the same side and contralateral rotation;[7] (3) for MT, the arm is placed in a pronated T-position, ensuring the thumb points upward;[17] (4) for LT, the arm is positioned in a prone V-position, with the thumb directed upward;[17] (5) for SA, the shoulder is positioned at 125° of flexion.[15] These standardized positions ensure consistent and accurate measurement of muscle activation during MVIC testing.

Exercise procedures: Muscle activations were measured during the prone T exercise under three distinct conditions: unguided (without any corrective cues or adjustments to the cervical region), external focus, and internal focus (Figure 1). To ensure consistency, all participants received standardized instructions before testing.

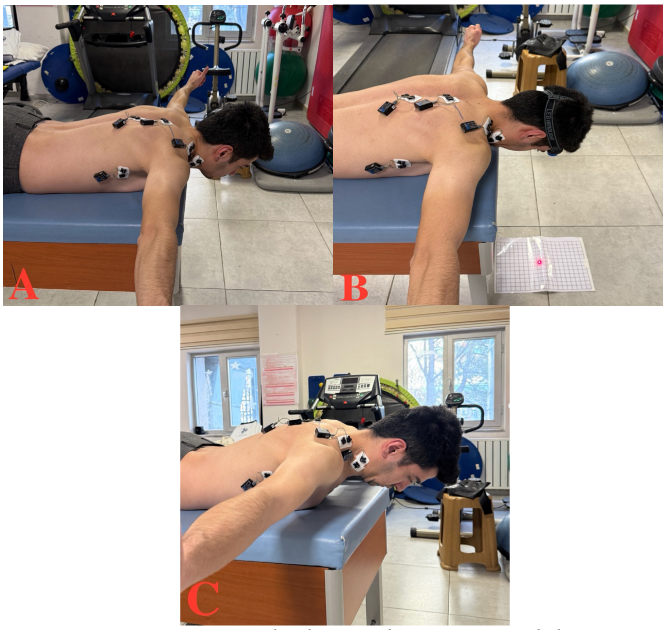

Figure 1. Prone T exercises under three conditions. A: Unguided prone T; B: External focus; C: Internal focus

Unguided (control) condition: Participants were instructed to perform the prone T exercise without any corrective cues or adjustments to the cervical region. In this position, participants performed prone horizontal abduction with the arm abducted, elbow extended, and humerus externally rotated. They lifted their hand toward the ceiling while retracting the scapula.[6] No additional instructions were provided during the control condition to record baseline muscle activation patterns without external influence and ensure result reliability (Figure 1A).[9]

Following the unguided condition, to ensure standardization of the exercises and achieve proper postural alignment prior to the exercises, participants were instructed on how to perform the craniocervical flexion through a gentle chin-tuck maneuver. The chin-tuck position was performed in supine position, and participants were instructed to maintain this position throughout exercise.[18] These focus instructions were provided in accordance with established guidelines from previous studies and relevant literature in the field.[9]

External focus condition: A headband with a laser pointer was placed on the participant's forehead, with the laser positioned between and slightly above the eyebrows. A flat wall was placed in front of the participant to project the laser beam. Participants were instructed: "position your head in the chin-tuck position and focus on the point where the laser hits the wall while performing the exercise" (Figure 1B).

Internal focus condition: Participants were instructed: "Position your head in the chin-tuck position and focus on maintaining the straight alignment of your neck while performing the exercise" (Figure 1C).

The sequence of MVICs and the internal and external focus conditions during the prone T exercise were randomized using "the Sequence Generator" (Random.org) to minimize order bias. To standardize the duration of each exercise phase, a metronome was set at 60 beats per minute, with each phase lasting 3 seconds. Participants performed three repetitions of each exercise to minimize fatigue. A 2-minute rest period was provided between repetitions to ensure adequate recovery.[2]

EMG data analysis: MyoResearch XP software (Noraxon) was used for EMG signal processing. Signals were band-pass filtered (20-450 Hz) and smoothed using a 100-ms RMS window. Muscle activity during prone T was normalized to MVIC, with averages from three repetitions expressed as %MVIC. Muscle activation was categorized as low (0-20%), moderate (21-40%), high (41-60%), or very high (>60%) activity.[2] Additionally, UT/MT, UT/LT, and UT/SA ratios were calculated from average %MVIC values to identify exercises suitable for targeting lower muscle ratios. Ratios were rated as moderate (0.8-1), good (0.6-0.8), or excellent (<0.6) (Figure 2).[7]

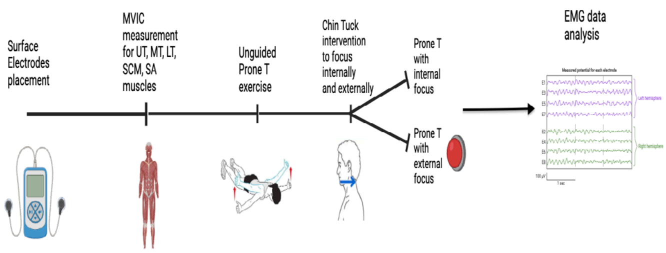

Figure 2. Testing protocol illustration

Statistical Analysis

All data analyses were conducted using SPSS version 24.0 (SPSS 24 for Windows, Armonk, NY: IBM Corp). Normality was assessed using the Shapiro-Wilk test and visual inspection of histograms and Q-Q plots. As data were not normally distributed, values are reported as median and interquartile range (IQR). The Friedman test was used to compare muscle activations (SCM, UT, MT, LT, and SA) across different focus conditions (unguided, internal, and external). Wilcoxon signed-rank tests with Bonferroni correction were performed for pairwise comparisons when significant differences were found. A significance level of 5% was used for statistical tests.

RESULTS

From August to October 2024, 36 individuals were assessed for eligibility. Six had a BMI over 25 kg/m^2, five reported chronic neck and shoulder pain (≥3 months), and 10 had a craniovertebral angle (CVA) greater than 50° based on photogrammetric assessment. Therefore, 15 participants (8 females, 7 males) met the inclusion criteria and were enrolled in this prospective pilot study. All participants were right-handed, with a mean age of 22.2±1.8 years and an average BMI of 21.2±2.2 kg/m^2.

Significant differences in muscle activations between focus conditions were found for SCM (p=0.008), UT (p=0.012), MT (p=0.013), and LT (p=0.017), according to the Friedman test. However, the SA muscle activation did not differ significantly between focus conditions (p=0.074) (Table 1, 2). Figure 3 shows an increasing trend in muscle activation under internal and external focus conditions compared to the unguided condition across all muscles.

Table 1. Normalized activity of each muscle at each focusing condition

	Maximal voluntary isometric contraction, %, median (IQR) (n=15)			
Muscles	Unguided	Internal focus	External focus	p^Y
SCM	3.28 (1.79-6.07)	6.9 (2.5-10.07)	5.7 (4.1-8.2)	0.008*
UT	33.3 (19.02-41)	39.5 (29.75-55.16)	37.2 (23.3-47.5)	0.012*
MT	42.9 (38.9-47.1)	48.1 (41.5-58.4)	48.1 (43.8-52.1)	0.013*
LT	45.4 (34.7-56.2)	56.7 (40.1-67.1)	49.8 (39.6-57.6)	0.017*
SA	11.5 (7.3-13.6)	12.7 (7-16.2)	14 (7.6-16.5)	0.074

IQR: Inter quartile range, SCM: Sternocleidomastoid, UT: Upper trapezius, MT: Middle trapezius, LT: Lower trapezius, SA: Serratus anterior, Y: Friedman test results, *: p>0.05

Table 2. Muscle activation ratios at each focusing condition

	Muscle activation ratios, median (IQR) (n=15)			
Muscles	Unguided	Internal focus	External focus	p^Y
UT/MT	0.8 (0.45-0.89)	0.75 (0.63-1.07)	0.69 (0.49-0.96)	0.368
UT/LT	0.73 (0.36-1.08)	0.69 (0.49-1.1)	0.79 (0.44-1.07)	0.116
UT/SA	3.21 (1.57-4.56)	3.35 (1.87-5.32)	2.8 (1.68-3.44)	0.232

IQR: Inter quartile range, UT/MT: Upper trapezius/middle trapezius, UT/LT: Upper trapezius/lower trapezius, UT/SA: Upper trapezius/serratus anterior, Y: Friedman test results

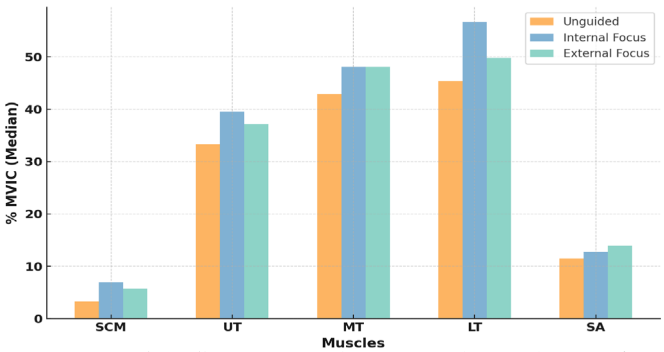

Figure 3. Bar chart illustrating muscle activation (%MVIC) across focus conditions

SCM: Sternocleidomastoid, UT: Upper trapezius, MT: Middle trapezius, LT: Lower trapezius, SA: Serratus anterior

However, when pairwise comparisons were statistically examined, SCM activation was significantly higher in internal and external focus conditions than in the unguided condition (p=0.004 and p=0.008). Nevertheless, no significant difference was found between internal and external focus for SCM muscle activation (p>0.05). While internal focus resulted in higher UT muscle activation compared to the unguided condition (p=0.013), no significant differences were found between external focus and either the unguided or internal focus conditions (p>0.05). MT muscle activation increased significantly with internal focus compared to unguided (p=0.002). However, the increase in MT muscle activity observed with external focus did not reach statistical significance after Bonferroni correction (p=0.03). Similarly, a trend towards higher LT muscle activation in internal focus compared to unguided was observed, but this did not reach the Bonferroni-corrected significance level (p=0.02).

Although no statistically significant differences were observed in the UT/MT, UT/LT, and UT/SA ratios across focus conditions (p>0.05), trends indicated a potential shift towards more favorable (lower) UT/MT and UT/LT ratios in both internal and external focus conditions.

DISCUSSION

The main objective of this study was to investigate cervical and scapular muscle activation levels under different attentional focus strategies during a combined chin-tuck and prone T exercise. According to the preliminary findings of this study, significant differences between conditions were observed for all muscles except the SA. Post-hoc analyses revealed that SCM activation was higher under both internal and external focus than the unguided condition. The internal focus of attention presented greater UT and MT muscle activation. In contrast, LT activation showed a clear upward trend in the internal focus condition but did not reach statistical significance after Bonferroni correction. The changes in muscle activation ratios were not statistically significant.

The chin-tuck maneuver typically is considered to increase the activation of deep cervical flexor muscles while minimizing the activation of superficial muscles such as the SCM.[19] However, this muscle activation pattern is often altered in individuals with neck pain or FHP due to impaired function of the deep cervical flexors and compensatory recruitment of superficial muscles, particularly the SCM.[4,16] Evidence suggests that individuals with neck pain tend to develop compensatory strategies involving increased SCM activation during craniocervical flexion.[16] Similarly in FHP, our pilot study observed significantly increased SCM activation under internal and external attentional focus conditions during the prone T exercise combined with chin-tuck. Dual-task activities are known to challenge the central nervous system (CNS) by simultaneously engaging cognitive and motor processes, often requiring adaptive changes in muscle recruitment to maintain postural control.[20] In our study, combining attentional focus cues with the motor task likely created such a dual-task demand, increasing the complexity of the exercise. Under these conditions, the CNS may prioritize stability by recruiting additional muscle support. While increased SCM activation is commonly observed in individuals with FHP, the additional rise seen during the exercise may raise concerns regarding the potential reinforcement of maladaptive patterns. Instead, the incorporation of attentional focus cues may facilitate controlled and functional activation of the SCM to maintain cervical stability.[21] This approach may be cautiously considered in early rehabilitation, especially when targeted SCM engagement is needed in individuals with FHP.

Previous research demonstrated that increased activation of the UT muscle in individuals with FHP could impair the scapular kinematics and overall postural stability.[2,4] Besides, Cools et al.[22] emphasized the biomechanical advantage of exercises that specifically aim to decrease UT activity, thereby promoting optimal scapular motion and muscle balance in this population. In our pilot study, our preliminary results indicated a significant increase in UT activation during the combined chin-tuck and prone T exercise under internal focus conditions compared to unguided conditions. Conversely, external focus conditions did not result in significantly increased UT activation. This contradictory response may be explained by the motor learning principles outlined by Wulf et al.,[11] suggesting that internal attentional focus promotes heightened conscious control and increased activation of task-specific muscles. In contrast, external focus encourages automatic movement control, reducing unnecessary muscle recruitment. Therefore, if the therapeutic goal specifically includes minimizing or maintaining UT activation during scapular stabilization exercises, external focus cues may be more effective in this population. Besides, despite increased UT activation under internal focus conditions, we found no statistically significant changes in UT/MT and UT/LT activation ratios. Nevertheless, the UT/MT ratio showed a decreasing trend from 0.8 in unguided conditions to 0.75 in internal focus and 0.69 under external focus, indicating a potential shift from moderate to good levels.[7] This suggests that despite increased UT activation, MT and LT engagement might help maintain muscle balance, given that a lower stabilizer-to-UT ratio is considered beneficial in rehabilitation.[23] However, further studies with larger samples are needed to confirm this trend and better understand the clinical relevance of attentional focus on trapezius muscle activation.

Previous research demonstrated increased muscle activation of the pectoralis major, biceps brachii, and triceps brachii under internal focus conditions.[24,25] Consistent with these findings, our pilot study observed significantly increased MT activation under internal focus conditions. Although no statistically significant increase in LT activation was observed, a similar upward trend was noted under internal focus conditions. Conversely, external focus conditions did not significantly enhance activation of either MT or LT, aligning with previous literature that external focus can promote automatic control and reduce unnecessary muscle activation.[11,21] The lack of differences in external focus conditions may be attributed to the small sample size or the increased neuromuscular demands of maintaining a prone position while externally focused. Thereby, to enhance activation of scapular stabilizers such as MT and potentially LT, internal attentional focus during exercises might provide a more effective strategy, especially during early rehabilitation stages that prioritize isolated muscle strengthening.

The lack of significant differences in SA activation across the unguided, internal, and external focus conditions in this study may stem from the muscle's primary role in scapular stabilization. The SA functions to anchor the scapula against the thoracic wall and facilitate controlled protraction,[26] highlighting its relatively constant low-level activation during static tasks such as the prone T exercise. Given its stabilizing function, the SA may be less responsive to short-term attentional focus manipulations compared to more dynamically involved muscles. Additionally, the small sample size might have limited the statistical power to detect subtle variations in SA activation, a common constraint in surface EMG studies.[27] Notably, while UT muscle activation increased significantly, no corresponding change was observed in the UT/SA ratio. This finding aligns with previous research suggesting that the SA maintains consistent activation levels during scapular stabilization, even when UT demand rises.[28] Thereby, to better understand how attentional focus affects SA engagement, future studies should employ dynamic, high-SA-demand tasks.

Limitations

This study has several limitations. First, as a pilot study, the small sample size limits the generalizability of the findings. Additionally, although deep cervical flexors play a key role during chin-tuck, their activation could not be assessed due to the limitations of surface EMG, underscoring the broader importance of evaluating deep stabilizing muscles in postural rehabilitation contexts.[29] Moreover, the study did not include a specific assessment of cervical core stabilization, which may have influenced individual muscle activation responses. Another important limitation is that the study evaluated only acute muscle activation during a single session, which does not allow conclusions about the long-term training or clinical effects of attentional focus strategies. Future studies may benefit from including larger sample sizes, integrating cervical stabilization assessments, and adopting longitudinal designs to examine long-term neuromuscular effects.

CONCLUSION

This pilot study provides preliminary evidence that internal attentional focus cues may selectively enhance cervical and scapular muscle activation, particularly for the SCM, UT, and MT, with a similar trend noted for the LT during combined chin tuck and prone T exercises. External focus cues showed limited effects, possibly due to task-specific stabilization demands or small sample size. Findings suggest attentional cueing may support postural rehabilitation and guide targeted exercises. Beyond postural rehabilitation, the preliminary findings of this study may offer broader insights for neuromuscular retraining in shoulder pathologies characterized by altered cervical-scapular coordination, such as rotator cuff repair or subacromial impingement.[30]

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Gazi University Rectorate Ethics Committee (Date: 06.08.2024, Decision No: 2024/1260).

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 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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REFERENCES

1. Szczygieł E, Fudacz N, Golec J, Golec E. The impact of the position of the head on the functioning of the human body: a systematic review. *Int J Occup Med Environ Health*. 2020;33(5):559-568. doi:10.13075/ijomeh.1896.01585
2. Cobanoglu G, Guzel NA, Ecemis ZB, Demirkan MY. Investigation of muscle activation during kinetic chain based exercises in individuals with and without forward head posture. *J Back Musculoskelet Rehabil*. 2024;37(6):1537-1549. doi:10.3233/BMR-230397
3. Arooj A, Aziz A, Khalid F, Iqbal MH, Ashfaq HB. Forward head posture in young adults: a systematic review: forward head posture in young adults. *Therapist*. 2022:32-35. doi:10.54393/tt.v3i1.38
4. Khan A, Khan Z, Bhati P, Hussain ME. Influence of forward head posture on cervicocephalic kinesthesia and electromyographic activity of neck musculature in asymptomatic individuals. *J Chiropr Med*. 2020; 19(4):230-240. doi:10.1016/j.jcm.2020.07.002
5. Weon JH, Oh JS, Cynn HS, Kim YW, Kwon OY, Yi CH. Influence of forward head posture on scapular upward rotators during isometric shoulder flexion. *J Bodyw Mov Ther*. 2010;14(4):367-374. doi:10.1016/j.jbmt.2009.06.006
6. Titcomb DA, Melton BF, Miyashita T, Bland HW. Evidence-based corrective exercise intervention for forward head posture in adolescents and young adults without musculoskeletal pathology: a critically appraised topic. *J Sport Rehabil*. 2022;31(5):640-644. doi:10.1123/jsr.2021-0381
7. Ekstrom RA, Soderberg GL, Donatelli RA. Normalization procedures using maximum voluntary isometric contractions for the serratus anterior and trapezius muscles during surface EMG analysis. *J Electromyogr Kinesiol*. 2005;15(4):418-428. doi:10.1016/j.jelekin.2004.09.006
8. Han JW. Biomechanical analysis of chin tuck exercise with a subject-specific neck model for the forward headed. *Int J Precis Eng Manuf*. 2016;19:587-592.
9. Chua LK, Jimenez-Diaz J, Lewthwaite R, Kim T, Wulf G. Superiority of external attentional focus for motor performance and learning: systematic reviews and meta-analyses. *Psychol Bull*. 2021;147(6):618-645. doi:10.1037/bul0000335
10. Murofushi K, Oshikawa T, Kaneoka K, et al. The effect of external-focus using a paper balloon on the activity of upper limb and trunk muscles during static and dynamic tasks. *Isokinet Exerc Sci*. 2022;30(4):345-355. doi:10.3233/IES-220029
11. Wulf G. Attentional focus and motor learning: a review of 15 years. *Int Rev Sport Exerc Psychol*. 2013;6(1):77-104.
12. Julious SA. Sample size of 12 per group rule of thumb for a pilot study. *J Appl Stat in Pharm Ind*. 2005;4(4):287-291. doi:10.1002/pst.185
13. Titcomb DA, Melton BF, Bland HW, Miyashita T. Evaluation of the craniovertebral angle in standing versus sitting positions in young adults with and without severe forward head posture. *Int J Exerc Sci*. 2024;17(1):73-85. doi:10.70252/GDNN4363
14. Zárate-Tejero CA, Rodríguez-Rubio PR, Brandt L, et al. Measuring craniovertebral angle reference values in adults using kinovea software. *Appl Sci*.2024;14(19):8639. doi:10.3390/app14198639
15. Moraes KJRd, Cunha DAd, Bezerra LÂ, Cunha RAd, Silva HJd. Surface electromyography: proposal of a protocol for cervical muscles. *Rev CEFAC*. 2012;14:918-924. doi:10.1590/S1516-18462011005000133
16. Falla D, Bilenkij G, Jull G. Patients with chronic neck pain demonstrate altered patterns of muscle activation during performance of a functional upper limb task. *Spine*. 2004;29(13):1436-1440. doi:10.1097/01.brs.0000128759.02487.bf
17. De Mey K, Danneels L, Cagnie B, Huyghe L, Seyns E, Cools AM. Conscious correction of scapular orientation in overhead athletes performing selected shoulder rehabilitation exercises: the effect on trapezius muscle activation measured by surface electromyography. *J Orthop Sports Phys Ther*. 2013;43(1):3-10. doi:10.2519/jospt.2013.4283
18. Titcomb DA, Melton BF, Miyashita T, Bland HW. The effects of postural education or corrective exercise on the craniovertebral angle in young adults with forward head posture: a randomized controlled trial. *Int J Exerc Sci*. 2023;16(1):954-973. doi:10.70252/PYPQ8483
19. Jull GA, O'leary SP, Falla DL. Clinical assessment of the deep cervical flexor muscles: the craniocervical flexion test. *J Manipulative Physiol Ther*. 2008;31(7):525-533. doi:10.1016/j.jmpt.2008.08.003
20. Saraiva M, Vilas-Boas JP, Castro MA. Postural control and muscle activity during dual-task in young adults. *Behav Sci*.2024;14(5):403. doi:10.3390/bs14050403
21. Wulf G, Lewthwaite R. Effortless motor learning? An external focus of attention enhances movement effectiveness and efficiency. *Effortl Attent New Perspect Cognit Sci Attent Action*. 2010:75-101.
22. Cools AM, Dewitte V, Lanszweert F, et al. Rehabilitation of scapular muscle balance: which exercises to prescribe? *Am J Sports Med*. 2007; 35(10):1744-1751. doi:10.1177/0363546507303560
23. Schory A, Bidinger E, Wolf J, Murray L. A systematic review of the exercises that produce optimal muscle ratios of the scapular stabilizers in normal shoulders. *Int Rev Sport Exerc Psychol*. 2016;11(3):321.
24. Schoenfeld BJ, Contreras B. Attentional focus for maximizing muscle development: the mind-muscle connection. *Strength Cond J*. 2016;38(1): 27-29. doi:10.1519/SSC.0000000000000190
25. Snyder BJ, Fry WR. Effect of verbal instruction on muscle activity during the bench press exercise. *J Strength Cond Res*. 2012;26(9):2394-2400. doi:10.1519/JSC.0b013e31823f8d11
26. Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. Clinical implications of scapular dyskinesis in shoulder injury: the 2013 consensus statement from the 'Scapular Summit'. *Br J Sports Med*. 2013;47(14):877-885. doi:10.1136/bjsports-2013-092425
27. Campanini I, Disselhorst-Klug C, Rymer WZ, Merletti R. Surface EMG in clinical assessment and neurorehabilitation: barriers limiting its use. *Front Neurol*. 2020;11:934. doi:10.3389/fneur.2020.00934
28. Ludewig PM, Hoff MS, Osowski EE, Meschke SA, Rundquist PJ. Relative balance of serratus anterior and upper trapezius muscle activity during push-up exercises. *Am J Sports Med*. 2004;32(2):484-493. doi:10.1177/0363546503258911
29. Dagli AC, Oner S, Oner Z, Dagli BY. An MRI analysis of the lumbar lordosis angle and lumbar muscle thicknesses in patients with non-specific low back pain. *Konuralp Med J*. 2023;15(3):294-301. doi:10.18521/ktd.1210087
30. Koçak H, Narin AN, Dagli BY. Examination of scapular dyskinesis in individuals with artroscopic rotator cuff repair. *Gevher Nesibe J Med Health Sci*. 2022;7(21):141-147. doi:10.5281/zenodo.7392249

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Original Article

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Knowledge levels of different speciality clinicians involved in the follow-up and treatment of developmental dysplasia of hip: misinformation known correctly

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ABSTRACT

Aims: In this article, it is aimed to measure the level of knowledge of intern physicians, general practitioners, pediatric health and diseases research assistants and specialist physicians about developmental dysplasia of the hip and to increase their awareness of the deficiencies identified in the relevant physician group.

Methods: Our study population consisted of general practitioners, intern physicians, pediatric health and diseases research assistants and specialist physicians. A questionnaire form about developmental dysplasia of the hip (DDH) was prepared. This questionnaire form was delivered to volunteer physicians digitally and they were asked to answer it. The questionnaires were collected digitally. The answers to the survey questions were analyzed and graphs showing the percentage distribution of the answers were created.

Results: In our study, a total of 168 volunteer physicians, including 76 intern physicians, 32 general practitioners, 40 pediatric research assistants and 20 specialists, were reached. Among the physicians who participated in the study, 45.2% were intern physicians who had not yet started their professional life. 45.1% of the physicians participating in the study were physicians with more than 1 year of professional experience. 95.2% of the participants stated that they received an orthopedics and traumatology internship during their undergraduate medical school education. 54.8% of the participants in the study were encountered with patients diagnosed with DDH. Physicians gave correct answers to the questions about DDH at rates ranging from 92.9% to 51.2%.

Conclusion: Our study has shown that there are some deficiencies in the level of knowledge of physicians who deal with the diagnosis and treatment of the patient population diagnosed with DDH. In this regard, our medical faculties and the ministry of health have important duties in medical faculties and in the training on DDH that will be given at the professional level.

Keywords: Hip, dysplasia, knowledge, questionnaire, physician

INTRODUCTION

Developmental dysplasia of the hip (DDH) joint is a dynamic disease in which the structures that make up the hip joint are normal in the intrauterine period, but subsequently show structural deterioration due to various reasons.[1,2] Over time, pathology in the soft tissues and bone tissues of the hip joint can lead to different levels of deformity in the hip joint. Since the pathology is usually due to underdevelopment of the acetabulum and develops over time, DDH has been used in the new terminology instead of congenital dislocation of the hip.[3] Due to this characteristic of the disease, the level of knowledge of general practitioners and relevant specialist physicians who follow up babies who are especially at risk in the neonatal period about DDH is important for the proper functioning of the screening program and the access of diagnosed patients to the correct treatment.

In the world, the general incidence of DDH varies between 0.1-10%. The incidence in Turkiye is estimated to be approximately 5-15 per 1,000 live births.[4] Breech presentation of the baby during normal delivery, female gender, multiple pregnancies, low amniotic fluid, first birth, and positive family history increase the risk of DDH.[5,6] In addition to birth-related risks, some postnatal malpractices also contribute to the development of DDH. One of these is swaddling the baby with traditional methods or using double diapers in risky babies. Studies have shown that swaddling and the use of double diapers increase the risk of developmental hip

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dysplasia.[6,7] Physicians who follow up children in the neonatal period and take an active role in DDH screening should be informed about these risk factors and wrong practices.

Hip ultrasonography is the gold standard diagnostic method for the diagnosis of DDH in the first 6 months of neonatal screening. The aim of the treatment of diagnosed babies is to provide anatomical reduction of the hip joint as soon as possible and to ensure the normal development of the hip joint by maintaining it. Providing the patient with a lifelong functional hip joint by eliminating the permanent damages that may occur is the most important gain of treatment in the long term. The later the diagnosis, the greater the complexity of the interventions and the risk of complications, and the lower the chance of success.

In patients diagnosed in the first 6 months of life, the first treatment option is to bring the hip joint into a reduced position with different bandages or orthoses.[8,9] The most commonly used method to maintain reduction in this period is the use of Pavlik bandage.[10] In hips that cannot be reduced using Pavlik bandage or in hips that show insufficient development during treatment, the hips should be reduced under general anesthesia and a pelvipedal cast should be applied covering the trunk and legs.[10] In the patient group in whom the treatment is not terminated in the following period and the need for treatment continues, osteotomy applications are required together with capsulorrhaphy methods that provide anatomical reduction of the hip.[11,12] If developmental dysplasia of the hip is left untreated, permanent deformities and osteoarthritis may develop.

A national screening program is essential for early detection and treatment of developmental dysplasia of the hip. Early diagnosis allows the use of conservative methods, which are simpler and less costly. As such, early detection and proper management at the primary care center are key to prevent further complications of the disease.[13] General practitioners, interns and pediatricians also play an important role in national screening and early diagnosis. In order to minimize possible wrong attitudes in practices related to DDH in primary health care centers, continuous in-service trainings on knowledge, attitudes and practices for DDH management should be provided.[14] Some other studies have reported that more than 50% of healthcare workers, including doctors, nurses and medical students, have very low knowledge about DDH.[4,15-17]

In this study, our aim was to determine the level of knowledge of physicians interested in the diagnosis and treatment of DDH and to find the frequency of incorrect practices and to draw attention to these practices.

METHODS

For this study, an application was made to Kırıkkale University Non-interventional Researches Ethics Committee (Date: 17.04.2024, Decision No: 2024.03.16). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The questionnaire study consisting of 17 questions prepared to measure the level of knowledge of the participants about DDH and to question their clinical preferences is given in Table. Intern physicians, general practitioners, pediatrician research assistants and specialist physicians were included in the questionnaire form prepared in our study. Participants were included in our study on a voluntary basis. The correct answers to the questions are indicated in red color in the Table. The answers to some questions could not be classified as correct or incorrect and allowed the responding clinician to express his/her own preferences and orientations regarding the diagnosis and treatment of DDH. No question pattern was used to reveal the identity information, institution of employment, age and gender of the participants and this information was not recorded. The participants were reached via e-mail in digital environment and the answers given by the participants were recorded digitally with the questionnaire prepared by us on Google form. The answers to the survey questions were analyzed and graphs showing the percentage distribution of the answers were created.

RESULTS

A total of 168 physicians volunteered to participate in the study, including 76 intern physicians, 32 general practitioners, 40 pediatric research assistants and 20 specialists (Figure 1). Of the physicians who participated in the study, 45.2% were intern physicians who had not yet started their professional life, while 9.7% were physicians in their first year of professional life. Among the physicians who participated in the study, 45.1% had more than 1 year of professional experience.

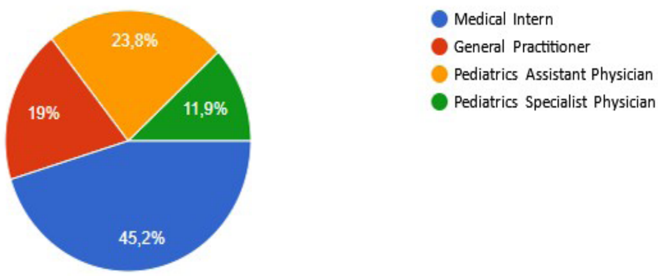

Figure 1. Distribution of physicians who participated in the questionnaire according to branches

95.2% of the participants stated that they received an orthopedics and traumatology internship during their undergraduate medical school education, while 4.8% stated that they did not receive an orthopedics and traumatology internship. Of the participants, 54.8% stated that they had encountered a patient diagnosed with DDH in their professional life, while 45.2% stated that they had not encountered a patient diagnosed with DDH in their professional life.

The distribution of the answers given by the physicians who participated in the survey to the questions about DDH disease is given collectively in Figure 2. When the distribution of the answers given by the physicians who participated in the survey to the questions about DDH disease is examined, 59.5% of the physicians who participated in the survey answered the question "Do you think the sentence 'Older mothers are more likely to have babies with DDH?' is correct with the answer no, while 40.5% gave the wrong answer with the answer yes. To the question "Do you think the statement 'All diseased babies are born with dislocated hips' is true?", 92.9% of the physicians who participated in the survey responded correctly with the answer no, while 7.1% responded incorrectly with the answer yes. While 78.6% of the physicians who participated in the survey responded correctly with the answer no, 21.4% responded incorrectly with the answer yes to the question

Table. Knowledge assessment questionnaire on DDH
1. Describe your specialty.
Medical intern
General practitioner
Pediatrics assistant physician
Pediatrics specialist physician
2. How many years are you in your profession?
3. Did you take orthopedics and traumatology internship during your undergraduate education at the faculty of medicine?
Yes
No
4. Have you encountered a patient diagnosed with DDH in your daily professional life?
Yes
No
5. Do you think the statement "Older mothers are more likely to have a baby with DDH" is correct?
Yes
No
6. Do you think the statement "All diseased babies are born with a dislocated hip" is correct?
Yes
No
7. Do you think the statement "DDH is more common in male babies" is correct?
Yes
No
8. Do you think the statement "Polyhydramnios history during pregnancy is among the risk factors of DDH" is correct?
Yes
No
9. Do you think the statement "Keeping the hip joints of babies in a certain position with swaddling from birth stimulates the normal development of the hip joint" is correct?
Yes
No
10. How many newborns with DDH are born every year in our country?
500-1000/year
5-8 thousand/year
15-18 thousand/year
50-100 thousand/year
Unpredictable
11. Which statement of the following is most accurate regarding the diagnosis of DDH?
The most reliable finding on physical examination is pili asymmetry
In patients diagnosed with DDH, treatment follow-up is performed with USG control until the 18th month.
Computed tomography of the hip can be used to replace plain hip radiographs.
In the national screening, babies are screened for DDH between the 4th and 6th weeks.
MRI is the most effective diagnostic tool.
12. Do you think the statement "Double diaper practices are an alternative method, especially in patients who have not considered Pavlik bandage treatment or who cannot adapt" is correct?
Yes
No
13. Which of the following is the reason for the approach, "Ideally, treatment of DDH should be performed at the earliest age"?
As the baby gets older, walking age is delayed due to plaster treatment.
As the baby gets older, the radiation received during the treatment process increases.
As the baby gets older, the cost of treatment increases.
As the baby gets older, the deterioration in pathologic anatomy increases.
As the baby gets older, the clinical findings become fainter and the diagnosis becomes more difficult.
14. Do you think the sentence "All hips that are not normal on USG in the first 3 months should be treated" is correct?
Yes
No
15. Which method do you think should be preferred to minimize the individual and societal (socioeconomic) effects of DDH?
Informing families.
Informing health personnel.
Hip USG in all newborns (universal screening).
Hip USG in all babies at risk for DDH (selective screening).
Double diapers for newborns with at least 2 risk factors.
16. In your daily professional life, which treatment option do you find most beneficial in the treatment of a patient diagnosed with DDH?
Swaddling
Double diaper
Pavlik bandage
Tubingen orthosis
Pelvipedal casting
17. How do you plan the treatment of patients diagnosed with DDH in your daily professional life?
I disagree with the decision at any stage of treatment
I refer the patient to the neonatal outpatient clinic for treatment
I refer the patient to the orthopedics and traumatology outpatient clinic for treatment
I undertake the entire non-surgical treatment process myself
DDH: Developmental dysplasia of the hip

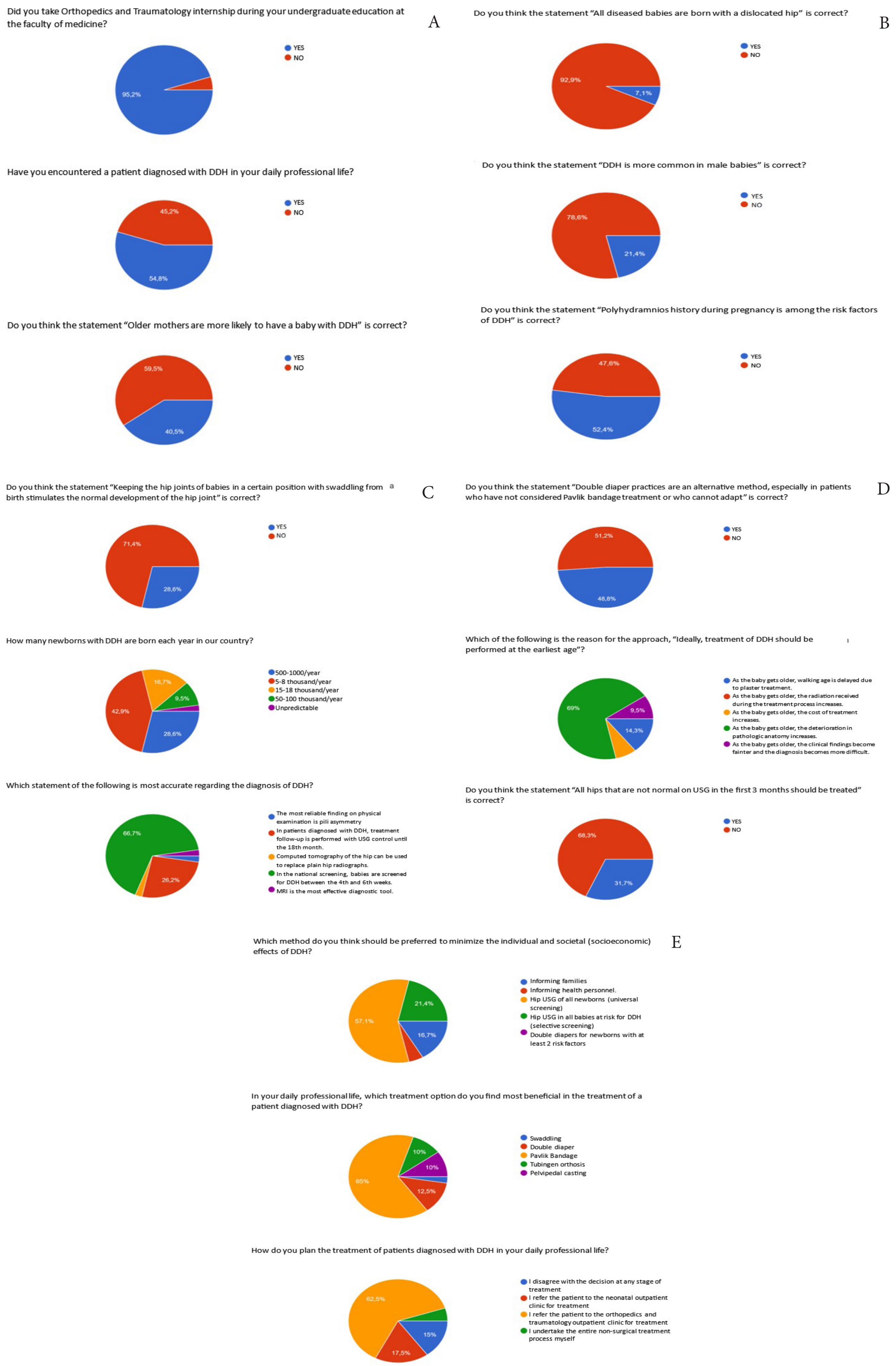

Figure 2. Distribution of the answers of the physicians who participated in the questionnaire to the questions related to DDH disease

DDH: Developmental dysplasia of the hip

"Do you think the sentence 'DDH disease is more common in male babies' is correct?". To the question "Do you think the sentence 'Polyhydramnios history during pregnancy is among the risk factors of DDH' is correct?", 52.4% of the physicians who participated in the survey answered correctly with yes, while 47.6% answered incorrectly with no. While 71.4% of the physicians who participated in the survey answered the question "Do you think the sentence 'Keeping the hip joints of babies in a certain position with swaddling from birth stimulates the normal development of the hip joint.' is correct, 71.4% of them answered correctly with the answer no, while 28.6% of them answered incorrectly with the answer yes.

To the question "How many newborns with DDH are born every year in our country?", 42.9% of the physicians who participated in the survey answered 5-8 thousand/year, 28.6% answered 500-1000 thousand/year, 16.7% answered 15-18 thousand/year, 9.5% answered 50-100 thousand/year, and 2.4% answered unpredictable. With this result, only 16.7% of physicians correctly knew the expected incidence of patients diagnosed with DDH in our country. In response to the question "Which of the following is the most accurate regarding the diagnosis of DDH?", 66.7% of the physicians who participated in the survey answered correctly with the answer "Babies are screened for DDH at 4-6 weeks in national screening."

To the question "Do you think the sentence ''Double diaper applications are an alternative method, especially in patients who have not considered pavlik bandage treatment or who cannot adapt?" is correct? 51.2% of the physicians who participated in the survey responded correctly with the answer no, while 48.8% responded incorrectly with the answer yes. 69% of the physicians who participated in the survey answered the question "Which of the following is the rationale for the approach "Ideally, the treatment of DDH should be performed at the earliest age?" to the question "As the age of the baby increases, the deterioration in pathologic anatomy increases." While 68.3% of the physicians who participated in the survey gave the correct answer no, 31.7% gave the wrong answer yes to the question "Do you think the sentence 'All hips that are not normal on USG in the first 3 months should be treated' is correct?

57.1% of the physicians who participated in the questionnaire responded to the question sentence "Which method should be preferred to minimize the individual and social (socioeconomic) effects of DDH?" as "Performing hip USG in all newborns (universal screening)" and recommended universal screening. The physicians who participated in the study answered the question "Which treatment option do you find most beneficial in the treatment of patients diagnosed with DDH in your daily professional life?" with pavlic bandage application by 65%. To the question sentence "How do you plan the treatment of patients diagnosed with DDH in your daily professional life?" 62.5% of the physicians who participated in the study answered "I refer the patient to the orthopedics and traumatology outpatient clinic for treatment."

DISCUSSION

We think that we obtained a quantitatively homogeneous distribution in the physician group participating in the study. It was seen that 95.2% of the physicians participating in the study received orthopedics and traumatology internship in their undergraduate medical school education. However, 45.2% of our participants stated that they had not encountered a patient diagnosed with DDH in their professional life. The group with the highest rate of not encountering a patient diagnosed with DDH was the general practitioner group with a rate of 87.5%. In the intern physician group, this rate was 65%. Pediatric health and diseases research assistant physicians and specialist physicians stated that they encountered a patient population diagnosed with DDH at a rate of 100%. In the light of these results, it can be inferred that it is inevitable to encounter GKD disease as the level of specialization increases or as professional experience increases. In addition, the low rate of encounter with patients diagnosed with DDH in our physician group with less than one year of professional experience, which we can describe as the new generation physician group, can also be interpreted as a result of the national screening program application that started in our country in 2013. Due to the decreasing frequency of patients diagnosed with DDH in daily clinical and outpatient clinic practices, we think that theoretical courses on the diagnosis, treatment and follow-up of DDH should be increased for intern physicians during orthopedics and traumatology internship and pediatrics internship in the undergraduate education of medical faculty.

According to our observations in the patient population diagnosed with DDH that we encounter as Kırıkkale University Faculty of Medicine Department of Orthopedics and Traumatology, the biggest problem related to DDH is the incorrect practices that are known to be correct in the society. It is observed that these practices are sometimes recommended to families by the physicians responsible for the treatment and follow-up of DDH. Again, based on our observations, the most common misleading recommendations among these practices are swaddling and the use of double diapers. We aimed to test the extent to which our physicians were aware of these misapplications in questions 9 and 12 of our questionnaire study. 71.4% correct response to the misapplication of swaddling in question 9 of our questionnaire study showed that our physicians were largely aware that swaddling is a risk factor. However, the 48.8% incorrect response to the double diaper misapplication in question 12 of our questionnaire study showed that there is a high level of misinformation in the physician group who will direct the diagnosis and treatment on this issue together with the society and that the level of knowledge on this subject should be increased with undergraduate and postgraduate in-professional trainings.

In question 6 of our questionnaire study, we wanted to question the knowledge that DDH is not a congenital disease and that it is a dynamic process that starts in the intrauterine period and continues in the postnatal period. 92.9% of the physicians who participated in the study stated that the sentence "All diseased babies are born with dislocated hips" contains a false statement. In questions 7 and 8 of our questionnaire study, we aimed to measure the level of knowledge of our physicians about the risk factors of DDH. The percentage of correct answers was high in both questions. However, the 47.6% incorrect answer percentage in question 8, in which we questioned the risk factor of polyhydramnios, revealed that the knowledge level of our physicians should be increased in terms of the risk factors of DDH. In addition, it is noteworthy that the highest percentage of incorrect answers in the 8th question of the questionnaire belonged to pediatric health and diseases specialist physicians with 80% and pediatric health and diseases research assistant physicians with 70%. We think that the knowledge level of pediatricians who question risk factors during initial examinations in neonatal outpatient clinics, especially in daily practice, should be increased with in-professional trainings.

With the 13th, 14th and 15th questions of our questionnaire study, we aimed to emphasize the importance of screening and early treatment of DDH and to measure the level of knowledge of our physicians on this subject. The high rate of correct answers to these questions showed that the level of knowledge of our physicians on this subject was sufficient. However, we think that the screening program implemented in our country should be explained in more detail to physician groups from all branches in order to reduce the rate of incorrect answers to lower rates. Considering that the universal screening program started in our country in 2013, we assume that our level of knowledge on this subject will increase even more in the following years.

In the 17th question of our questionnaire, we wanted to inquire to what extent the physicians concerned took responsibility for the treatment of patients diagnosed with DDH during DDH screening. In response to the question "How do you plan the treatment of patients diagnosed with DDH in your daily professional life?" 62.5% of the physicians who participated in the study answered "I refer the patient to the orthopedics and traumatology outpatient clinic for treatment". These results show that most of the physicians do not take an active role in starting conservative treatments, which constitute most of the treatment and the first step.

Limitations

There are some limitations in our study. We did not use any question pattern that would reveal the identity information of the participants, the institution they work for, their age and gender, and no information was collected. Participants were reached digitally and we did not have the chance to observe the participants while marking the questionnaire. For this reason, we were not able to determine the conditions under which the participants completed the survey and whether they reached the correct answers to the questions by using different sources. We think that this situation decreases the reliability rate of the survey. Orthopedic residents and specialists who play an active role in the treatment process of DDH, especially after the diagnosis, were not included in our study.

CONCLUSION

The diagnosis, treatment and follow-up of DDH is a process carried out jointly by multiple physician groups. Starting from the first examination of the patients in the neonatal period until the surgical intervention if necessary, the physician groups who will encounter patients diagnosed with DDH and who will organize the treatment should have sufficient knowledge about DDH. It is recommended that the knowledge deficiencies in different physician groups that emerged as a result of our study should be eliminated through undergraduate education and on-the-job trainings on related subjects. In addition, when the rate of not encountering patients diagnosed with DDH is considered, the result shows that practical applications about DDH should be included more in pediatric health and diseases internship and orthopedics and traumatology internship in the undergraduate education system. At this point, our medical faculty institutions that provide basic medical education are of great importance. We think that we need multidisciplinary studies and symposiums to be carried out in our educational institutions under the leadership of the Ministry of Health and our medical faculties.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Kırıkkale University Non-interventional Researches Ethics Committee (Date: 17.04.2024, Decision No: 2024.03.16).

Informed Consent

All participants signed and free and informed consent form in this study.

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. Wright J, James K. Developmental dysplasia of the hip. In: Paediatric Orthopaedics in Clinical Practice. London: Springer; 2016. p. 69-90.
2. Aronsson DD, Goldberg MJ, Kling TF Jr., Roy DR. Developmental dysplasia of the hip. *Pediatrics*. 1994;94(2 Pt 1):201-208.
3. Bilgili F, Sağlam Y. 0-6 ay çocuklarda gelişimsel kalça displazizi (GKD) tedavisi. *TOTBİD Derg.* 2014;13:396-402. doi:10.14292/totbid.dergisi.2014.45
4. Kulcu NU, Orak MM, Gerenli N, Sari E, Say A. The knowledge of pediatricians about developmental hip dysplasia in a training hospital. *J Curr Pediatr.* 2015;13(2):89-97.
5. Ortiz-Neira CL, Paolucci EO, Donnon T. A meta-analysis of common risk factors associated with the diagnosis of developmental dysplasia of the hip in newborns. *Eur J Radiol* 2012;81(3):344-351. doi:10.1016/j.ejrad.2011.11.003
6. Agarwal A, Gupta N. Risk factors and diagnosis of developmental dysplasia of hip in children. *J Clin Orthop Trauma* 2012;3(1):10-14. doi:10.1016/j.jcot.2011.11.001
7. Loh B, Woollett E. Update on the management of infant and toddler developmental dysplasia of the hip. *Aust J Gen Pract.* 2021;50(4):207-212. doi:10.31128/AJGP-07-20-5543
8. Sewell MD, Eastwood DM. Screening and treatment in developmental dysplasia of the hip-where do we go from here? *Int Orthop.* 2011;35(9):1359-1367. doi:10.1007/s00264-011-1257-z
9. Graf R. New possibilities for the diagnosis of congenital hip joint dislocation by ultrasonography. *J Pediatr Orthop.* 1983;3(3):354-359. doi:10.1097/01241398-198307000-00015
10. Balta O, Bilgiç E, Bostan B, Kurnaz R, Guneş T, Aytekin K. Redüksiyon sırasında yaşın gelişimsel kalça displazisi kapalı redüksiyon tedavisine etkisi. *Çağdaş Tıp Derg.* 2015;5(3):173-179. doi:10.16899/ctd. 49132
11. Lankinen V, Vuorinen RL, Helminen M, et al. Costs of abduction treatment in developmental dysplasia of the hip. Analysis of 900 patients. *Ann Med.* 2023;55(2):2290694. doi:10.1080/07853890.2023.2290694

12. Güner Şİ, Güner S. Gelişimsel kalça displazili çocuklarda tedavi yöntemleri. *Van Tıp Derg.* 2017;24(3):204-209. doi:10.5505/vtd.2017.38039
13. Zdravkovic N, Stojanovic S. Early diagnosis of developmental hip dysplasia in the district of Pirot, Serbia. *Med Biol.* 2004;11(1):26-30.
14. Uzel M, Ergun GU, Ekerbicer HC. The knowledge and attitudes of the primary care physicians on developmental dysplasia of the hip. *Saudi Med J.* 2007;28(9):1430-1434.
15. Melo TE, Resende TM, Silva RC, Cruz SA, Oliveira VM. Developmental dysplasia of the hip: do the responsible for screening know what to do? *Acta Ortop Bras.* 2016;24(6):312-317. doi:10.1590/1413-785220162406165319
16. Alshahrani KM, Alsiddiky A, Alamro SM, Alqarni AA. Assessing the level of DDH knowledge among parents in Riyadh city in Saudi Arabia. *Int Arch Integr Med.* 2018;5:141-149.
17. Kremli MK, Alshahid AH, Khoshhal KI, Zamzam MM. The pattern of developmental dysplasia of the hip. *Saudi Med J.* 2003;24(10):1118-1120.

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Does trigger point sensitivity affect proprioception? Effects of trigger point sensitivity in the upper trapezius muscle on proprioception

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ABSTRACT

Aims: Trigger points are classified into two types: active and latent. Both are commonly associated with muscle dysfunction and restricted range of motion. Active trigger points cause localized or referred pain, while latent trigger points elicit pain only upon palpation. This study was aimed to investigate the effects of trigger point sensitivity in the upper trapezius muscle on proprioception.

Methods: A total of 69 participants aged 18–40 years were included in this study and were divided into three groups: the control group (n=23), the active trigger point group (n=23), and the latent trigger point group (n=23). Sociodemographic data were collected from the participants, and cervical joint range of motion, neck functions and joint position errors in flexion, extension, and rotation movements were assessed. Cervical joint range of motion was evaluated using a universal goniometer. Neck function was assessed using the Neck Disability Index (NDI). Joint position errors in flexion, extension, and rotation movements were measured using a laser pointer repositioning test. All evaluations were performed by the same physiotherapist to ensure consistency.

Results: Significant differences were found between the groups in terms of cervical joint range of motion ($p<0.001$) and joint position errors ($p<0.001$), with the active trigger point group exhibiting the most pronounced impairments. Both the active and latent trigger point groups demonstrated higher joint position errors compared to the control group, with the active trigger point group showing the most severe dysfunctions.

Conclusion: The data indicate that trigger points, particularly active ones, negatively impact joint position sense, affecting movement and posture. Therefore, it is crucial to address trigger point sensitivity more frequently in clinical practice and future research, as it plays a critical role in pain and functional loss. The findings highlight the need for further studies investigating the effects of trigger points in different muscles and regions on proprioception.

Keywords: Position sense, trigger points, joint range of motion

INTRODUCTION

Myofascial trigger points are sensitive, palpable taut nodules within skeletal muscle fibers.[1] There are two types of trigger points: active and latent. Active trigger points cause constant pain in the region where they are located and/or in referred areas, and their presence is diagnostic of myofascial pain syndrome.[2] Latent trigger points, on the other hand, elicit pain upon palpation in their immediate or referred areas; unlike active trigger points, they only produce pain when stimulated.[3] Both latent and active myofascial trigger points have been associated with muscle dysfunction, weakness, and restricted range of motion.[2]

The cervical spine plays a critical role in determining the position of the head relative to the body and coordinates input from the vestibular and visual systems through a highly sensitive proprioceptive mechanism.[4] Pain in this region can disrupt proprioceptive signals by interfering with afferent input from proprioceptors, potentially resulting in faulty proprioceptive information. This misinformation can trigger prolonged reflex activation of neck muscles, eventually leading to neck pain and a vicious cycle of dysfunction.[4,5]

Studies have shown that proprioception is negatively affected in individuals diagnosed with cervical spondylosis, spondyloarthritis, idiopathic neck pain, and cervical disc herniation.[6-9]

Attention to proprioception in myofascial pain has increased with the discovery of fascial structures. It has been found that

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fascia, similar to the presence of trigger points, may transmit erroneous positional signals when under stress. Furthermore, due to its memory-like properties, this dysfunction may become persistent over time. Langevin, who emphasized the need to investigate the relationship between trigger point sensitivity and proprioception, served as an inspiration for the design of this study.[10]

To date, no studies have been found in the literature that specifically examine how proprioception is affected by the presence of trigger points, which are a major contributor to neck pain. Although individuals with active trigger points have been included in mechanical, idiopathic, or chronic neck pain groups, the presence of trigger points has not been specifically addressed in these studies. Since latent trigger points may also affect proprioception due to their similarities with active points in terms of palpation sensitivity, twitch response, and pain, this study aimed to compare cervical proprioceptive sense in healthy individuals, and those with active and latent trigger points. By classifying participants with active and latent trigger points under the heading of "trigger point sensitivity," this study is expected to contribute to the literature by revealing its impact on proprioception.

METHODS

Participants

Ethical approval was obtained from the Gazi University Ethics Committee (Date: 25.04.2024, Decision No: 2024-648), and written informed consent was collected from all participants. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The flowchart of the study is presented in Figure.

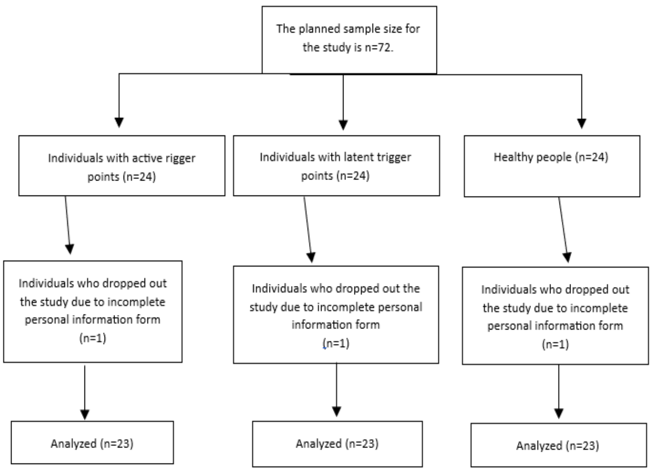

Figure. Flow chart

Between August 15 and September 15, 2024, a total of 69 individuals aged 18-40 years were recruited from the Physical Medicine and Rehabilitation outpatient clinic of Tokat State Hospital. The sample included 23 individuals with one or two active trigger points in the upper trapezius muscle, 23 individuals with latent trigger points, and 23 healthy volunteers.

The diagnosis of active trigger points was based on three widely accepted clinical criteria: point tenderness, referred pain, and local twitch response. Latent trigger points were defined as clinically silent regions that presented with tenderness and referred pain only upon stimulation.[11]

Healthy volunteers were recruited from among the relatives of patients and hospital staff who had provided informed consent. Individuals with vestibular, neurological, or inflammatory rheumatic diseases, as well as those with a history of cervical spine surgery, were excluded.

Sample size was calculated using the G*power software (Version 3.0.10, Universität Düsseldorf, Düsseldorf, Germany). Based on a referenced study, a minimum of 63 participants was required to achieve 80% power at a 0.05 significance level. Accounting for a potential 10% data loss, 72 individuals were enrolled in the study. Due to incomplete data from three participants, data from 69 individuals were analyzed.

Measurements

Personal Information Form: This form collected demographic and clinical data, including age, sex, body-mass index (BMI), dominant side, history of previous injuries or illnesses, and current medication use.

Neck Disability Index (NDI): The NDI, developed by Vernon and Mior, assesses the impact of neck pain on daily activities. Its Turkish validity and reliability were confirmed by Arslan et al.[12,13] NDI scores range from 0-4 (no disability), 5-14 (mild), 15-24 (moderate), 25-34 (severe), and ≥35 (complete disability).[14]

Cervical joint position error (JPE): Proprioceptive deficits were evaluated using the protocol developed by Revel et al.[15] A specially designed laser pointer (Tracker™ USA) was affixed to each participant's forehead. Participants were seated comfortably 90 cm from an A2-sized target paper placed at eye level.

The laser beam was calibrated to the Cartesian center point while the head was in the neutral position, defined as the zero position. All measurements were conducted with eyes closed. Each participant was given three practice trials for each movement direction (flexion, extension, right rotation, left rotation), which were excluded from data analysis. During the actual trials, participants returned to the zero position with eyes open before each test, then moved their head through the full range of motion at a comfortable pace and attempted to return as precisely as possible to the starting position. Each movement was performed six times. The distance (in centimeters) between the final laser position and the zero point was recorded and averaged. This average was defined as the 'absolute error'. To convert the error into degrees of deviation, the formula Arctan (absolute error/90) was used. The results were recorded as the "cervical joint position error."[16]

Cervical range of motion (ROM): A universal goniometer, a reliable and valid instrument, was used to assess cervical ROM.[17] While in a seated position, participants were tested for active cervical flexion, extension, right rotation, and left rotation. Normal ROM values were recorded in degrees.

Statistical Analysis

Mean, standard deviation, or frequency and percentage values were reported for sociodemographic data. Categorical variables were compared using Pearson's Chi-square test and Fisher's exact test. For numerical data, normally distributed variables were compared using One-Way ANOVA, while non-normally distributed variables were analyzed with the Kruskal-Wallis test. One-way ANOVA was used for parametric data analysis, and Kruskal-Wallis analysis was performed for non-parametric data. The significance level was set at p<0.05. Post-hoc analyses were conducted to determine the source of any significant differences.

RESULTS

The study included a total of 69 individuals, divided equally into three groups: those with active trigger points (n=23), those with latent trigger points (n=23), and healthy controls (n=23). The mean age of the participants was 27.75±5.46 years. The sociodemographic characteristics of 69 participants are presented in Table 1. Age, smoking history, gender, dominant side, and presence of musculoskeletal disorders in medical history were found to be similar between groups (p>0.05). However, a significant difference was detected in body-mass index values between the groups (p=0.02).

The cervical joint flexion, extension, right and left rotation measurement values of the groups are presented in Table 2. Flexion and extension values showed significant differences between the groups (p<0.001), (p=0.003); however, no significant differences were found between the right and left rotation values (p>0.05). Post hoc analyses revealed that the cervical joint flexion and extension values in the active trigger point group were statistically significantly lower than those in both the latent trigger point group (p=0.005) and the healthy control group (p<0.001), while no significant difference was observed between the latent trigger point group and the healthy control group (p>0.05).

Neck Disability Index total scores differed significantly among the groups. Post hoc analyses revealed that the active trigger point group had significantly higher scores than the latent trigger point group (p<0.001) and the healthy control group (p<0.001). Additionally, the latent trigger point group had significantly higher scores than the healthy control group (p=0.007) (Table 3).

The data related to cervical joint position errors for flexion, extension, and both rotation directions are presented in Table 4. Significant differences were found between groups in cervical joint position errors during flexion, extension, and rotation movements. Following post hoc analyses, the pairwise comparisons revealed the following findings for flexion, extension, right rotation, and left rotation: In flexion, significant differences were found between the active and latent trigger point groups (p=0.002), the active and healthy control groups (p<0.001), and the latent and healthy control groups (p=0.03). In extension, the active trigger point group had significantly higher position errors than both the latent trigger point group and the healthy control group (p<0.001 for both comparisons), while no significant difference was found

Table 1. Sociodemographic characteristics

		Control group n=23, X±SD	Active trigger point group n=23, X±SD	Latent trigger point group n=23, X±SD	p
Age (years)		25.57±5.58	31.13±7.62	26.57±6.72	p=0.059
BMI (kg/m²)		21.92±3.26	25.17±3.78	24.09±4.32	*p=0.025
Smoking history (pack-years)		1.02±4.14	1.00±2.58	1.39±3.88	p=0.539
		n (%)	**n (%)**	**n (%)**	
Gender	Women	16 (69.60)	20 (87)	17 (73.90)	p=0.347
	Men	7 (30.40)	3 (13)	6 (26.10)	
Dominant side	Right	20 (87)	21 (91.30)	21 (91.30)	p=0.853
	Left	3 (13)	2 (8.70)	2 (8.70)	
History of musculoskeletal disorders	Yes	4 (17.40)	3 (13)	4 (17.40)	p=0.897
	No	19 (82.60)	20 (87)	19 (82.60)	

The level of statistical significance was set at p<0.05. n: Number of participants. X: Mean. SD: Standard deviation, BMI: Body-mass index, *p-values were obtained using Kruskal-Wallis test

Table 2. Normal range of motion of the cervical joint

	Control group n=23, X±SD	Active trigger point group n=23, X±SD	Latent trigger point group n=23, X±SD	p	η2
Cervical joint flexion (degree)	77.04±10.55^a	59.78±11.12^b	73.35±17.17^a	*p<0.001	0.24
Cervical joint extension (degree)	66.74±9.95^a	55.22±14.80^b	66.43±12.30^a	**p=0.003	0.16
Cervical joint right rotation (degree)	76.70±10.14	73.04±17.49	75.09±11.40	p=0.933	0.01
Cervical joint left rotation (degree)	80.22±11.25	79.57±13.39	79.70±9.99	p=0.909	0.001

Statistical significance level was assumed to be p<0.05, n: Number of subjects, x: Mean, SD: Standard deviation, η^2= effect size measure indicating eta squared, a, b: Different letters indicate statistically significant differences. while similar letters indicate statistical similarity. *p-values were obtained using Kruskal Wallis test. Post hoc pairwise comparisons were performed using the Mann-Whitney U test, **p-values were obtained using one way ANOVA. Post hoc analysis was performed using the Tukey HSD test

Table 3. Neck Disability Index points

	Control group n=23, X±SD	Active trigger point group n=23, X±SD	Latent trigger point group n=23, X±SD	p	η^2
Neck Disability Indexes total point	1.65±1.49^a	15.65±4.74^b	4.65±4.33^a	p<0.001*	0.72

Statistical significance level was assumed to be p<0.05, n: Number of subjects, x: Mean, SD: Standard deviation, η^2= effect size measure indicating eta squared, a. b: Different letters indicate statistically significant differences. while similar letters indicate statistical similarity

Table 4. Cervical joint position error test results

	Control group, n=23, X±SD	Active trigger point group, n=23, X±SD	Laten trigger point group, n=23, X±SD	p	η2
Flexion (⁰)	2.38±0.92ᵃ	4.66±1.52ᵇ	3.32±1.30ᶜ	p<0.001*	0.35
Extension (⁰)	2.65±1.01ᵃ	5.59±2.37ᵇ	3.11±1.11ᵃ	p<0.001*	0.39
Right rotation (⁰)	2.71±0.90ᵃ	5.30±2.16ᵇ	3.93±1.77ᶜ	p<0.001*	0.28
Left rotation (⁰)	2.70±1.27ᵃ	5.26±2.48ᵇ	3.74±1.45ᶜ	p<0.001*	0.25

p<0.05. Statistical significance level was assumed to be p<0.05. ⁰: Degree, η^2= Effect size measure indicating eta squared, n: Number of subjects, X: Mean, SD: Standard deviation, a, b, c: Different letters indicate statistically significant differences. while similar letters indicate statistical similarity

between the latent trigger point and healthy control groups (p>0.05). In right rotation, significant differences were found between the active and latent trigger point groups (p=0.023), the active and healthy control groups (p<0.001), and the latent and healthy control groups (p=0.045). In left rotation, significant differences were found between the active and latent trigger point groups (p=0.016), the active and healthy control groups (p<0.001), and the latent and healthy control groups (p=0.003).

In summary, post hoc analyses showed that position errors in flexion and both rotation directions differed significantly between all pairwise group comparisons (p<0.05). In extension, the active trigger point group had significantly higher position errors compared to the other two groups (p<0.05), while no significant difference was found between the latent trigger point group and the healthy control group (p>0.05).

DISCUSSION

This study aimed to evaluate the impact of active and latent myofascial trigger points on cervical proprioception. The findings revealed that individuals with trigger points-both active and latent-exhibited significantly greater cervical joint position error (JPE) and decreased range of motion (ROM) compared to healthy individuals.

While prior research has examined proprioceptive deficits in individuals with idiopathic neck pain, cervical spondylosis, or disc herniation, to our knowledge, this is the first study that specifically evaluates proprioceptive sense in relation to trigger point sensitivity.[6-9]

The results showed that the active trigger point group had significantly higher JPE values in flexion, extension, and left rotation compared to both the latent and healthy groups, consistent with the hypothesis that increased pain and muscle tension from active trigger points may interfere with proprioceptive feedback.[2] The presence of significant JPE values in the latent group as well suggests that even subclinical trigger points can affect joint position sense.

Interestingly, no significant difference was observed in JPE during right rotation. One possible explanation is that the affected side may have been the right side in a significant portion of the participants, causing the head to return more easily to the right due to motor preference or familiarity. This hypothesis could be further explored in future studies by stratifying trigger point locations by side.

In terms of ROM, the reduced movement in the active trigger point group aligns with existing literature, which attributes limited cervical mobility to muscle stiffness, pain avoidance behavior, and tissue sensitivity.[2,19-21] The latent group also exhibited decreased ROM, suggesting that even in the absence of spontaneous pain, muscle tightness associated with latent trigger points can limit mobility.

Another important outcome was the variation in disability levels among the groups. Based on the NDI, no disability was observed in the healthy group, while the latent group showed mild disability and the active group showed moderate disability. These results are consistent with Martín-Sacristán et al.[22] and other studies that found moderate disability in individuals with active MTrPs and no reported disability in healthy subjects.[23] In populations with more severe underlying conditions-such as whiplash-associated disorders-MTrPs often coexist with moderate to severe disability, as reported in several studies.[24-26]

The role of fascial structures in proprioceptive regulation has gained increasing attention in recent years. Myofascial dysfunction may alter the quality and quantity of sensory input, contributing to impaired joint position sense.[10] The fact that proprioception was impaired even in the latent trigger point group supports this emerging view.

Limitations

This study has some limitations. First, it only included individuals aged 18-40, limiting generalizability to older populations. Second, only the upper trapezius muscle was evaluated; future studies could include other muscles with high trigger point prevalence. Finally, while a laser-based method was used for JPE measurement, other tools such as 3D motion analysis could provide more precise data.

CONCLUSION

This study showed that trigger point sensitivity, especially when active, impairs cervical joint position sense and reduces neck function. These findings highlight the importance of including trigger point assessment in clinical evaluations of cervical proprioception. Addressing trigger points during rehabilitation may help improve sensorimotor control and reduce the risk of recurrent neck pain.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Gazi University Ethics Committee (Date: 25.04.2024, Decision No: 2024-648).

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 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. Hong CZ. Pathophysiology of myofascial trigger point. *J Formos Med Assoc*. 1996;95(2):93-104.
2. Shah JP, Thaker N, Heimur J, Aredo JV, Sikdar S, Gerber L. Myofascial trigger points then and now: a historical and scientific perspective. *PM R*. 2015;7(7):746-761. doi:10.1016/j.pmrj.2015.01.024
3. César FDLP, Jan D. International consensus on diagnostic criteria and clinical considerations of myofascial trigger points: a Delphi study. *Pain Med*. 2018;19(1):142-150. doi:10.1093/pm/pnx207
4. Peng B, Yang L, Li Y, Liu T, Liu Y. Cervical proprioception impairment in neck pain-pathophysiology, clinical evaluation, and management: a narrative review. *Pain Ther*. 2021;10(1):143-164. doi:10.1007/s40122-020-00230-z
5. Holm S, Indhal A, Solomonow M. Sensorimotor control of the spine. *J Electromyogr Kinesiol*. 2002;12(3):219-234. doi:10.1016/s1050-6411(02)00028-7
6. Ozen T, Tonga E, Polat MG, Bayraktar D, Akar S. Cervical proprioception accuracy is impaired in patients with axial spondyloarthritis. *Musculoskelet Sci Pract*. 2021;51,102304. doi:10.1016/j.msksp.2020.102304
7. Reddy RS, Tedla JS, Dixit S, Abohashrh M. Cervical proprioception and its relationship with neck pain intensity in subjects with cervical spondylosis. *BMC Musculoskelet Disord*. 2019;20(1):447. doi:10.1186/s12891-019-2846-z
8. Stanton TR, Leake HB, Chalmers KJ, Moseley GL. Evidence of impaired proprioception in chronic, idiopathic neck pain: systematic review and meta-analysis. *Phys Ther*. 2016;96(6):876-887. doi:10.2522/ptj.20150241
9. Doita M, Sakai H, Harada T et al. The influence of proprioceptive impairment on hand function in patients with cervical myelopathy. *Spine (Phila Pa 1976)*. 2006;31(14):1580-1584. doi:10.1097/01.brs.0000222034.78210.43
10. Langevin HM. Fascia mobility, proprioception, and myofascial pain. *Life (Basel)*. 2021;11(7):668. doi:10.3390/life11070668
11. Li L, Stoop R, Clijsen R, et al. Criteria used for the diagnosis of myofascial trigger points in clinical trials on physical therapy: updated systematic review. *Clin J Pain*. 2020;36(12):955-967. doi:10.1097/AJP.0000000000000875
12. McCarthy MJH, Grevitt MP, Silcocks P, Hobbs G. The reliability and validity of the Vernon and Mior Neck Disability Index (NDI). In orthopaedic proceedings. *Bone Joint*. 2012;94:86.
13. Aslan E, Karaduman A, Yakut Y, Aras B, Simsek IE, Yaglý N. The cultural adaptation, reliability and validity of neck disability index in patients with neck pain: a Turkish version study. *Spine (Phila Pa 1976)*. 2008;33(11):362-365. doi:10.1097/BRS.0b013e31817144e1
14. Lemeunier N, da Silva-Oolup S, Olesen K, et al. Reliability and validity of self-reported questionnaires to measure pain and disability in adults with neck pain and its associated disorders: part 3-a systematic review from the CADRE Collaboration. *Eur Spine J*. 2019;28(5):1156-1179. doi:10.1007/s00586-019-05949-8
15. Revel M, Andre-Deshays C, Minguet M. Cervicocephalic kinesthetic sensibility in patients with cervical pain. *Arch Phys Med Rehabil*. 1991;72(5):288-291.
16. Roren A, Mayoux-Benhamou MA, Fayad F, Poiraudeau S, Lantz D, Revel M. Comparison of visual and ultrasound based techniques to measure head repositioning in healthy and neck-pain subjects. *Man Ther*. 2009;14(3):270-277. doi:10.1016/j.math.2008.03.002
17. Adegoke BOA, Offiah MN, Okoye EC, Akosile CO. Intra-Rater reliabilities and concurrent validity of the universal goniometer and tape measure for measuring cervical active range of motion *J Musculoskelet Res*. 2015;18(01):1550005. doi:10.1142/S0218957715500050
18. Lluch E, Nijs J, De Kooning M, et al. Prevalence, incidence, localization, and pathophysiology of myofascial trigger points in patients with spinal pain: a systematic literature review. *J Manip Physiol Ther*. 2015;38(8):587-600. doi:10.1016/j.jmpt.2015.08.004
19. Simons DG, Travel JG, Simons LS. Myofascial Pain and Dysfunction: the Trigger Point Manual (Vol. 1) The Upper Half of Body, 2nd Edition. Baltimore: Lippincott Williams & Wilkins; 1999.
20. Liu C, Wang Y, Yu W, Xiang J, Ding G, Liu W. Comparative effectiveness of noninvasive therapeutic interventions for myofascial pain syndrome: a network meta-analysis of randomized controlled trials. *Int Surg J*. 2024;110(2):1099-1112. doi:10.1097/JS9.0000000000000860
21. Mejuto-Vázquez MJ, Salom-Moreno J, Ortega-Santiago R, Truyols-Domínguez S, Fernández-de-Las-Peñas C. Short-term changes in neck pain, widespread pressure pain sensitivity, and cervical range of motion after the application of trigger point dry needling in patients with acute mechanical neck pain: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2014;44(4):252-260. doi:10.2519/jospt.2014.5108
22. Martín-Sacristán L, Calvo-Lobo C, Pecos-Martín D, Fernández-Carnero J, Alonso-Pérez JL. Dry needling in active or latent trigger point in patients with neck pain: a randomized clinical trial. *Sci Rep*. 2022;12(1):3188. doi:10.1038/s41598-022-07063-0
23. Muñoz-Muñoz S, Muñoz-García MT, Alburquerque-Sendín F, Arroyo-Morales M, Fernández-de-las-Peñas C. Myofascial trigger points, pain, disability, and sleep quality in individuals with mechanical neck pain. *J Manip Physiol Ther*. 2012;35(8):608-613. doi:10.1016/j.jmpt.2012.09.003
24. Fernández-Pérez AM, Villaverde-Gutiérrez C, Mora-Sánchez A, Alonso-Blanco C, Sterling M, Fernández-de-Las-Peñas C. Muscle trigger points, pressure pain threshold, and cervical range of motion in patients with high level of disability related to acute whiplash injury. *J Orthop Sports Phys Ther*. 2012;42(7):634-641. doi:10.2519/jospt.2012.4117
25. Castaldo M, Ge HY, Chiarotto A, Villafane JH, Arendt-Nielsen L. Myofascial trigger points in patients with whiplash-associated disorders and mechanical neck pain. *Pain Med*. 2014;15(5):842-849. doi:10.1111/pme.12429
26. Tough EA, White AR, Richards SH, Campbell JL. Myofascial trigger point needling for whiplash associated pain-a feasibility study. *Man Ther*. 2010;15(6):529-535. doi:10.1016/j.math.2010.05.010

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Case Report

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Post-operative complications and rehabilitation challenges following total knee replacement: a case report

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ABSTRACT

Total knee replacement (TKR) is a widely performed surgical procedure for advanced osteoarthritis (OA), aimed at relieving pain and restoring joint function. However, post-operative complications, including persistent pain, joint stiffness, and poor adherence to rehabilitation protocols, can impair functional recovery and quality of life. This case report describes a 56-year-old female, Mrs. Valarmathi, who presented with persistent right knee pain, stiffness, and mobility limitations following a TKR performed for severe OA. Clinical evaluation revealed reduced range of motion, muscle weakness, altered gait mechanics, kinesiophobia, and moderate depressive symptoms. Despite structured physiotherapy interventions involving cryotherapy, TENS, passive and active mobilization, and strengthening exercises, the patient's progress was hindered by poor home program compliance. Subsequent development of a suspected joint infection requiring aspiration further complicated her recovery. The case highlights the multifactorial challenges in post-TKR rehabilitation, including musculoskeletal impairments, psychosocial barriers, and lack of patient adherence. Early physiotherapy, patient education, psychological support, and close follow-up are essential to prevent complications and enhance functional outcomes. This case underscores the importance of a comprehensive, multidisciplinary approach to TKR rehabilitation. Patient education and adherence to home exercises are critical to optimizing recovery and preventing avoidable setbacks.

Keywords: Total knee replacement, osteoarthritis, rehabilitation, physiotherapy, case report, kinesiophobia, postoperative complications

INTRODUCTION

Osteoarthritis (OA) is a chronic, progressive joint disorder that predominantly affects synovial joints, leading to the deterioration of articular cartilage, subchondral bone remodeling, synovial inflammation, and structural damage to surrounding tissues such as ligaments, menisci, and periarticular muscles. While traditionally considered a degenerative consequence of aging and mechanical "wear and tear," current research highlights a multifactorial etiology involving genetic predisposition, biomechanical stress, joint injuries, metabolic imbalances, and chronic inflammation driven by proinflammatory mediators.[1] OA primarily targets heavily used, weight-bearing joints such as the knees, hips, spine, and hands, presenting clinically with joint pain, stiffness, and limited mobility that worsen with activity and may persist at rest in advanced stages. Diagnosis is mainly clinical, supplemented by radiologic evaluation, although imaging findings may not always align with symptom severity. Key risk factors include aging, obesity, joint trauma, and uneven mechanical loading. Socioeconomic and racial disparities also influence OA prevalence, severity, and access to care. With no definitive cure or disease-modifying treatments available, initial management emphasizes non-surgical interventions like weight reduction, physical therapy, and pharmacological pain relief. Surgical approaches such as arthroplasty are reserved for cases unresponsive to conservative care.[2]

PREVALENCE

Knee OA is a growing public health concern in India, with prevalence rates varying significantly across regions due to demographic, lifestyle, and environmental factors. Nationwide, community-based studies estimate that approximately 28.7% of adults suffer from knee OA, with rural South India showing even higher rates-up to 34.6% among individuals aged 40 and above.[3] Urban populations, particularly the elderly, are at increased risk, with some reports indicating prevalence as high as 41.1%.[4] In Tamil Nadu, the burden remains substantial; for instance, a study in the rural areas of Kanchipuram district reported a knee OA prevalence of 27.1%, closely mirroring findings from other parts of the state. Notably, older women exhibit higher susceptibility.[5] In Puducherry, the situation appears more

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severe among the urban elderly, where a striking 56.6% were found to have knee OA.[6] However, studies conducted in clinical settings, such as tertiary care hospitals, suggest a more conservative estimate of around 19.6%, likely due to methodological differences.[7] These findings underscore the regional variability in OA prevalence and highlight the need for targeted public health interventions and improved access to early diagnosis and conservative management strategies.

TOTAL KNEE REPLACEMENT

Arthroplasty, or joint replacement surgery, is usually recommended when other treatments no longer ease joint pain or disability, especially in cases like osteoarthritis. Before considering surgery, doctors may try options such as pain and anti-inflammatory medications, physical therapy, cortisone or lubrication injections, activity modification, walking aids, exercise, and weight loss. People who undergo arthroplasty often experience significant relief from joint pain, improved movement, and better quality of life.[1] The most commonly replaced joints are the hip and knee, though the shoulder, elbow, ankle, and fingers can also be treated.[8]

Total knee replacement (TKR), also known as total knee arthroplasty (TKA), is a surgical procedure in which the damaged or degenerated surfaces of the knee joint are replaced with artificial implants to relieve pain and restore mobility. It is most commonly performed in patients suffering from advanced osteoarthritis or other debilitating joint conditions that have not responded to conservative treatments.[9] In recent years, India has witnessed a significant rise in the number of TKR procedures, with approximately 70,000 joint replacements conducted annually, a large portion of which are knee surgeries. This surge reflects both the increasing burden of osteoarthritis and improvements in surgical techniques and healthcare accessibility. In Tamil Nadu, data from the Chief Minister's Comprehensive Health Insurance Scheme (CMCHISTN) between January 2017 and July 2021 revealed that 20,165 TKR surgeries were performed-1,420 in government hospitals and 18,745 in private institutions-highlighting the growing demand for knee replacement in the state.[10] Although specific statistics for Puducherry are limited, the region's aging population and the availability of specialized orthopaedic services suggest a parallel upward trend in TKR procedures. This increasing reliance on surgical intervention underscores the need for early diagnosis, preventive strategies, and comprehensive post-operative care to improve patient outcomes.

LACK OF KNOWLEDEGE ABOUT THE REHABILITATION AFTER THE SURGERY

In rural areas, the situation is exacerbated by limited access to physiotherapy services and a shortage of trained professionals, resulting in delayed or inadequate rehabilitation for orthopedic patients.[11] This skepticism can hinder collaborative care and delay the initiation of essential rehabilitation protocols. The cumulative effect of these factors underscores the urgent need for educational initiatives targeting both healthcare providers and patients to enhance the understanding and integration of physical rehabilitation in orthopedic care.

CASE DESCRIPITION

Mrs. Valarmathi, a 56-year-old female with a history of right TKR for severe osteoarthritis, presents with persistent anterior knee pain, stiffness, and functional limitations. Clinical assessment reveals reduced active and passive range of motion, particularly in knee flexion and extension. Muscle strength testing shows bilateral lower limb weakness (notably in quadriceps and gluteal), with associated muscle tightness in the quadriceps, hamstrings, gastrocnemius, and ilio-tibial band. Gait analysis shows compensatory mechanisms such as hip hiking, circumduction, and forward trunk lean, indicating impaired dynamic stability and limited knee flexion during swing phase. Sensory function remains intact, but postural assessment indicates pelvic tilt, spinal misalignment, and gluteal atrophy, suggesting core and hip involvement. The presence of kinesiophobia (Tampa score: 40) and moderate depressive symptoms (PHQ-9: 9) highlight psychosocial barriers that may impede rehabilitation. Collectively, these findings suggest a multifactorial dysfunction involving musculoskeletal impairment, altered biomechanics, and psychological factors, requiring a comprehensive, phased management approach.

CHIEF AND PAST MEDICAL HISTORY

A 56-year-old female patient presented on November 5/2024 with complaints of persistent pain in the right knee following a TKR procedure performed on October 3, 2024, at a government Hospital in Puducherry, Since the surgery, she has experienced significant difficulty with knee flexion and extension, as well as problems with walking and performing daily activities. The patient reported that prior to the TKR; she had been using Ayurvedic medications for pain relief due to severe OA in the right knee. X-Ray findings also indicate early signs of OA in the left knee. Her medical history is notable for Diabetes Mellitus and BP, which she has had for the past potentially contributing to delayed post-surgical recovery.

PAIN ASSESSMENT

- **Duration of symptoms:** Chronic
- **Mode of onset:** Gradual
- **Location of pain:** Anterior aspect of the knee
- **Radiation:** No shooting pain down the leg
- **Depth of pain:** Deep
- **Quality/type of pain:** Stabbing
- **Symptom pattern:** Constant
- **Consistency of pain:** Present for hours
- **Severity of pain:** Non-tolerable
- **Time of occurrence:** Both day and night time
- NPRS
- **At best:** 4
- **At worst:** 8
- **Aggravating factors:** While bending the knee
- **Relieving factors:** While applying cryotherapy and rhythmic oscillation of knee
- **Pain affects the mood:** Yes
- **Mood:** Depressed

ON OBSERVATION

- **Attitude of limb:** Right leg slightly externally rotated.
- **Surgical scar:** Present (1 cm, anterior aspect of knee).
- **Skin tone:** Vascular changes/chronic inflammatory.

- **Gait pattern:** Stiff knee gait (right side).
- **Knee position:** Right knee appears to be flexed throughout the gait cycle, particularly during the stance phase.

  → in-complete knee extension during stance phase reduces weight acceptance on that limb.
- **Step length:** Step length is shortened on the affected side.
- **During swing phase:** Patient does not achieve enough knee flexion.

  → Compensation may be required to clear the limb, such as hip hiking and trunk leaning.
- **Weight bearing:** Patient is guarding the right leg due to pain.
- **Trunk & uppebody:** Slight bend forward in order to maintain balance. → Reduced arm swing in upper body

Clinical Implication

- Reduced gait efficiency → higher energy cost during walking (Figure 1, 2).


Figure 1. On observation from superior view of knee


Figure 2. On observation lateral aspect of knee

ON PALPATION

- **Swelling present:**
  - **Right:** 18 cm
  - **Left:** 15 cm
  - → Significantly swollen. Indicates fluid retention/ inflammation → restricts knee movement.
- **Tone/spasm:**
  - Protective spasm (↑)
  - Hamstring & quadriceps may be tight
- **Tenderness:**
  - Grade III

On examination (Table):

Table. Motor assessment

Muscle group	Right	Left
Knee		
Quadriceps (ext)	3/5	3/5
Hamstring (flex)	3/5	3/5
Hip		
Gluteus maximus (ext)	3/5	3/5
Gluteus medius (abd)	3/5	3/5
Gluteus minimus	3/5	3/5
Internal & external rotators	3/5	3/5
Ankle-DF/PF	3/5	3/5

Muscle tightness (right leg):

- **Muscles involved:**
  - Quadriceps, hamstring, gastrocnemius, ilio tibial band, hip flexors
- **End-feel:**
  - Firm (knee flexion) due to soft tissue tightness
  - Quadriceps restriction
  - **Knee extension:** Hamstring restriction
- **Patellar mobility:**
  - Reduced due to soft tissue tightness

Trick movement (hip hiking):

- Patient lifts the limb by raising the pelvis on the opposite side to help clear the ground
- **Reason:** Limited knee flexion; reduced foot clearance → compensatory lift of leg

Circumduction gait:

- Patient swings the affected leg outwards in a semi-circular motion instead of lifting it straight forward
- **Reason:** Knee flexion is inadequate → makes straight leg swing difficult

Vaulting (on the opposite limb):

- The unaffected limb plantar flexes excessively to allow the affected leg to clear the ground

- **Reason:** Affected knee is stiff, so patient raises the heel of the unaffected leg to compensate

Forward trunk lean (during stance phase):

- Patient leans forward
- **Reason:** Helps shift body weight; demand dependence

Reduced Step Length:

- Step on the affected limb is shorter than normal
- **Reason:** Fear of weight-bearing, pain, stiffness
  → Limits normal stride

Capsular pattern:

- Post-surgical fibrosis/adhesion in the knee joint capsule

Type of muscle contraction causing movement problems:

- Both concentric and eccentric contraction of muscles are affected

Sensory assessment:

Dermatome assessment:

- L3, L4 (bilateral) → Normal

Sensory tests:

- Light touch-normal
- Pinprick test-normal
- Vibration test-normal
- 2-point discrimination-normal
- Pain, temperature-preserved

Kinesiophobia:

- Present
- Use of Tampa Scale for measurement

Postural assessment:

Anterior view (ant view):

- Pelvic tilt/shift due to weight distribution or muscle imbalance
- **Knee:** Bow legs (both)
- **Foot:** Excess supination
- Uneven shoulders
- ↓ Arm & body chain

Lateral view (lat view):

- Trunk alignment-forward lean
- Knee joint-slight knee flexion
- **Ankle/toe:** Weak dorsiflexion

Posterior view (post view):

- Pelvic asymmetry
- Hip hiking present
- Spinal alignment-postural scoliosis
- Gluteal atrophy
- Uneven shoulders

Balance (static & dynamic):

- **Timed up & go test:** Slow & unsteady gait
- **SLS (single leg stance):** Difficult, ↓ 30 seconds

Coordination (non-equilibrium):

- Heel to shin test
- **Foot tapping:** Slow

Investigation:

- **X-Ray:** Shows TKR (total knee replacement) fitting properly (**Figure 3**).

Figure 3. After the procedure of TKR on the right knee

TKR: Total knee replacement

Functional assessment:

- **FIM (functional independence measure):**
  - **Motor:** 55
  - **Cognitive:** 27
  - **Total score:** 82
  - → (Moderate dependence)

Clinical scores:

- **Tampa score:** 40
- **Depression score (PHQ-9):** 9 (moderate)

Medical diagnosis: OA knee grade 4 (Kellegren And Lawrence)

- **Surgical procedure:** Total knee arthroplasty
- **TKR complication:** Post surgical chronic pain

PHYSIOTHERAPY DIAGNOSIS

Tibiofemoral Hypomobility

Patient presents with post-operative tibiofemoral hypomobility syndrome (TFHypo) following TKR, characterized by restricted knee flexion beyond 45 degrees, deep joint pain during weight-bearing, joint stiffness, swelling, capsular tightness, diminished patellar mobility, and protective muscle spasms, culminating in moderate functional dependence (FIM score: 82). Secondary features align with tibiofemoral rotation with valgus (TFRVal) syndrome, including valgus knee alignment, gluteal weakness, increased hip internal rotation, dynamic instability, gait compensations such as hip hiking and trunk lean, and tightness in the ilio -tibial band, quadriceps, and hamstrings. Psychosocial factors, notably kinesiophobia and depression, further exacerbate movement avoidance and valgus loading patterns. This complex interplay of mechanical and psychosocial impairments underscores the necessity for a comprehensive rehabilitation approach addressing both joint mobility and alignment to optimize functional recovery.

Management

Short-term goals:

- Reduce pain & stiffness
- Initiate knee ROM
- Improve quadriceps strength
- Improve balance & weight shifting
- Correct gait pattern

Long-term goals:

- Achieve functional knee ROM
- Normalize gait pattern
- Improve lower limb strength
- Enhance dynamic balance
- Regain functional independence
- Reduce kinesiophobia
- Improve psychological well-being

Treatment

Physiotherapy and pharmacotherapy

Pain management:

- Cryotherapy (5 to 10 minutes)
- TENS (Burst mode, frequency:100 to 125 HZ)
- Grades I and II (knee and patella) mobilizations are specifically designed for pain management. Grade I involves small amplitude, rhythmic oscillations at the beginning of the available joint range, primarily targeting pain relief without provoking symptoms. Grade II consists of larger amplitude oscillations within the midrange of joint movement, also aimed at alleviating pain without reaching the joint's end range.

Knee ROM goals:

- Wax therapy-3 pad method: dip and wrap
- Passive-assisted knee flexion
- Heel slides
- Hold and contact relax technique
- Movement with mobilization for flexion and extension glides (Figure 4).

Stretching:

- Low load sustained stretching are performed for hamstring, quadriceps
- Hamstring
- Gluteal
- Calf
- Ilio-tibial band

Figure 4. Tens application for pain

Balance & coordination:

- Single leg stance
- Foam surface weight shifting

Strength training:

- Quads (Isometrics)
- SLR (Straight Leg Raise)
- Seated knee extensions
- Gluteal bridges long arc
- Clamshell
- Prone knee extension
- Marching the hips
- Calf raises
- Plantar flexor, dorsiflexors, invertors and evertors strengthening with Theraband
- Swiss ball kicking

Functional activities:

- Kneel sitting
- Quadruped position
- Kneeling
- Cross sitting to normal position

Gait training:

- Weight shifting drills
- Pillar bar walking
- Stair climbing

DISCUSSION

The patient initially arrived at the physiotherapy department in a wheelchair. She had been referred by the orthopedic doctor, who recommended the use of Continuous Passive Motion (CPM) therapy along with knee strengthening exercises. The exact range of knee flexion was unknown, as the surgery had been performed in a government hospital and detailed surgical records, including information about the prosthetic components used, were not available. Therefore, CPM therapy was initiated with a starting range of 0–40 degrees for the first two days. Initially, the patient experienced significant fear and reluctance to mobilize the leg using CPM, as uncontrolled knee flexion exacerbated the pain. As a result, CPM was not introduced in the early stages of rehabilitation. Instead, wax therapy was employed to help reduce joint adhesions and improve mobility, facilitating easier passive mobilization of the knee joint. Following wax therapy, passive mobilization techniques, specifically anterior, posterior & patellar gliding, were performed, along with exercises within a range of 0-45 degrees. Initially, the patient's range of motion was limited to 0-5 degrees. After initial sessions, the patient began to complain of pain during mobilization beyond 45 degrees of knee flexion. To manage this, ultrasound therapy for scar mobilization and transcutaneous electrical nerve stimulation (TENS) for pain relief were initiated. Passive mobilization was discontinued, and the patient was encouraged to perform active knee flexion exercises. Functional positions such as transitioning from quadruped to kneeling and knee sitting were practiced. From the edge of the couch, the patient was guided to fall backward, allowing the legs to move freely off the table while performing medial and lateral active gliding movements with mobilization techniques. Low-sustained stretching techniques were introduced.

Knee strengthening exercises included both static and dynamic quadriceps activation. In long sitting, the patient performed static quadriceps contractions by pressing down on a foam roller placed under the knee. Dynamic strengthening included short arc exercises in the supine position with a weight cuff, as well as exercises in high sitting. In prone lying, a pillow was placed under the leg for pressing exercises. The patient also practiced transitioning from cross-sitting to an extended position. Hamstring strengthening was carried out in the prone position using a Theraband and weight cuffs. Dorsiflexors and plantarflexors, as well as invertors and evertors, were trained. For hip strengthening, standing marching exercises with weight cuffs were performed, along with clamshell exercises for the hip abductors. Gluteus maximus strengthening was achieved through prone straight leg raises. Weight-bearing activities were introduced, such as kicking a ball with the unaffected leg to encourage weight bearing on the affected side. The patient was also trained in stair climbing and eccentric control. Balance and coordination exercises included single-leg standing, closed-stance standing with eyes open and closed, and tandem walking. The treatment sessions continued; however, after a few days, there was no improvement in knee flexion beyond 45 degrees. Upon inquiry, the patient admitted to not following the prescribed exercise program at home, which became a major setback in her recovery. She also reported experiencing severe pain at night. Later, she returned with a noticeable bulge over the anterior aspect of the knee, which appeared to be an infection, as it was accompanied by pus formation. It was revealed that, instead of adhering to the exercise regimen, she had been frequently applying hot and cold packs at home to manage the pain. Subsequently, she underwent aspiration of the pus at the hospital. After this procedure, she did not return for further physiotherapy sessions.

However, following the treatment, there was noticeable improvement. The patient's psychological well-being was also significantly affected, as she was unable to perform daily activities that she could before the surgery. To address this, we provided psychological support to enhance the treatment outcomes and achieve better results in rehabilitation.

FEAR OF MOVEMENT AND PAIN LEAD TO POOR TREATMENT OUTCOMES

It is shown in **Figure 5**.

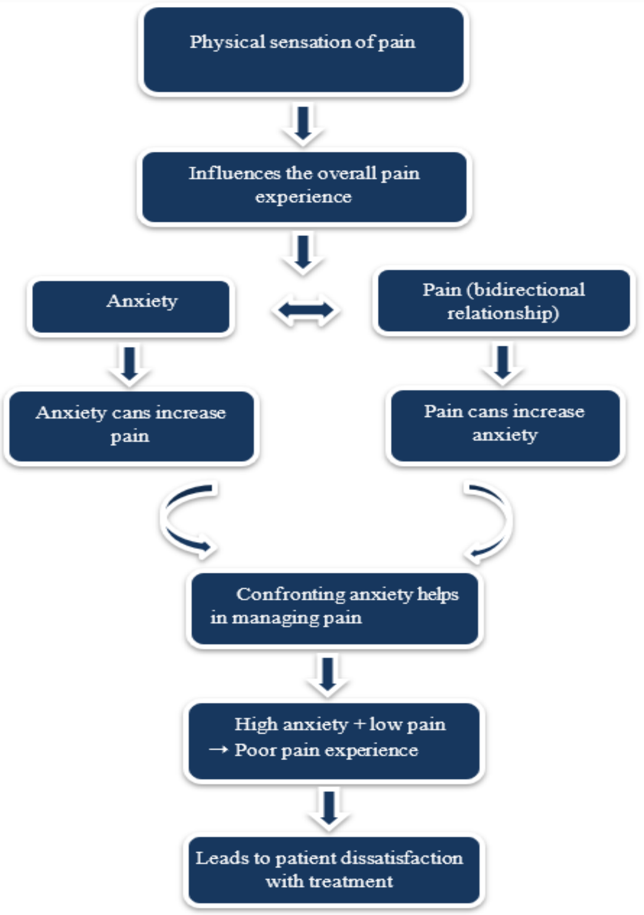

Figure 5. Fear of movement

CONCLUSION

This case underscores the importance of a comprehensive, pre-operative measures& multidisciplinary approach to TKR rehabilitation. Patient education and adherence to home exercises are critical to optimizing recovery and preventing avoidable setbacks

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. Lane NE, Brandt K, Hawker G, et al. OARSI-FDA initiative: defining the disease state of osteoarthritis. *Osteoarthritis Cartilage*. 2011;19(5):478-482. doi:10.1016/j.joca.2010.09.013
2. Shtroblia V, Petakh P, Kamyshna I, Halabitska I, Kamyshnyi O. Recent advances in the management of knee osteoarthritis: a narrative review. *Front Med (Lausanne)*. 2025;12:1523027. doi:10.3389/fmed.2025.1523027
3. Pal CP, Singh P, Chaturvedi S, Pruthi KK, Vij A. Epidemiology of knee osteoarthritis in India and related factors. *Indian J Orthop*. 2016;50(5): 518-522. doi:10.4103/0019-5413.189608
4. Kandasamy S, Vadivelu R, Shanmugam SK, Mahendran BS. Exploring the burden of knee osteoarthritis in rural South India: community prevalence, risk factors, and functional assessment among adults aged 40 and above. *Cureus*. 2024;16(11):e73452. doi:10.7759/cureus.73452
5. Venkatachalam J, Natesan M, Eswaran M, Johnson AKS, Bharath V, Singh Z. Prevalence of osteoarthritis of knee joint among adult population in a rural area of Kanchipuram District, Tamil Nadu. *Indian J Public Health*. 2018;62(2):117-122. doi:10.4103/ijph.IJPH_344_16
6. Vijayaragavan R, Thirugnanasambanthan S, Vincent A. Prevalence of osteoarthritis according to modified ACR and EULAR 2009 among patients attending orthopaedics department in a tertiary care hospital, Puducherry. *J Med Sci Clin Res*. 2021;6:10.
7. Nash WJ, Al-Nammari S, Khan WS, Pengas IP. Surgical management of the forefoot in patients with rheumatoid arthritis-a review article. *Open Orthop J*. 2015;9:78-83. doi:10.2174/1874325001509010078
8. Londhe SB, Shah RV, Doshi AP, Upasani T, Antao N, Agrawal G. What do patients want out of their total knee arthroplasty?: An Indian perspective. *J Clin Orthop Trauma*. 2022;25:101761. doi:10.1016/j.jcot.2022.101761
9. Government of India Ministry of Health and family welfare department of health and family welfare Lok Sabha starred question no. 3129 to be answered on the 06th august, 2021 knee replacement surgeries.
10. Shemjaz AM, Anuj T, Saddam MH. Awareness and knowledge of physical therapy among medical interns a pilot study. *Int J Physiother*. 2016;3(2):170-176. doi:10.15621/ijphy/2016/v3i2/94879
11. Fernandes J, Bandekar S. Obstacles in obtaining optimal physiotherapy services for musculoskeletal conditions in rural communities of Goa: a cross-sectional study. *Indian J Phys Ther Res*. 2024;6(1):60-64. doi:10.4103/ijptr.ijptr_16_23