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Correlation between Shoulder Pain, Disability and Axial Thoracolumbar Vertebral Rotation in Subacromial Impingement Syndrome

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ABSTRACT
Background: Subacromial impingement syndrome (SIS) is the most frequent condition affecting the shoulder. Although there is little evidence about the relation between shoulder pain, disability and axial thoracolumbar vertebral rotation in patients with SIS.
Objective: This study aimed to determine the relation between shoulder pain, disability and axial thoracolumbar vertebral rotation in cases of SIS.
Patients and methods: A total of 34 Individuals of both sexes with a mean age of 27.76 ± 6.15 years and a mean BMI of 25.16 ± 2.82 kg/m^2 were recruited for the study with a diagnosis of unilateral SIS. Shoulder pain and disability levels were assessed by shoulder pain and disability index (SPADI), while axial thoracolumbar vertebral rotation was assessed using a scoliometer.
Results: Current research revealed that the mean of axial thoracolumbar vertebral rotation for all subjects was 5.09 ± 0.93 degrees with the minimum and maximum rotation found as 4 and 7 degrees respectively and this was considered within normal values, also there was no significant correlations between pain, disability and total score of SPADI and axial thoracolumbar vertebral rotation
Conclusion: Patients with SIS had a normal axial thoracolumbar vertebral rotation.
Keywords: SIS, SPADI, Axial thoracolumbar vertebral rotation.

INTRODUCTION
Subacromial impingement syndrome (SIS) is one of the most prevalent shoulder conditions accounts for 44–65% of all shoulder pain diagnoses [(1)]. It happens when the subacromial space gets too narrow. It can impact the supraspinatus tendon, the subacromial bursa, and the long head of the biceps tendon, all of which are located in this region [(2)]. Shoulder pain and disability are common in SIS patients who have no documented history of trauma. Elevating the arm and lying on the affected side are the primary causes of this pain [(3)].

The pathogenesis of SIS is multifaceted, with symptoms induced by both intrinsic and extrinsic causes. Intrinsic SIS may result from inflammation of the subacromial bursa or degeneration of the rotator cuff tendons. Extrinsic SIS may be associated with postural dysfunction of the scapula and spinal column, or weak or dysfunctional rotator cuff and scapular muscles [(4)].

Numerous studies provided evidence for the connection between the shoulder girdle's function, scapular orientation, and spinal position. Firstly, the humerus, clavicle, scapula, and spine are all connected anatomically by several articulations and muscles. The orientation of these bones affects the length of the muscles and their capacity to produce tension. Also, these muscles can directly affect the orientation of these bony components [(5)].

Secondly, SIS has been correlated with several postural abnormalities. These include a downward rotation, a protracted and anteriorly tilted scapula, an anterior shoulder posture, and increased thoracic kyphosis. The subacromial space may decrease as a result of these postural abnormalities, leading to shoulder dysfunction and SIS [(5)]. Based on this, postural evaluation became an integral common component in the evaluation of shoulder musculoskeletal problems [(6)].

Furthermore, it is believed that the alignment of the spine might influence the orientation of the scapula. It has been found that subjects with lateral deviation of the spine demonstrated the scapula on the convex side was more internally and anteriorly inclined, whereas the one on the concave side was more externally, downwardly rotated, and tilted posteriorly [(7)]. The scapula is the firm foundation for the position and function of the shoulder and upper limb. Consequently, when the scapula is abnormally oriented, it can affect the shoulder joint mechanics and lead to shoulder pathology as SIS [(8)].

So, the current study aimed to investigate the relationship between shoulder pain, disability levels and axial thoracolumbar vertebral rotation as a measure for the spinal lateral deviation in patients with SIS.

PATIENTS AND METHODS
This study was a cross-sectional study that was conducted at the outpatient clinic at the Faculty of Physical Therapy, Cairo University, Egypt.

Study Participants and recruitment criteria:
The study included a total of 34 patients with SIS according to the sample size calculation using G* power application program (version 3.1.9.7, Franz Faul, University at Kiel, Germany).

Inclusion criteria: Non-athletic patients of both sexes, and aged between 20-40 years with a BMI between 18.5-29.9 kg/m^2. An orthopedic surgeon referred patients who had been diagnosed with unilateral SIS (Stage I, or II), with four or more of the following findings: Shoulder pain that was located either

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anteriorly or laterally to the acromion process, tender greater tuberosity of the humerus, pain worsening by shoulder flexion and/or abduction, a painful movement arc ranging from 60° to 120°, positive supraspinatus empty-can test, Neer impingement sign, external rotation resistance test, and Hawkins test [5, 9-11].

Exclusion criteria: Systematic illnesses, pregnancy, any degenerative disorders or disc lesions, upper limbs or spinal fractures or surgeries, shoulder instability, cervical radiculopathy, adhesive capsulitis, tumors, shoulder labral or cartilage lesions, capsular or ligamentous tears or avulsions and any apparent deformity in the lower limbs including leg length discrepancy [9].

I- Instrumentation:

1. **The shoulder pain and disability index (SPADI):** The SPADI was used to assess shoulder pain and disability in five conditions, as well as the amount of difficulty in eight activities. SPADI's total score ranges from 0 to 100%, with higher values indicating more disability [12]. The Arabic SPADI demonstrated high concept validity, test-retest reliability, and internal consistency (ICC = 0.95 [0.91-0.97]. It correlates significantly with Quick DASH, NRS, and shoulder ROM. SPADI is highly suggested for evaluating persons with shoulder difficulties [13].

2. **Scoliometer:** It is a simple and inexpensive equipment that measures the angle of spinal rotation in the lumbar and thoracic areas [14]. It has a metal sphere placed within a water receiver. The sphere may be shifted to either side in a range of 0 to 30 degrees on an increasing unit scale. The Scoliometer's intra-observer and interobserver reliability range from very good to excellent, and it is considered as a valuable screening tool. Additionally it has a good sensitivity (71%) and specificity (83%) in detection of vertebral rotation especially in the thoracic spine. It has been found that the Scoliometer's validity is reasonable to very good when compared to the Gold Standard Cobb angle obtained from radiography [14-17].

II- Assessment procedures:

1. **The shoulder pain and disability levels:** Shoulder pain and disability were assessed using the Arabic version of SPADI, which comprises five categories for pain and eight categories for disability. When laying on the affected side, pushing with the affected arm, feeling the back of your neck, and reaching for something on a high shelf, the pain was measured at its worst. Hair washing, back washing, putting on an undershirt or jumper, putting on a shirt with buttons down the front, putting on pants, setting an object on a high shelf, carrying a ten-pound heavy object, and taking something out of the back pocket were all used to determine the impairment level. For every category, a visual analogue scale with a range of 0 to 10 points was offered and participants were asked to rate their degree of symptomatology. When it comes to pain, a subject who scored 0 felt no pain at all, whereas 10 was in severe pain. In the same way, in the disability category score of 0 denoted no trouble, whereas a score of 10 denoted extreme difficulty requiring help. The pain score, disability score, and total SPADI score were calculated by adding the scores and converting them into percentages [18].

2. **Axial thoracolumbar vertebral rotation:** Axial vertebral rotation is mostly linked to lateral displacement of the spine in the coronal plane, so assessment of axial TL vertebral rotation is an indirect method of assessing lateral spinal deviation [19]. Participants were barefoot throughout the measurement. They were instructed to take off their upper body clothes, with the exception of ladies wearing gowns with bare backs. When the individual was upright, the spinous processes of each thoracic and lumbar vertebra, from T1 to L5, were palpated. Demographic pens were used to mark the spinous processes [20].

The patient was instructed to bend his trunk such that it was nearly parallel to the ground, with relaxed arms hanging perpendicular to the trunk and folded hands. The scoliometer was positioned by placing the device's center on the mark corresponding to each vertebra's spinous process. The therapist held the scoliometer perpendicular to the spine's axial axis above the spinous process and moved it with contact with the skin from L5 to T1 and from T1 to L5, while maintaining its perpendicular orientation. The therapist detected the level of the spine that has the greatest axial vertebral rotation which had the largest reading in the scoliometer. These whole procedures were repeated for three trials and the average of the three trials was determined as the angle of axial thoracolumbar vertebral rotation (figure 1). The patient was allowed to rest and straight his back for few seconds between the three trials[20].

Figure (1): The evaluation of vertebral rotation using scoliometer.

Ethical approval:

The study was approved by The Ethical Committee of the Faculty of Physical Therapy, Cairo University (No: P.T.REC/012/005179). Objectives and procedures of the study were illustrated for each patient before the beginning of the study with insurance of full privacy. Everyone completed an informed written permission form. Throughout its implementation, the study complied with the Helsinki Declaration.

Data analysis:

SPSS for Windows, version 26.0, was used for statistical analysis. After then, the numerical data was presented as medians and ranges or mean ± SD and variances. The Shapiro-Wilk test was used to screen the data for the normalcy assumption, and Levene's test was used to check for homogeneity of variance and the existence of extreme scores. To check for correlation, the Pearson correlation coefficient test was employed. A p-value ≤ 0.05 was established as the threshold for significance.

RESULTS

Normality tests revealed that all dependent variables were normally distributed except axial thoracolumbar vertebral rotation and did not violate the parametrical assumption.

The outcomes being analyzed:

1. Descriptive statistics for all patients' characteristics.
2. Pain and functional disability of the shoulder as assessed by SPADI (pain score, functional score, and total SPADI score) in percentage.
3. Thoracolumbar (TL) vertebral rotation in degrees.

A. Descriptive statistics for the patient's characteristics:

34 patients with unilateral SIS were recruited in the study, with a mean age of 27.76 ± 6.15 years, and mean BMI of 25.162 ± 2.82 kg/m². Gender distribution revealed that there were 11 females and 23 males. All the sample was right dominant shoulder and the affected shoulder distribution revealed that 76.5% of the patients had right shoulders affected and 23.5% had left shoulders affected (Table 1).

Table (1): Descriptive statistics for the demographics

	N	Range	Minimum-Maximum	Mean ± SD
Age (years)	34	20	20-40	27.76 ± 6.15
Weight (kg)	34	50.0	50.0-100.0	74.78 ± 13.24
Height (m)	34	.37	1.50-1.87	1.72 ± 0.101
BMI (kg/m²)	34	9.1	20.1-29.2	25.16 ± 2.82

B. Descriptive statistics for all dependent variables: The descriptive statistics for all dependent variables as expressed in mean ± SD, minimum, and maximum are illustrated in **(Table 2)**.

Table (2): Mean values of all dependent variables.

	N	Range	Minimum-Maximum	Mean ± SD
SPADI pain score	34	53	19-72	51.76 ± 13.95
SPADI function score	34	68.8	13.1-81.9	44.37 ± 16.18
SPADI total score	34	55.4	22.3-77.7	47.60 ± 14.09
TL vertebral rotation	34	3	4-7	5.09 ± 0.93

C. The correlation between the SPADI pain, function and total score and the axial thoracolumbar vertebral rotation: Parametric correlation analysis revealed no significant correlations between the SPADI pain, function, total score and axial thoracolumbar vertebral rotation (Table 3). Scatter plots for the correlations are illustrated in figures (2-4).

Table (3): The correlation between SPADI pain, function, total score and axial thoracolumbar vertebral rotation

	Parametric correlation	SPADI pain score	SPADI function score	SPADI total score
TL axial vertebral rotation	Pearson Correlation	0.200	0.215	0.215
	Sig. (2-tailed)	0.258	0.222	0.223
	N	34	34	34

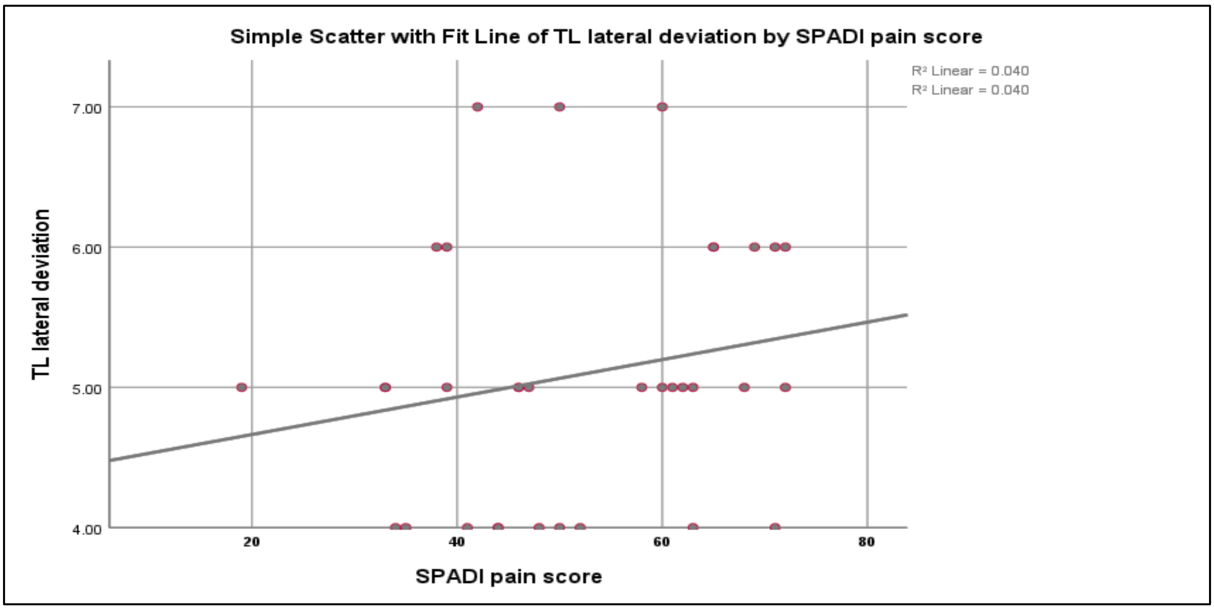

Figure (2): Scatter plot for the correlation between SPADI pain score and axial TL vertebral rotation.

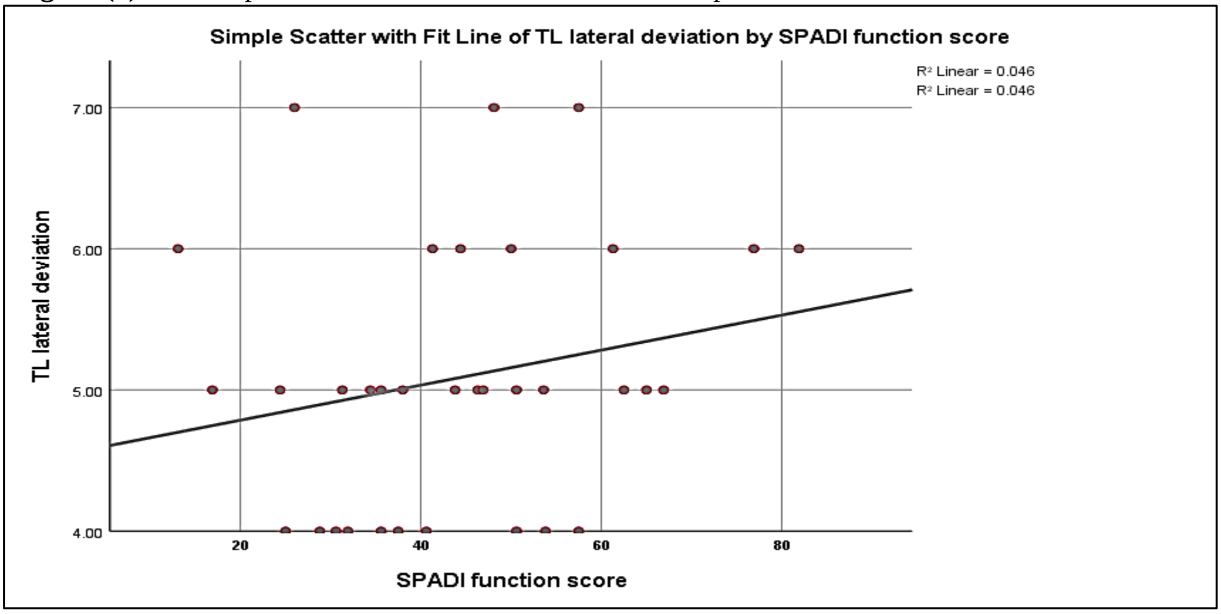

Figure (3): Scatter plot for the correlation between SPADI function score and axial TL vertebral rotation.

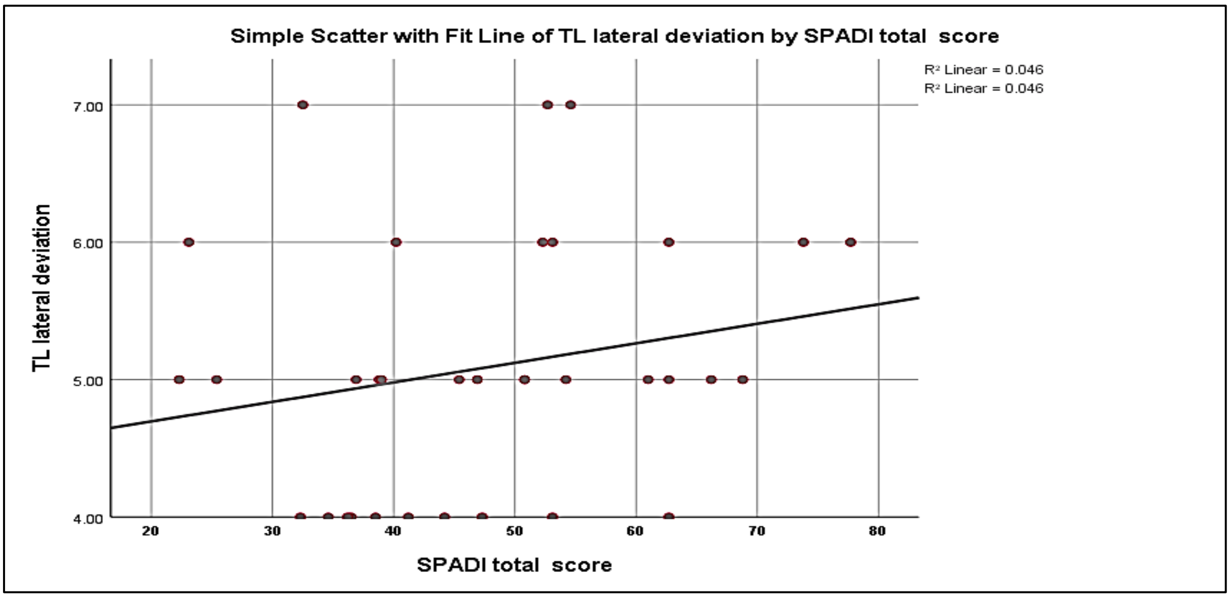

Figure (4): Scatter plot for the correlation between SPADI total score and axial TL vertebral rotation.

DISCUSSION

The current study was conducted to investigate the correlation between shoulder pain, disability and axial thoracolumbar vertebral rotation in patients with unilateral SIS.

The current results revealed that the angle of axial TL vertebral rotation for all patients was ranging between 4 to 7 degrees with the mean of 5.09 ± 0.93 degrees. This indicates the presence of vertebral rotation and lateral deviation but not to a significant degree to be considered as abnormal lateral spinal deviation, which need further investigation. Previous researches supported values of axial vertebral rotation greater than 7 degrees to be considered as a cut point referral for further investigation for the diagnosis of abnormal lateral spinal deviation [21, 22].

No significant correlations have been found between SPADI (pain, function and total) score and axial thoracolumbar vertebral rotation (r=0.200, 0.215, and 0.215 and p=0.258, 0.222, and 0.223 respectively). These result is supported by **Fathy** [5] who found abnormalities in the thoracic spine posture in the sagittal plane in patients with SIS, but found no correlation between shoulder pain, disability and these postural abnormalities. This might be explained by the need for long time for shoulder pain and disability to be adapted by abnormal spinal postures. This might raise the possibility for long term follow up for these cases. However, other researchers investigated the relation between the angle of axial vertebral rotation and scapular position, which can affect the shoulder girdle. They found that the scapular position is affected during rest and motion in patients with excessive lateral deviation of the spine [7, 8]. This can raise the relation between vertebral rotation, lateral spinal deviation and scapular and shoulder kinematics, which can lead to shoulder pathology as SIS [5, 8, 23]. Also The research made by **Gur *et al.*** [24] found a relation between spinal vertebral rotation and shoulder girdle problems. They found that improving lateral spinal deviation by bracing treatment decreased spinal vertebral rotation. As a consequence, this improved scapular abnormal movement and shoulder girdle problems including SIS.

The conflict between the results of current research and other researches that found significant correlation might be due to the sample they used that may be already having abnormal lateral curvature of the spine, but current study used a sample of SIS without apparent spinal deformities. Also, this can be attributed to the intensity of pain and functional disability as the pain and dysfunctional levels of the patients recruited in our study that were between mild to moderate only.

We would suggest for future research to recruit patients with different levels of pain and disability, ranging from mild to severe. Also to follow up these cases to investigate the long-term effect of shoulder affection on the spine.

CONCLUSION

According to the study's findings, there is no significant correlation between shoulder pain, disability and axial thoracolumbar vertebral rotation in patients with SIS.

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