Sonographic Comparison of Neck Extensor Muscle Thickness of Ankylosing Spondylitis and Non-radiographic Axial Spondyloarthritis Patients with Healthy Volunteers

Sonographischer Vergleich der Halsstreckmuskeldicke von Patienten mit ankylosierender Spondylitis und nicht-röntgenologischer axialer Spondyloarthritis mit gesunden Probanden

Authors

Çağlar Karabaş[1], Berke Aras[2], Kemal Erol[3], Ömer Kuzu[2]

Affiliations

1 Department of Physical Medicine and Rehabilitation, Kastamonu Rehabilitation Center, Kastamonu, Turkey
2 Department of Physical Medicine and Rehabilitation, Ankara City Hospital Physical Therapy and Rehabilitation Hospital, Ankara, Turkey
3 Department of Physical Medicine and Rehabilitation, Division of Rheumatology, Selcuk University Faculty of Medicine, Konya, Turkey

Key words

ankylosing spondylitis, non-radiographic axial spondyloarthritis, neck muscle, ultrasound, axial spondyloarthritis

Schlüsselwörter

Axiale Spondyloarthritis, Spondylitis ankylosans, nicht röntgenologische axiale Spondyloarthritis, Ultraschall, Nackenmuskulatur

published online 19.07.2022

Bibliography

Akt Rheumatol 2022; 47: 523–528
DOI 10.1055/a-1853-9489
ISSN 0341-051X

Georg Thieme Verlag, Rüdigerstraße 14,
70469 Stuttgart, Germany

Correspondence

Dr. Çağlar Karabaş
Kastamonu Rehabilitation Center
Department of Physical Medicine and Rehabilitation
Kastamonu
37010 Kastamonu
Turkey
Tel.: + 90 539 665 9690
drckarabas@gmail.com

ABSTRACT

Introduction This study examines the neck extensor muscle thickness of patients with ankylosing spondylitis (AS) and non-radiographic axial spondyloarthritis (nr-axSpA) by comparing them with healthy volunteers. It also aims to evaluate the relationship between muscle thickness and disease activity, functional parameters, neck disability and quality of life in patients with AxSpA.

Method In this cross-sectional study, 30 patients with AS and 30 patients with nr-AxSpA who were admitted to a Physical Medicine and Rehabilitation outpatient clinic were included consecutively. Thirty healthy participants were included as a control group. The thickness of muscles was measured bilaterally by ultrasound and the muscle thickness average was recorded. All patients with axSpA were asked to complete the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), the Bath Ankylosing Spondylitis Functional Index (BASFI), the Bath Ankylosing Spondylitis Metrology Index (BASMI), the Ankylosing spondylitis Quality of Life (AsQoL) scale and the Neck Disability Index (NDI).

Results Mean patient age was 42.36 ± 10.0 in the AS group, 38.13 ± 7.94 in the nr-axSpA group and 39.06 ± 8.25 in the healthy group. A statistically significant decrease was found in multifidus, semispinalis capitis, semispinalis cervicis and splenius capitis muscle thickness in AS patients compared with the healthy group, and in semispinalis cervicis muscle thickness in nr-axSpA patients compared with the healthy group. However, when trapezius muscle thickness was compared between the groups, no statistical difference was found. There was a significant negative correlation between neck extensor muscle thickness and age, BASDAI, NDI and AsQoL in patients with axSpA.

Conclusion The thickness of the neck extensor muscles is decreased in patients with AxSpA compared with healthy individuals, and this situation can be reliably detected by ultrasound.

ZUSAMMENFASSUNG

Einleitung Diese Studie untersucht die Dicke der Halsstreckmuskulatur von Patienten mit ankylosierender Spondylitis (AS) und nicht-röntgenologischer axialer Spondyloarthritis (nr-axSpA) im Vergleich mit gesunden Probanden. Des Weiteren wird die Beziehung zwischen Muskeldicke und Krankheitsaktivität, funktionellen Parametern, Behinderung durch Nackenbeschwerden und Lebensqualität bei Patienten mit AxSpA bewertet.

Methode In diese Querschnittsstudie wurden 30 Patienten mit AS und 30 Patienten mit nr-AxSpA, die in die Ambulanz für Physikalische Medizin und Rehabilitation aufgenommen wurden, konsekutiv eingeschlossen. Als Kontrollgruppe wurden 30 gesunde Teilnehmer eingeschlossen. Die Dicke der Muskeln wurde bilateral durch Ultraschall gemessen und die Durchschnittswerte wurden aufgezeichnet. Alle Patienten mit axSpa wurden gebeten, den Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), den Bath Ankylosing Spondylitis Functional Index (BASFI), den Bath Ankylosing Spondylitis Metrology Index (BASMI), die Ankylosing Spondylitis Quality of Life (AsQoL) Scale und den Neck Disability Index (NDI) auszufüllen.

Ergebnisse Das Durchschnittsalter der Teilnehmer betrug 42,36 ± 10,0 Jahre in der AS-Gruppe, 38,13 ± 7,94 Jahre in der nr-axSpA-Gruppe und 39,06 ± 8,25 Jahre in der gesunden Gruppe. Bei AS-Patienten zeigte sich im Vergleich zur gesunden Gruppe eine statistisch signifikante Abnahme der Muskeldicke des M. multifidus, M. semispinalis capitis, M. semispinalis cervicis und M. splenius capitis und bei nr-AxSpA-Patienten des M. semispinalis cervicis. Der Vergleich der Trapeziusmuskeldicke zwischen den Gruppen ergab keinen statistischen Unterschied. Bei Patienten mit axSpA bestand eine signifikante negative Korrelation zwischen der Dicke der Nackenstreckmuskulatur und dem Alter, BASDAI, NDI und AsQoL.

Schlussfolgerung Die Dicke der Nackenstreckmuskulatur ist bei Patienten mit AxSpA im Vergleich zu Gesunden verringert, was sonographisch zuverlässig feststellbar ist.

Introduction

Axial spondyloarthritis (axSpA) is a chronic inflammatory disease that mainly affects the spine and sacroiliac joints. AxSpA is classified as ankylosing spondylitis (established AS) with sacroiliac joint involvement fulfilling the modified New York criteria (mNY criteria) and non-radiographic axial spondyloarthritis (nr-axSpA) without the sacroiliac joint involvement fulfilling mNY criteria detected by conventional radiography [1]. In both AS and nr-axSpA patients, symptoms such as the neck, low back, and gluteal pain, morning stiffness, difficulty in movement, fatigue, and sleep disturbance are observed, and these symptoms cause a decrease in quality of life [2].

In axSpa, vertebral bodies, intervertebral discs, and paravertebral muscles of the spine undergo structural changes due to chronic inflammation. During the disease, sclerosis in the apophyseal joints, erosion and reactive sclerosis in the vertebral body, calcification in the interspinal ligaments, and intervertebral disc pathologies are observed. Atrophic changes occur in the paravertebral muscles due to chronic changes in the spine and limitation of movement, leading to impairment and disability in patients' activities of daily living [2, 3]. In a study by Zhang et al., it was shown that the ratio of muscle fiber area to collagen fibril area in paraspinal muscle tissues decreased significantly in the histopathological examination of paraspinal muscles in patients with AS [4].

It is hypothesized that patients with AxSpA may also experience changes in the cervical paravertebral muscle structure due to pain, spinal inflammation, limitation of movement, and increased neck flexion. To our knowledge, there is no study in the literature evaluating cervical paraspinal muscle (multifidus, semispinalis cervicis, semispinalis capitis, splenius capitis, and trapezius) thickness in patients with axSpA.

This study examines the neck extensor muscle thicknesses of patients with AS and nr-axSpA by comparing them with healthy volunteers. It also aims to evaluate the relationship between muscle thickness and disease activity, functional parameters, neck disability, and quality of life.

Methods

Study Design and Participation

A cross-sectional design was made to compare the ultrasound measurements of neck extensor muscle thickness of patients with AS, with nr-axSpA, with healthy participants. Patients meeting ASAS criteria for AxSpA were enrolled to the study [5]. Among these patients, patients who met the modified New York criteria were classified as AS and the other patients as nr-axSpA [6]. Thirty patients with AS and 30 patients with nr-AxSpA who were admitted to Kastamonu Rehabilitation Center Hospital Physical Medicine and Rehabilitation outpatient clinic , were included to the study consecutively [7]. Thirty healthy participants matched for age, sex, and Body Mass Index (BMI) were included as control group of the study. Patients who had trauma or spine surgery, inflammatory diseases other than AS and nr-axSpA, cervical spondylosis, cervical disc herniation, and a history of malignancy were excluded. The healthy group consisted of individuals who did not have chronic neck pain and were not diagnosed with any additional disease that could cause neck pain. The study was approved by the Ethics Committee of Kastamonu Training and Research Hospital (2020-KAEK-143–53/25.02.2021). The study was conducted in accordance with the Helsinki Declaration. Written informed consent was obtained from all participants.

Clinical Assessment

Demographic and clinical data such as age, gender, and BMI of all participants in the study were recorded. Symptom duration, sacroiliac X-ray, and laboratory findings of patients with axSpA were also examined.

In all patients with axSpA, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) [8] for disease activity, the Bath Ankylosing Spondylitis Functional Index (BASFI) [9] for functional status, the Bath Ankylosing Spondylitis Metrology Index (BASMI) for spinal mobility [10] Ankylosing spondylitis Quality of Life (AsQoL)

scale [11] for quality of life and Neck Disability Index (NDI) for neck disability [12] were applied.

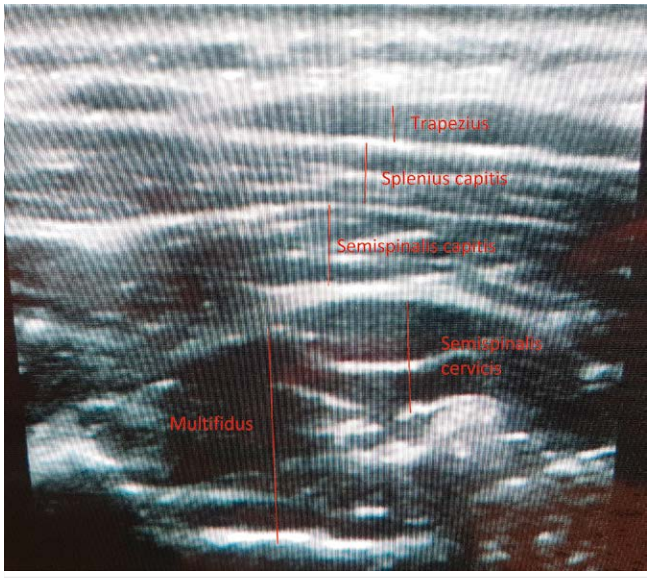
Ultrasound Measurement

Sonographic evaluations of the neck extensor muscles of the participants were performed with a 12 MHz linear probe (GE Logic BT12, GE Healthcare) by the same physician with ten years of US experience and who did not know in which group the participants were. The fourth cervical (C4) vertebral process was chosen as the US imaging level, similar to the protocol applied in a study evaluating the muscle thickness of the neck extensor muscles [13]. This level also was used in a study by Valera-Calero et al., that evaluated the cervical multifidus muscle morphology from the C4 level in healthy individuals [14]. The spinous process at the C4 level was determined by US-guided palpation and marked with an indelible marker pen in the prone position. After identification, each participant was seated upright in a chair with arms on their legs, and their head and neck were placed in a neutral position. The probe was placed transversely over the C4 spinous process and slid laterally until the echogenic vertebral lamina was clearly defined. The thickness of the multifidus, semispinalis capitis, semispinalis cervicis, splenius capitis, and trapezius muscles were measured bilaterally by determining the maximum distance between the fascial borders of each muscle when the muscles were at rest, and the average of the muscle thicknesses was recorded (▶ **Fig. 1**).

To test the intra-rater reliability, the same physician performed initial sonographic muscle thickness measurements in 30 healthy individuals according to the study methodology and repeated them ten days later.

Statistical Analysis

The study population was determined as 81 using the G-power program by taking impact size 0.355 (based on similar study results) alpha = 0.05, power (1-beta) = 0.80 at a confidence level of 95 %. A total of 90 patients were included in the study, considering a dropout rate of 25 %.



▶ **Fig. 1** Ultrasound image for cervical extensor muscle thickness measurements.

Statistical analysis was performed using the 23.0 SPSS (IBM, Armonk, NY, USA) statistical package program. In descriptive statistics, the number (%) was given for discrete variables, and mean ± standard deviation or median (per 25–75) for continuous variables. Compliance of the data with normal distribution was evaluated with the Kolmogorov-Smirnov test and histogram. The Chi-square test was used for discrete variables to compare the differences between groups. Student t-test was used for pairwise comparison between groups with normal distribution, and Mann-Whitney U test was used for pairwise comparison between groups of data not conforming to normal distribution. One-way ANOVA was used to compare the three groups with normal distribution, and the Tukey test was used as a posthoc test to compare statistically significant parameters. Spearman correlation analysis was performed for abnormally distributed data. Whether the correlation coefficient calculated by the correlation analysis was statistically significant was tested with the "determination coefficient" (0.01 and 0.05). The significance level was accepted as $p < 0.05$. The kappa score determined Intra-rater reliability.

Results

The groups' mean ages were 42.36 ± 10.0 in AS group, 38.13 ± 7.94 in the nr-axSpA group, and 39.06 ± 8.25 in the healthy group. While there were 11 women and 19 men in the AS group, there were 14 women and 16 men in the nr-axSpA group and healthy group. There was no statistical difference between the three groups regarding age, gender, and BMI (respectively; $p = 0.152$, $p = 0.665$, $p = 0.673$); and similar disease activity (BASDAI scores > 4) were found between patients with AS and nr-axSpA ($p = 0.152$). A statistically significant difference was found between the AS and nr-axSpA groups in terms of duration of symptoms, BASFI, BASMI, ASQoL, NDI, CRP, right and left sacroiliac grades ($p = 0.006$, $p = 0.012$, $p = 0.045$, $p = 0.038$, $p = 0.005$, $p = 0.023$, $p < 0.001$, $p < 0.001$). The demographic and clinical characteristics of the participants are given in ▶ **Table 1**.

When the patients' multifidus, semispinalis capitis, semispinalis cervicis, and splenius capitis muscle thicknesses were compared between the AS, nr-axSpA and healthy groups, there was a statistically significant difference ($p < 0.001$ $p = 0.008$, $p < 0.001$, $p = 0.020$, respectively). When the statistically significant results were compared post-hoc, there was a statistically significant difference between the AS and nr-axSpA groups in the multifidus, semispinalis capitis muscles (respectively, $p = 0.012$, $p = 0.016$). However, no statistical difference was found between the semispinalis cervicis and splenius capitis (respectively, $p = 0.965$, $p = 0.325$). Significant differences were found in the multifidus, semispinalis capitis, semispinalis cervicis, and splenius capitis muscles when the AS and healthy controls were compared (respectively, $p < 0.001$, $p = 0.021$, $p < 0.001$, $p = 0.015$) . In the nr-axSpA and healthy groups comparison, there was a statistical difference in the semispinalis cervicis muscle, but no statistical difference was found in the multifidus, semispinalis capitis, and splenius capitis muscles (respectively, $p = 0.001$, $p = 0.222$, $p = 0.992$, $p = 0.339$). No statistical difference was found when the trapezius muscle thickness was compared between the groups ($p = 0.070$) (▶ **Table 2**).

Kappa scores were determined as 0.861 for multifidus, 0.790 for semispinalis capitis, 0.722 for semispinalis cervicis, 0.679 for

▶ **Table 1** Demographic and clinical characteristics of the participants.

	AS Group (n = 30)	nr-axSpA Grubu (n = 30)	Healthy Group (n = 30)	p-value
Age (years)	42.36 ± 10.0	38.13 ± 7.94	39.06 ± 8.25	0.152
Gender (F/M), n (%)	11/19 (36.7/63.3)	14/16 (46.7/53.3)	14/16 (46.7/53.3)	0.665
BMI (kg/m2)	27.93 ± 4.87	27.47 ± 4.08	26.86 ± 5.01	0.673
Duration of symptoms (month)	96 (48–180)	60 (22.5–99)		**0.006**
BASDAI (>4), n (%)	24 (80)	19 (63.3)		0.152
BASFI	4.35 (1.90–6.73)	1.95 (0.48–3.68)		**0.012**
BASMI	0.5 (0–2.25)	0 (0–1.0)		**0.045**
ASQoL	12.0 (9.75–14)	9.0 (5.0–12.0)		**0.038**
Neck Disability Index	17.5 (11.0–26.25)	11.0 (3.0–18.25)		**0.005**
CRP	12.0 (2.5–19.5)	4.0 (1.87–7.47)		**0.023**
Right sacroiliac grade	3.5 (3.0–4.0)	1.0 (1.0–2.0)		**<0.001**
Left sacroiliac grade	3.0 (3.0–4.0)	1.0 (0.75–1.0)		**<0.001**

AS: Ankylosing spondylitis; nr-axSpA: non-radiographic axial spondyloarthritis; F: female; M: male; BMI: Body Mass Index; (mean ± standard deviation; n (%); median (per 25–75) $p < 0.05$ considered statistically significant).

▶ **Table 2** Comparison of neck extensor muscle thickness between groups.

	AS Group (n = 30)	nr-axSpA Group (n = 30)	Healthy Group (n = 30)	p-value
Multifidus (cm)	1.31 ± 0.15^{bc}	1.42 ± 0.16^{a}	1.49 ± 0.14^{a}	**<0.001**
Semispinalis Capitis (cm)	0.54 ± 0.09^{bc}	0.62 ± 0.11^{a}	0.61 ± 0.12^{a}	**0.008**
Semispinalis Cervicis (cm)	0.46 ± 0.10^{c}	0.47 ± 0.09^{c}	0.57 ± 0.11^{ab}	**<0.001**
Splenius Capitis (cm)	0.35 ± 0.07^{c}	0.38 ± 0.10	0.41 ± 0.09^{a}	**0.020**
Trapezius (cm)	0.15 ± 0.03	0.16 ± 0.04	0.17 ± 0.03	0.070

AS: Ankylosing spondylitis; nr-axSpA: non-radiographic axial spondyloarthritis. a: Indicates the group that differs from the AS group. b: b: indicates the group that differs from the nr-axSpA group. c: Indicates the group that differs from the healthy group.

splenius capitis, and 0.741 for trapezius muscle to assess intra-rater reliability.

The results of the correlation analysis between neck extensor muscle thickness (multifidus, semispinalis capitis, semispinalis cervicis, splenius capitis, and trapezius) and age, BMI, symptom duration, BASDAI, BASFI, BASMI, AsQoL, NDI, CRP, right and left sacroiliac grade of 60 patients diagnosed with axial SpA (AS, nr-axSpA) are shown in ▶ **Table 3**.

Discussion

To our knowledge and based on our detailed research in the literature, this is the first study to evaluate neck extensor muscle thickness by ultrasonography in patients with axSpA. As a result of the study, multifidus, semispinalis capitis, semispinalis cervicis, and splenius capitis muscle thicknesses were decreased in AS patients, and semispinalis cervicis muscle thicknesses were decreased in nr-axSpA patients compared to the healthy group. In addition, there was a significant negative correlation between neck extensor muscle thickness and age, disease activity index, neck disability index, and quality of life in patients with axSpA.

Cervical extensor paraspinal muscles play an important role in stabilizing and moving the cervical spine in the neck. They help the lateral flexion of the spine to the same side when contracted unilaterally and the extension movement of the spine when contracted bilaterally. Structural and morphological changes in the muscles cause early symptoms such as pain, stiffness, and posture disorder. In cases such as persistent pain and inflammation and phobia of exercises due to pain, limitation of movement and muscle atrophy can occur, which causes the pain to become chronic and limiting the person's daily living activities. In a study conducted on office workers with unilateral chronic neck pain, it was found that semispinalis capitis muscle thickness was decreased compared to the control group evaluated by ultrasonography [15]. In a study by Penas et al., it was

▶ **Table 3** Correlation analysis between neck extensor muscle thicknesses and parameters in patients with axial SpA.

	Multifidus	Sscapitis	SSservicis	SPC	Trapez
Age	-,464**	-,520**	-,261*	-,268*	-0.060
BMI	-.243	.003	.197	.040	-.016
Duration of symptoms	-.123	-.151	.042	.030	-.068
BASDAI	-,428**	-0.223	-,346**	-,353**	-0.162
BASFI	-.243	-.075	-.150	-.195	-,262*
BASMI	-.067	-.039	.129	-.165	.091
AsQol	-,335**	-0.071	-0.196	-,392**	-0.113
Neck Disability Index	-,324*	-,260*	-0.239	-,285*	-0.253
CRP	-.094	.051	.019	-.198	-.011
Right sacroiliac grade	-.210	-,306*	.044	-.071	-.082
Left sacroiliac grade	-.168	-.157	.093	-.100	-.037

*: $p<0.05$; **: $p<0.001$. BMI: Body Mass Index. Spearman correlation analysis was performed and denoted as rho.

found that the cross-sectional area of the multifidus muscle was lower in women with chronic neck pain compared to the control group [16]. Goodarzi et al. found a significant difference in the participants' resting multifidus, semispinalis cervicis, semispinalis capitis, splenius capitis, and trapezius muscle thicknesses with forward head posture compared to those with normal head posture [13]. These studies in the literature show the relationship between muscle thickness and pain/posture disorder. Similarly, in the present study, when compared to the control group, the thickness of the muscles other than the trapezius was significantly lower in the AS group. In the nr-axSpa group, only the semispinalis cervicis muscle thickness was significantly reduced compared to the control group. The major decrease in muscle thickness in the AS group is thought to be since chronic inflammation, immobilization, and postural changes are more established over time.

There is no study in the literature evaluating paraspinal muscles in the neck in AxSpA patients. The number of studies evaluating the lumbar paraspinal muscles is few [17, 18]. Akgul et al. evaluated the cross-sectional area and fat infiltration of the paraspinal muscles (multifidus, erector spinae, psoas) in patients with nr-axSpA and established AS with MRI. They found that the paraspinal muscles' cross-sectional area was similar between the groups, and patients with AS had higher degrees of fat infiltration than patients with nr-axSpA [17]. Resorlu et al. compared multifidus and erector spinae muscle cross-sectional areas and fatty degenerations in the lumbar region between AS patients and the control group. Paravertebral muscle cross-sectional areas and fatty degeneration were higher in AS patients compared to the control group.

Additionally, a negative correlation was observed between the cross-sectional area of paravertebral muscles and the duration of the disease [18]. Although the anatomy of the cervical and lumbar spine regions and their involvement in the axSpA are different, in the present study in which the cervical paraspinal muscles were evaluated, findings consistent with the studies performed in the lumbar region were found. A statistically significant difference was found in paravertebral muscle thickness between AS, nr-axSpA, and control groups. Moreover, there was a significant negative correlation between disease duration and muscle thickness.

Magnetic resonance imaging, computed tomography, and ultrasonography are frequently used in evaluating the cervical spine and paraspinal muscles. Ultrasound is frequently preferred recently in evaluating the musculoskeletal system because it does not contain radiation, is inexpensive, and is easily accessible. However, it is known that it depends on the person's experience doing it [19]. A systemic review emphasized that ultrasonography is a reliable and valid method for cervical muscle evaluation [20]. In a study by Nagai et al. in which the gender differences in neck flexor and extensor muscle thicknesses were compared with ultrasound, they did not find a statistical difference between men and women in cervical extensor muscle thicknesses. In addition, intra-class correlation coefficient (ICC) intra-rater reliability was 0.852 [21]. In this study, the ICC was found to be between 0.679 and 0.861. The findings show that ultrasound is an effective diagnostic method for evaluating neck paravertebral muscle thickness in axSpa patients.

In diseases with chronic neck pain, muscle strength and volume decrease over time due to various reasons, and this situation becomes a vicious circle with more pain and stiffness. Therefore, neck exercises are important in preserving the existing muscle volume and stabilizing the spine in diseases that tend to become chronic. Kashfi et al. compared the effectiveness of general exercise and deep neck muscle-specific neck exercises in patients with chronic neck pain. While both exercise treatments are effective, the importance of a specific exercise program for deep neck muscles has been emphasized both on pain and to reduce chronic complications [22]. Exercise plays a vital role in the rehabilitation process of axSpA patients. Regular exercise is vital in this patient group to increase mobility, endurance, and strength, reduce pain and increase the quality of life of the patients [23]. A study by Öztürk et al. concluded that atrophy occurs in the paravertebral muscles due to increased thoracic kyphosis, mechanical stress and inflammatory pain, and immobilization in patients with AS and nr-axSpA [24]. The present study determined that neck muscle thicknesses decreased in patients with AS, nr-axSpA compared to the control group. The importance of exercise therapy is emphasized in patients with established AS and in patients who have not yet completed their evolution and whose disease duration is short.

Therefore, planning a specific exercise program for the paravertebral muscles in the early period in patients with axSpA will positively affect possible pain, disability, and quality of life.

The correlation analysis determined a negative correlation between muscle thickness and age, BASDAI, AsQol, NDI scores. In addition, a negative correlation was found between trapezius muscle thickness and BASFI and sacroiliac joint grade and SSC. This explains that as mobility impairment and radiologic progression increase , paraspinal muscle involvement is more significant. Since AS and

nr-axSpA are chronic inflammatory processes, we think the relationship between paraspinal muscle thickness and functional index, quality of life scale, and neck disability index is bidirectional rather than a cause-effect relationship. For this reason, atrophy in cervical neck extensors causes increased neck pain, worsening in functional status, deterioration in the quality of life, and as a result, the chain of the vicious circle cannot be broken, resulting in a decrease in the thickness of the muscles due to pain and immobility.

The limitations of the study include evaluating cervical muscle thickness only at the C4 level, not using muscle cross-sectional area, and measuring only resting muscle thickness. The number of our patients was small, which may have caused inadequacy in the statistical evaluation of the data. In addition, our study was a cross-sectional study, so the effects of the patients in the future follow-up are not known. However, the strength of this study is that it is the first study in which muscle thickness was compared with ultrasound in both AS and nr-axSpA patients.

Conclusion

In conclusion, neck extensor muscle thicknesses are decreased in patients with AxSpA compared to healthy individuals, and this situation can be reliably detected by ultrasound. This study will guide studies that will examine the neck muscles in detail with large patient groups diagnosed with AxSpA.

Conflicts Of Interest

The authors declare that they have no conflict of interest.

References

[1] Pike J, Dong Y, Piercy J et al. Cross-walk of the Assessment of Spondyloarthritis International Society Health Index and Ankylosing Spondylitis Quality of Life Scores in Ankylosing Spondylitis and Non-radiographic Axial Spondyloarthritis Patients. Rheumatology and Therapy 2021; 1–14

[2] An S-B, Kim K-N, Chin D-K et al. Surgical outcomes after traumatic vertebral fractures in patients with ankylosing spondylitis. Journal of Korean Neurosurgical Society 2014; 56: 108

[3] Neidhart M, Baraliakos X, Seemayer C et al. Expression of cathepsin K and matrix metalloproteinase 1 indicate persistent osteodestructive activity in long-standing ankylosing spondylitis. Annals of the rheumatic diseases 2009; 68: 1334–1339

[4] Zhang Y, Xu H, Hu X et al. Histopathological changes in supraspinous ligaments, ligamentum flava and paraspinal muscle tissues of patients with ankylosing spondylitis. International journal of rheumatic diseases 2016; 19: 420–429

[5] Rudwaleit M, Haibel H, Baraliakos X et al. The early disease stage in axial spondylarthritis: results from the German Spondyloarthritis Inception Cohort. Arthritis & Rheumatism: Official Journal of the American College of Rheumatology 2009; 60: 717–727

[6] van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. Arthritis and rheumatism 1984; 27: 361–368. doi:10.1002/art.1780270401

[7] Strand V, Rao SA, Shillington AC et al. Prevalence of axial spondyloarthritis in United States rheumatology practices: Assessment of SpondyloArthritis International Society criteria versus rheumatology expert clinical diagnosis. Arthritis care & research 2013; 65: 1299–1306

[8] Akkoc Y, Karatepe AG, Akar S et al. A Turkish version of the bath ankylosing spondylitis disease activity index: reliability and validity. Rheumatology international 2005; 25: 280–284

[9] Ozer HT, Sarpel T, Gulek B et al. The Turkish version of the bath ankylosing spondylitis functional index: Reliability and validity. Clinical rheumatology 2005; 24: 123–128

[10] Jenkinson TR, Mallorie P, Whitelock H et al. Defining spinal mobility in ankylosing spondylitis (AS). The Bath AS Metrology Index. The. Journal of rheumatology 1994; 21: 1694–1698

[11] Öncülokur N, Keskin D, Garip Y et al. Turkish version of evaluation of Ankylosing Spondylitis Quality of Life Questionnaire in patients with ankylosing spondylitis: a validation and reliability study. Archives of rheumatology 2018; 33: 443

[12] Aslan E, Karaduman A, Yakut Y et al. The cultural adaptation, reliability and validity of neck disability index in patients with neck pain: a Turkish version study. Spine 2008; 33: E362–E365

[13] Goodarzi F, Rahnama L, Karimi N et al. The effects of forward head posture on neck extensor muscle thickness: an ultrasonographic study. Journal of manipulative and physiological therapeutics 2018; 41: 34–41

[14] Valera-Calero JA, Arias-Buría JL, Fernández-de-Las-Peñas C et al. Echo-intensity and fatty infiltration ultrasound imaging measurement of cervical multifidus and short rotators in healthy people: A reliability study. Musculoskeletal Science and Practice 2021; 53: 102335

[15] Rezasoltani A, Ahmadipoor A, Khademi-Kalantari K et al. The sign of unilateral neck semispinalis capitis muscle atrophy in patients with chronic non-specific neck pain. Journal of back and musculoskeletal rehabilitation 2012; 25: 67–72

[16] Fernández-De-Las-Peñas C, Albert-Sanchís JC, Buil M et al. Cross-sectional area of cervical multifidus muscle in females with chronic bilateral neck pain compared to controls. journal of orthopaedic & sports physical therapy 2008; 38: 175–180

[17] Akgul O, Gulkesen A, Akgol G et al. MR-defined fat infiltration of the lumbar paravertebral muscles differs between non-radiographic axial spondyloarthritis and established ankylosing spondylitis. Modern rheumatology 2013; 23: 811–816

[18] Resorlu H, Savas Y, Aylanc N et al. Evaluation of paravertebral muscle atrophy and fatty degeneration in ankylosing spondylitis. Modern rheumatology 2017; 27: 683–687

[19] Bokaee F, Rezasoltani A, Manshadi FD et al. Comparison of cervical muscle thickness between asymptomatic women with and without forward head posture. Brazilian journal of physical therapy 2017; 21: 206–211

[20] Javanshir K, Amiri M, Mohseni-Bandpei MA et al. Ultrasonography of the cervical muscles: a critical review of the literature. Journal of manipulative and physiological therapeutics 2010; 33: 630–637

[21] Nagai T, Schilaty ND, Krause DA et al. Sex differences in ultrasound-based muscle size and mechanical properties of the cervical-flexor and-extensor muscles. Journal of athletic training 2020; 55: 282–288

[22] Kashfi P, Karimi N, Peolsson A et al. The effects of deep neck muscle-specific training versus general exercises on deep neck muscle thickness, pain and disability in patients with chronic non-specific neck pain: protocol for a randomized clinical trial (RCT). BMC musculoskeletal disorders 2019; 20: 1–8

[23] Gonca İ, Sarpel T. Ankilozan Spondilit Tedavisinde Egzersizin Önemi. SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi 2006; 4: 155–161

[24] Ozturk EC, Yagci I. The structural, functional and electrophysiological assessment of paraspinal musculature of patients with ankylosing spondylitis and non-radiographic axial spondyloarthropathy. Rheumatology International 2021; 41: 595–603