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IS THERE A RELATIONSHIP BETWEEN MYOFASCIAL PAIN SYNDROME AND CORONAL AND SAGITTAL ALIGNMENT IN ADOLESCENT IDIOPATHIC SCOLIOSIS?

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ABSTRACT

Objective: To investigate the presence of myofascial pain syndrome (MPS) in adolescent idiopathic scoliosis (AIS) and the relationship between the presence of MPS and coronal/sagittal alignment in participants with AIS.

Materials and Methods: This was a prospective, cross-sectional study. Participants with AIS aged 10-18 years were included in the study and separated into two groups according to having MPS: AIS with MPS group and AIS without pain (non-MPS group). Participants' demographic characteristics, Cobb angle, coronal balance, the presence of MPS, the location of the curve and pain, sagittal spinopelvic parameters [sagittal vertical axis, cervical lordosis (CL), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt, sacral slope, pelvic incidence], aesthetic evaluation, and visual analog scale results were evaluated and both groups were compared in terms of these parameters.

Results: One hundred sixty eight participants diagnosed with AIS aged 10-18 years were included in the study. The mean age was 14.9±2.2 years. Participants were separated into two groups:the MPS group (n=106) and non-MPS group (n=62). The location of myofascial pain was more common in the lumbar (23.8%) and main thoracic regions (23.2%) in participants diagnosed with MPS. Age, Cobb angle, CL, TK, LL, and Trunk Aesthetic Clinical Evaluation tool (p=0.001, 0.018, 0.016, 0.024, 0.011, and 0.031, respectively) were found significantly different between both groups. Also, decreased CL angle (odds ratio=0.960) was determined as a significant risk factor for the presence of MPS. There was no relationship between pain intensity and the location of the major curve or the location of the pain.

Conclusion: MPS should be remembered as a source of pain in AIS. Older age, greater curve size, decreased CL, increased TK and LL angles, and the worst aesthetic appearance was found in participants with AIS and MPS. The location of myofascial pain or the location of the major curve was not associated with pain intensity.

Keywords: Aesthetics, myofascial pain, sagittal alignment, scoliosis, trigger point

INTRODUCTION

Back pain is one of the common complaints in adolescent idiopathic scoliosis (AIS)[1-3]. There are so many reasons for back pain in the pediatric population: Spondylolysis and spondylolisthesis, trauma and degenerative conditions, infectious and inflammatory diseases, neoplasms, myofascial problems, etc. As we know, spinal asymmetry is accepted as a risk factor for the presence of back pain in scoliosis[4]. Also, the spinal deformity may deteriorate the biomechanics of the spine and paraspinal muscles and can cause increased inflammatory responses[5]. The prevalence of back pain in AIS was found to be between 23% and 85%, and it was reported that patients with AIS had a higher prevalence of back pain than patients without scoliosis[3,5].

The mechanism of the myofascial pain syndrome (MPS) is still controversial. Alterations of inflammatory markers in circulation have been investigated for MPS, and elevated inflammatory biomarkers (C-reactive protein, IL-6, IL-1β, etc.) were observed in patients with myofascial pain[6]. Additionally, mechanical factors such as prolonged abnormal posture have been recognized as a risk factors for MPS[7-9]. Scoliosis is one of the precipitating structural reasons for the MPS[10]. According to a review article by López-Torres et al.[11], muscular imbalance in scoliosis can also cause pain, and myofascial release techniques and postural control have been found useful for this myofascial pain in scoliosis.

As far as we know, there is no literature on MPS and scoliosis. Based on this information, it was aimed to investigate the presence of MPS in AIS, and to determine the relationship between sagittal and coronal alignment and MPS in participants with AIS.

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MATERIALS AND METHODS

It was a prospective, cross-sectional trial. Participants who were admitted to Scoliosis Outpatient Clinic in University of Health Sciences Turkey, İstanbul Kanuni Sultan Süleyman Training and Research Hospital were evaluated for eligibility, and those who met the inclusion criteria were included in the study between October 10, 2021, and April 25, 2022. The inclusion criteria were being diagnosed with AIS, being between the ages of 10-18 years, agreeing to participate in the study, and for the MPS group, meeting the diagnostic criteria for active trigger points (TrPs)[12]: A palpable taut band in the muscle, local twitch response, a hypersensitive tender spot in the taut band, and referred pain pattern. Having neurological deficits or other pathologies for secondary scoliosis, having other causes for pain except for the MPS (discopathy, spondylolysis, spondylolisthesis, etc.), receiving brace or exercise therapy for scoliosis, having a history of spinal trauma, and the previous history of the spinal surgery was accepted as the exclusion criteria.

Participants were separated into two groups according to the presence of myofascial pain: AIS with MPS (MPS group) and AIS without pain (non-MPS group).

Ethical Status

The study protocol was approved by the University of Health Sciences Turkey, İstanbul Kanuni Sultan Süleyman Training and Research Hospital Ethical Board in conformity with the Declaration of Helsinki (under number: KAEK/2020.07.128). Written and verbal consent forms were obtained from the participants. Also, the study was registered at Clinicaltrials.gov (ID No: NCT05185050).

Outcome Measures

The characteristics of the participants were recorded at first applying to the scoliosis outpatient clinic. The clinical evaluation was performed by an investigator, and all radiographic parameters were measured using the Surgimap® software program by another investigator.

Scoliosis Severity and Location of the Curve

Cobb angle was measured to determine the scoliosis severity[1]. The location of the major curve was specified according to the Lenke classification (proximal thoracic, main thoracic, thoracolumbar, and lumbar)[13].

Spinal Coronal Balance

The horizontal distance between the vertical line drawn from the center of the C7 vertebra and the vertical line drawn from the center of S1 was measured for coronal balance[14].

Spino-pelvic Sagittal Balance

The sagittal vertical axis (SVA), cervical lordosis (CL), thoracic kyphosis (TK), and lumbar lordosis (LL) angles were measured for evaluating sagittal spinal balance, and pelvic tilt (PT), sacral slope (SS), and pelvic incidence (PI), were measured for evaluating sagittal pelvic balance[15].

Aesthetic Evaluation

The Trunk Aesthetic Clinical Evaluation (TRACE) tool was used for the aesthetic examination of the participants. It is a 12-point scale that evaluates shoulder, hemithorax, scapulae, and waist asymmetries[16].

Presence of MPS and Pain Intensity

The diagnosis of MPS was made according to the diagnostic criteria of Simon et al[17]. According to these criteria, at least one minor criterion and five major criteria were needed for diagnosis. The major criteria were (i) spontaneous localized pain, (ii) referred pain from the TrPs, (iii) palpable taut band in the muscle, (iv) localized tenderness in a taut band, and (v) decreased range of motion. The minor criteria were (i) altered sensations by pressure on the TrPs, (ii) local twitch response by transverse snapping palpation or needling of a TrPs, (iii) reducing pain by stretching of the muscle or TrP injections[12,17]. Pain intensity was evaluated using visual analog scale (VAS). There is a 10 cm horizontal line on the scale from "no pain" to "very severe pain"[18]. The location of the pain was classified as cervical/proximal thoracic (TrPs in the trapezius muscle were also assumed to be in this group), main thoracic, thoracolumbar, and lumbar regions according to palpation of the TrPs.

Calculation of the Sample Size

It was calculated with the G*power program. Based on the mean value of Cobb angle to achieve $\alpha<0.05$ and $\beta=95\%$, a minimum of 62 participants were calculated for each group as described by Teles et al.[19].

Statistical Analysis

All the analyses of the data were performed with SPSS® (MacOs, IBM Corp., Armonk, NY, USA) v23.0. The distribution of the variables was assessed by histogram and Shapiro-Wilk test. Characteristics of the participants were defined as mean (standard deviation), median (minimum-maximum), and percentages. Inter-group analysis was performed with an independent t-test or Mann-Whitney U test based on the distribution of the variables, and chi-square (χ^2) test was performed for categorical variables. After the screening of the independent variables with univariate analysis, multiple regression analysis was performed. All results were evaluated in the 95% confidence interval and $p<0.05$ was considered statistically significant.

RESULTS

Two hundred and ninety-six children with scoliosis were evaluated for eligibility. One hundred and sixty-eight participants diagnosed with AIS aged 10-18 years were included in the study. One hundred and twenty-eight participants have excluded: Twenty-four participants had neuromuscular scoliosis, twenty-two of them were not between the ages of 10-18 years, thirty-six of them were currently receiving brace and/or exercise therapy, eight had a previous history of spinal surgery, nine were diagnosed with spondylolisthesis, three of them were diagnosed with spondylolysis, and two were diagnosed with lumbar discopathy, twenty-two participants only had a local muscle spasm without referred pain or local twitch response, and two had a history of spinal trauma (Figure 1).

Participants were divided into two groups according to the presence of MPS: The MPS group (n=106) and the non-MPS group (n=62). The mean age of the participants was 14.9±2.2 years. They were homogeneously distributed in both groups in terms of age, gender, Risser classification, Tanner stage, and location of the major curve. The location of pain was more common in the lumbar (23.8%) and main thoracic regions (23.2%) in participants diagnosed with MPS (Table 1).

Based on the comparison of the MPS and non-MPS groups for spinal coronal/sagittal alignment and aesthetic evaluation, there were statistically differences in terms of age, Cobb angle, CL angle, TK angle, LL angle, and TRACE tool (p=0.001, 0.018, 0.016, 0.024, 0.011, and 0.031, respectively). No significant difference was shown in terms of coronal balance, PT, SS, PI, and SVA (Table 2). Those variables with $p<0.20$ in univariate analysis were included in the logistic regression analysis. Based on the results, decreased CL angle (odds ratio: 0.960) was determined as a significant risk factor for the presence of MPS in AIS (Table 3).

When the MPS group was divided into three groups mild (VAS: 1-4), moderate (VAS: 5-6), and severe pain (VAS: 7-10), the LL angle was found significantly changed between the groups. However, there was no relationship between the location of the major curve or the location of pain and pain intensity (Table 4).

DISCUSSION

To our knowledge, this is the first study to determine the MPS in AIS patients and evaluate the relationship between MPS and spinal coronal and sagittal alignment, location of pain, location of the major curve, and aesthetic appearance of the patients. Based on the results, AIS patients with MPS had older age, greater curvature, decreased CL, increased TK, and LL and more asymmetrical trunk appearance compared to AIS patients without pain. Additionally, decreased CL angle was found as a risk factor for MPS in AIS, and increased LL angle was associated with increased pain intensity. However, pain intensity was not related to the location of pain and the location of the major curve.

Back pain is a common complaint of AIS patients[4]. AIS patients have more back pain complaints compared to the non-scoliosis population[2,5,20]. According to Théroux et al.[2] study results, spinal pain is mostly seen in the main thoracic and lumbar regions. Similarly, it was found predominantly in the lumbar and main thoracic parts of the spine in the present study. The pain intensity of the AIS patients was documented as mild or moderate in the literature[3]. Similarly, in the current study, the pain intensity of the participants was found to be mild and moderate level.

Increased muscle tension and muscle weakness have been shown to contribute to TrP formation in MPS[21]. It was shown that the paraspinal muscle activation on the concave side was increased in the surface electromyography examinations performed in patients with AIS[22]. This spinal asymmetry supported the presence of pain in AIS[23]. Based on this information, when the

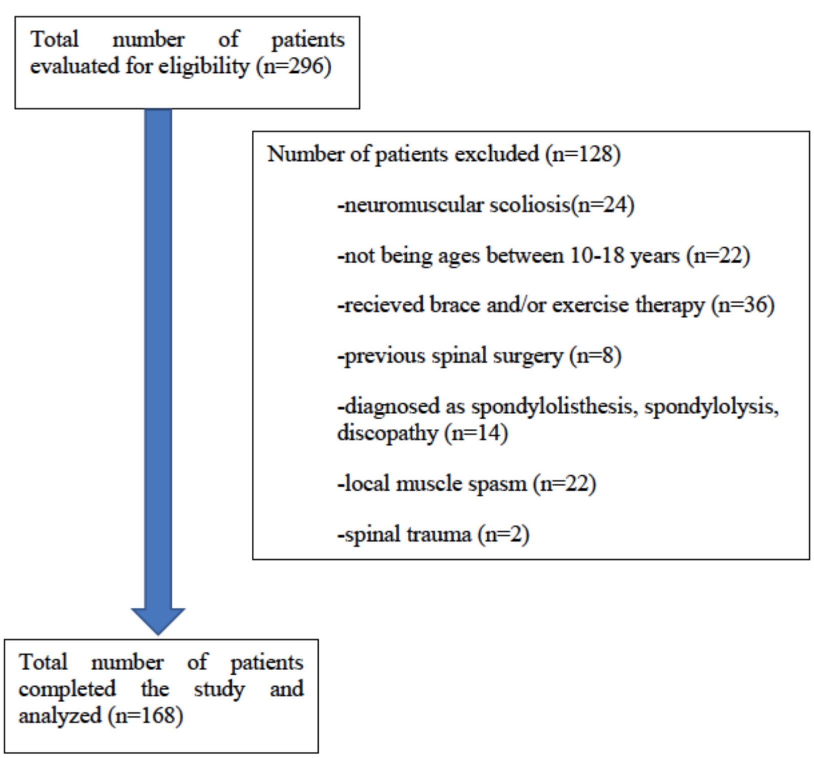

Figure 1. The flow diagram of the study

Table 1. Demographic and clinical characteristics of the participants

	MPS group (n=106)	Non-MPS group (n=62)	Total (n=168)	p
Age (years)/mean (SD)	15.3 (1.9)	14.1 (2.2)	14.9 (2.2)	0.384
Gender (n)/female/male	76/30	42/20	118/50	0.588
Risser classification/median (min-max)	4 (0-5)	3 (0.5)	4 (0-5)	0.186
Tanner stage/median (min-max)	3 (1-5)	3 (1-5)	3 (1-5)	0.152
Lenke classification (%)				0.708
Lenke 1	32 (30.2%)	23 (37.1%)	55 (32.7%)	-
Lenke 2	8 (7.5%)	1 (1.6%)	9 (5.4%)	-
Lenke 3	3 (2.8%)	3 (4.8%)	6 (3.6%)	-
Lenke 4	1 (0.9%)	1 (1.6%)	2 (1.2%)	-
Lenke 5	42 (39.6%)	32 (51.6%)	74 (44%)	-
Lenke 6	20 (18.9%)	2 (3.2%)	22 (13.1%)	-
TRACE/mean (SD)	5.3 (2.2)	4.5 (2.4)	5.02 (2.3)	0.564
VAS/mean (SD)	4.6 (1.7)	-	-	-
Pain intensity n (%)				
Mild pain	54 (51%)	-	-	-
Moderate pain	35 (33%)	-	-	-
Severe pain	17 (16%)	-	-	-
Location of the major curve n (%)				0.618
Proximal thoracic	4 (3.8%)	1 (1.6%)	5 (3%)	-
Main thoracic	41 (38.7%)	24 (38.7%)	65 (38.7%)	-
Thoracolumbar	32 (30.2%)	23 (37.1%)	55 (32.7%)	-
Lumbar	29 (27.4%)	14 (22.6%)	43 (25.6%)	-
Location of the pain n (%)				
Proximal thoracic	12 (7.1%)	-	12 (7.1%)	-
Main thoracic	39 (23.2%)	-	39 (23.2%)	-
Thoracolumbar	15 (8.9%)	-	15 (8.9%)	-
Lumbar	40 (23.8%)	-	40 (23.8%)	-

MPS: Myofascial pain syndrome, SD: Standard deviation, TRACE: Trunk Aesthetic Clinical Evaluation, VAS: Visual analog scale, min: Minimum, max: Maximum

Table 2. Inter-group analysis of the variables in the study

	MPS group (n=106)	Non-MPS group (n=62)	p	95% Confidence interval of the difference	
				Lower	Upper
Age (year)	15.3 (1.9)	14.1 (2.2)	0.001*[a]	-1.89	-0.53
Cobb angle (°)	22.2 (8.5)	19.4 (6.7)	0.018*[a]	-5.19	-0.49
CL (°)	14.9 (10.6)	19.2 (11.0)	0.016*[a]	0.79	7.60
TK (°)	42.3 (15.3)	37.6 (11.1)	0.024*[a]	-8.71	-0.62
LL (°)	53.0 (13.8)	47.3 (13.6)	0.011*[a]	-9.98	-1.32
TRACE	5.3 (2.2)	4.5 (2.4)	0.031*[a]	-1.51	-0.07
Coronal balance (mm)	6.6 (6.6)	8.5 (8.6)	0.210[b]	-0.67	4.36
PT (°)	9.1 (10.5)	10.4 (9.6)	0.516[b]	-1.87	4.42
SS (°)	31.4 (20.2)	34.6 (15.4)	0.450[b]	-2.29	8.67
PI (°)	38.1 (25.8)	43.5 (19.9)	0.340[b]	-1.66	12.40
SVA (°)	17.9 (14.6)	17.4 (16.4)	0.435[b]	-5.52	4.48

[a]Analysed with independent t-test, [b]Analysed with Mann-Whitney U test, *p<0.05 is considered for significance.
MPS: Myofascial pain syndrome, CL: Cervical lordosis, TK: Thoracic kyphosis, LL: Lumbar lordosis, TRACE: Trunk Aesthetic Clinical Evaluation, PT: Pelvic tilt, SS: Sacral slope, PI: Pelvic incidence, SVA: Sagittal vertical axis

presence of MPS was evaluated in the participants with AIS, it was seen that 63.1% of the participants were diagnosed with MPS by Travel & Simon's diagnostic criteria. According to Teles et al.[19], the prevalence of back pain in the past 30 days was 85.8%. However, Sato et al.[24] showed that 58.8% of the AIS patients had back pain. In another study, the prevalence of back pain was stated as 47.3%[3]. The prevalence of MPS in the current study was obtained by excluding other causes of spinal pain. The difference between the results can be explained by this situation.

In several studies, the location of back pain was found related to the location of the major curve[3,19]. Similarly, in the present study, there was a significant relationship between the location of the myofascial pain originating from the TrP and the location of the major curve. On the other hand, the pain intensity was not found to be related to the location of the major curve, and curve size, whereas the greater curve size was significantly related to the presence of MPS in AIS in the current study. These results were similar to previous studies[3,25,26].

Teles et al.[19] found a relationship between low back pain and lower LL angle. Conversely, in Makino et al.[27] study, increased LL was determined as a risk factor for the presence of back pain. In the present study, similar to Makino et al.'s.[27] result, there was a positive relationship between pain intensity and greater LL angles. As is known, hypokyphosis is a common finding in AIS and is associated with pain in adult spinal deformity[28]. The relationship between back pain and hypokyphosis has also been demonstrated in AIS[19]. In the current study, although the participants were hypokyphotic, those with AIS and MPS had a higher TK angle than those without pain. Several studies showed that decreased CL was associated with pain[9,29].

Additionally, McAviney et al.[29] reported a significant relationship between CL below 20 degrees and the presence of pain. In the current study, the mean CL angle was 16.5±10.9 degrees, and decreased CL was found as a risk factor for MPS in AIS. Deep flexor muscles support the CL[30]. Decreased CL may be associated with the presence of TrP in deep flexor muscles.

Aesthetic appearance is accepted as one of the main goals of treatment in AIS[16]. In the current study, it was found that participants with AIS and MPS had the worst aesthetic appearance compared to participants with AIS without pain. This was the first time to investigate the relationship between pain and aesthetic appearance. Back pain is related to biopsychosocial factors in AIS patients[30]. This result may be related to the relationship between pain perception and psychological aspects of having scoliosis. Further studies are needed to clarify this.

Table 3. Multiple regression analysis between presence of myofascial pain, participants' characteristics, scoliosis severity, and sagittal spino-pelvic parameters stratified by presence of myofascial pain

	Presence of MPS			
	β	Exp (β)	95% CI (lower-upper)	p
Age	0.162	1.176	(0.83-1.66)	0.355
Cobb angle	0.047	1.048	(0.98-1.12)	0.143
TRACE	0.072	1.074	(0.88-1.31)	0.482
CL	-0.04	0.960	(0.93-0.99)	0.026*
TK	0.025	1.026	(0.99-1.06)	0.168
LL	0.013	1.013	(0.98-1.05)	0.479
Coronal balance	-0.017	0.983	(0.93-1.04)	0.550
Risser				
Stage 0	(Reference)			
Stage 1	-0.511	0.600	(0.09-4.07)	0.601
Stage 2	-1.876	0.153	(0.02-1.33)	0.089
Stage 3	-0.266	0.766	(0.09-5.90)	0.798
Stage 4	-0.667	0.513	(0.06-4.68)	0.554
Stage 5	-0.538	0.584	(0.04-8.54)	0.694
Tanner stage				
Stage 1	(Reference)			
Stage 2	0.158	1.172	(0.17-7.99)	0.872
Stage 3	1.167	3.212	(0.46-22.35)	0.239
Stage 4	0.042	1.043	(0.12-8.68)	0.969
Stage 5	1.294	3.647	(0.25-52.18)	0.341

*p<0.05 is considered for significance
MPS: Myofascial pain syndrome, SD: Standard deviation, CL: Cervical lordosis, TK: Thoracic kyphosis, LL: Lumbar lordosis, TRACE: Trunk Aesthetic Clinical Evaluation, CI: Confidence interval

This study is important for the clinical evaluation of patients with scoliosis and back pain. The results suggested that the source of pain in these patients might be MPS. To our knowledge, this is the first study to investigate the relationship between MPS and coronal and sagittal alignment in AIS. Also, prospective study design can be accounted as a strength of the study.

Study Limitations

There are also some limitations of this study. These results may not apply to moderate to severe and severe scoliosis. Additionally, pain could be classified as chronic or acute pain. Also, it was a cross-sectional study, so the presence of instant pain was investigated. Longitudinal studies can be designed to prevent this situation.

Table 4. Comparison of the outcome measures between three subgroups in MPS-group

	Mild pain (n=54)	Moderate pain (n=35)	Severe pain (n=17)	p^a	p^b	95% CI of the difference	
						Lower	Upper
Cobb angle (°)	22.4 (8.3)	23.1 (9.3)	20.1 (7.5)	0.631	Mild-mod: 0.976	-5.44	0.4.02
					Mild-sev: 0.678	-3.25	7.66
					Mod-sev: 0.550	-3.10	8.94
TRACE	5.0 (2.0)	5.7 (2.2)	5.2 (2.7)	0.302	Mild-mod: 0.370	-1.82	0.45
					Mild-sev: 0.993	-2.05	1.69
					Mod-sev: 0.884	-1.44	2.45
CL (°)	14.7 (10.9)	15.4 (11.7)	14.7 (7.5)	0.935	Mild-mod: 0.987	-6.80	5.31
					Mild-sev: 1.000	-5.90	5.81
					Mod-sev: 0.992	-5.97	7.36
TK (°)	40.2 (13.9)	43.3 (16.7)	46.8 (16.1)	0.151	Mild-mod:0.370	-1.82	0.45
					Mild-sev: 0.993	-2.05	1.69
					Mod-sev: 0.884	-1.44	2.45
LL (°)	49.8 (11.6)	54.1 (16.8)	60.6 (10.4)	0.008*	Mild-mod: 0.485	-12.23	3.78
					Mild-sev: 0.003*	-18.28	-3.26
					Mod-sev: 0.250	-15.94	2.85
SVA (°)	19.7 (17.9)	15.5 (10.0)	16.9 (10.5)	0.891	Mild-mod: 0.408	-3.02	11.42
					Mild-sev: 0.809	-5.87	11.54
					Mod-sev: 0.960	-9.08	6.35
PT (°)	8.5 (10.7)	11.5 (8.9)	6.5 (12.3)	0.142	Mild-mod: 0.394	-8.13	2.09
					Mild-sev: 0.915	-6.57	10.50
					Mod-sev: 0.384	-3.59	13.56
PI (°)	36.2 (25.0)	42.8 (24.1)	34.3 (31.6)	0.964	Mild-mod: 0.520	-19.58	6.36
					Mild-sev: 0.995	-19.74	23.52
					Mod-sev: 0.709	-13.70	30.70
SS (°)	31.9 (20.0)	32.1 (18.9)	27.9 (24.1)	0.377	Mild-mod: 1.000	-10.42	10.14
					Mild-sev: 0.901	-12.52	20.59
					Mod-sev: 0.900	-12.82	21.17
Location of the curve n (%)				0.131	-	0.04	0.34
Thoracic	21 (38.9%)	20 (37%)	13 (24.1%)	-	-	-	-
Thoracolumbar	14 (40%)	7 (20%)	14 (40%)	-	-	-	-
Lumbar	10 (58.8%)	5 (29.4%)	2 (11.8%)	-	-	-	-
Location of the pain n (%)				0.568	-	0.03	0.32
Thoracic	24 (44.4%)	23 (42.6%)	7 (13%)	-	-	-	-
Thoracolumbar	20 (57.1%)	11 (31.4%)	4 (11.4%)	-	-	-	-
Lumbar	7 (41.2%)	6 (35.3%)	4 (23.5%)	-	-	-	-

p^a: Significance value for inter-group analysis, p^b: Significance value for post-hoc analysis, *p<0.05 is considered for significance.
MPS: Myofascial pain syndrome, CL: Cervical lordosis, TK: Thoracic kyphosis, LL: Lumbar lordosis, TRACE: Trunk Aesthetic Clinical Evaluation, PT: Pelvic tilt, SS: Sacral slope, PI: Pelvic incidence, SVA: Sagittal vertical axis, mod: Moderate, sev: Severe, CI: Confidence interval

CONCLUSION

In conclusion, MPS should be remembered as a source of pain in AIS. Although the pain severity did not change, a relationship was found between the presence of myofascial pain and spinal alignment and curve magnitude. In the future, studies investigating the pain sub-groups in AIS will be affected positively in terms of providing effective treatment methods.

Ethics

Ethics Committee Approval: The study protocol was approved by the University of Health Sciences Turkey, İstanbul Kanuni Sultan Süleyman Training and Research Hospital Ethical Board in conformity with the Declaration of Helsinki (under number: KAEK/2020.07.128).
Informed Consent: Written and verbal consent forms were obtained from the participants.
Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.D.K., M.K., Y.F.A., T.A., Concept: M.D.K., M.K., T.A., Design: M.D.K., M.K., T.A., Data Collection or Processing: M.D.K., M.K., Y.F.A., T.A., Analysis or Interpretation: M.D.K., M.K., Literature Search: M.D.K., Writing: M.D.K., M.K.
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