Relationship between Radiological Measurements of Subcoracoid Impingement and Subscapularis Tendon Lesions

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Background: The value of radiological measurements of subcoracoid impingement such as the coracohumeral interval in predicting subscapularis tendon injuries is controversial. We aimed to assess the relationship between radiological measurements of subcoracoid impingement and subscapularis tendon lesions in young and middle-aged adults.

Methods: This study was designed as a retrospective cohort study. Patients between the ages of 18–55 years without a history of shoulder surgery or major trauma were included and patients with arthritis, instability, or retracted rotator cuff tears were excluded from the study. Magnetic resonance images were evaluated and patients were grouped into two according to the subscapularis tendon condition: normal or pathologic. Glenoid version, axial coracohumeral distance, coracoglenoid angle, coracoid index, sagittal coracoid-glenoid tubercule distance, and axial coracoacromial inclination-glenoid version difference were measured for all patients. Measurement findings were compared between the groups. Correlation analysis was performed for age and radiologic measurements. A p < 0.05 was considered statistically significant for all tests.

Results: A total of 298 patients, 107 women (35.1%) and 191 men (64.9%), with a mean age of 34.46 ± 10.10 years (range, 18–55 years) were examined in the study. Subscapularis tendon pathology was noted in 85 patients (28.5%). The diagnosed pathologies were tendinosis in 48 patients (56.5%), partial tears in 28 (32.9%), and full thickness tears in 9 (10.6%). A significant relationship was observed between increasing age and subscapularis tendon lesions (p = 0.001). There was no statistically significant relationship between subscapularis pathology and calculated measurements. Axial coracohumeral distance and coracoglenoid angle measurements showed a statistically significantly negative correlation with age. A positive correlation was found between axial coracohumeral distance and coracoglenoid angle measurements (p < 0.001) and also between glenoid version and coracoid index measurements (p = 0.004). Axial coracohumeral distance and coracoglenoid angle measurements showed a negative correlation with glenoid version and coracoid index measurements (p < 0.05).

Conclusions: In this study, the coracohumeral distance and coracoglenoid angle decreased and the incidence of subscapularis tendon lesions increased as the age progressed. However, no relationship was found between radiological measurements and subscapularis tendon lesions.

Keywords: Subcoracoid impingement, Subscapularis tendon, Axial coracohumeral distance, Coracoglenoid angle, Coracoid index
Subscapularis tendon pathologies represent a spectrum ranging from tendon degeneration to full-thickness tears. The etiology is attributed to be multifactorial with intrinsic, extrinsic, and environmental factors. Subcoracoid impingement is thought to be an important factor in degenerative subscapularis tendon pathologies. Subcoracoid impingement is a result of compression between lesser tuberosity and coracoid process. Subscapularis tendon could be trapped in this narrowed space during shoulder range of motion, especially in addition, forward flexion, and internal rotation position. It has been mentioned that coracohumeral distance is decreased by internal rotation.

Subcoracoid impingement could be caused by idiopathic, traumatic, and iatrogenic reasons. Acquired conditions like previous surgery, fracture malunion or nonunion, glenohumeral instability, anterior-superior migration of humeral head due to rotator cuff insufficiency, or mass lesions in subcoracoid area can be diagnosed more easily. However, a primary reason with anatomic variation prone to coracohumeral impingement is challenging in diagnosis. X-ray, ultrasonography (USG), computed tomography (CT), and magnetic resonance (MR) imaging are used to diagnose the secondary pathologies and also provide information about anatomic variation in primary cases. Radiologic measurements on MR images such as coracoid index, coracohumeral interval, and coracoglenoid angle were studied to define the relation between subscapularis tendon pathology and subcoracoid impingement. However, the effort to understand the relation of subscapularis tendon pathology with imaging measurements is still lacking.

The prevalence of rotator cuff pathologies has been reported to be associated with increasing age. In a population-based study evaluating the epidemiology of rotator cuff tears, the relationship between rotator cuff tears and age was found as 66.7 ± 10.1 years and 55.6 ± 12.5 years for rotator cuff tear and non-tear groups, respectively. It has been emphasized in the literature that there may be changes in the coracoid morphology with increasing age. To our knowledge, many studies evaluating the relationship between radiological measurements and subscapularis tendon pathology were conducted in patients with advanced age. In our opinion, the relationship between narrowing of the coracohumeral distance and subscapularis pathologies in elderly patients can be evaluated as a coexistence rather than a cause and effect relationship. Our theory is that there will be no relationship between radiological parameters and subscapularis tendon pathology when a younger patient group is examined. In addition, this study aimed to evaluate the differences in radiologic measurements of subcoracoid impingement with increasing age.

**METHODS**

This study was designed as a retrospective cohort study. The approval of Institutional Ethical Review Board of Near East University Hospital was obtained for this study (IRB No. YDU/2020/85-1192). Informed consent was waived. Shoulder MR images of 1,057 patients obtained between March 2018 and May 2020 were reviewed using the digital radiology database of our institution. Hospital records and MR images of the patients were investigated for inclusion and exclusion criteria. Adult patients who had MR imaging for insidious, long-lasting shoulder pain between ages 18–55 years without previous history of surgery and major trauma were included in the study. Patients with degenerative joint diseases, calcific tendinitis, mass lesions, signs of previous trauma or surgery, findings of instability, and decentralized humeral head were excluded. Also, patients with retracted full thickness (stage 2 and 3 lesions according to the Patte's classification or massive rotator cuff tears (large and massive tears based on Deorio and Cofield classification) were excluded as the rotator cuff dysfunction may affect the coracohumeral distance and other radiologic measurements. After applying the inclusion and exclusion criteria, the MR images of the remaining 298 patients were included in the study. Radiologic measurements of subcoracoid impingement and subscapularis tendon pathologies were investigated in these patients. MRI evaluation for subscapularis tendon pathology and all the measurements were done by a senior musculoskeletal radiologist (YK).

The patients were grouped into two according to the subscapularis tendon condition: normal or pathologic. Cases with tendinosis, partial articular or bursal side tears, and nonretracted full thickness tears in the subscapularis tendon on MR images were considered pathologic. The integrity of the subscapularis tendon was evaluated on axial and sagittal MR images. A normal tendon was defined as an intact tendon without any pathological signal change. A partial tear was defined as a partial detachment from the lesser tuberosity or defect on the articular or bursal side of the tendon with a preserved continuity of the remaining part of the tendon. A full-thickness tear was defined as a disruption of continuity of the tendon. Glenoid version, axial coracohumeral distance, coracoglenoid angle, coracoid index, sagittal coracoid-glenoid tubercle distance, and coracoacromial inclination-glenoid version difference were measured in all patients. Demographic characteris-
tics were recorded. Measurement findings were compared between pathologic and normal subscapularis tendon groups.

MR imaging of all patients evaluated in the study were performed in a single institute (Near East University Hospital). MRI examinations were performed using shoulder coil with a 1.5 T system (Magnetom Aera; Siemens Healthcare, Erlangen, Germany). In our department, the standard imaging protocol for shoulder MR imaging includes axial proton density turbo spin-echo (TSE) fat-suppressed (FS) images (TR, 1,540 ms; TE, 38 ms; echo-train length, 14; slice thickness, 3 mm; slice gap, 0.6 mm; matrix, 224 × 320; and FOV, 20 cm), sagittal proton density TSE FS images (TR, 1,600 ms; TE, 27 ms; echo-train length, 21; slice thickness, 3 mm; slice gap, 0.3 mm; matrix, 240 × 320; and FOV, 18 cm), sagittal T1 TSE images (TR, 438 ms; TE, 10 ms; echo-train length, 48; slice thickness, 3 mm; slice gap, 0.3 mm; matrix, 240 × 320; and FOV, 18 cm), coronal proton density TSE FS images (TR, 1,330 ms; TE, 27 ms; echo-train length, 23; slice thickness, 3 mm; slice gap, 0.6 mm; matrix, 240 × 320; and FOV, 20 cm), and coronal T1 TSE images (TR, 365 ms; TE, 10; echo-train length, 52; slice thickness, 3 mm; slice gap, 0.6 mm; matrix, 240 × 320; and FOV, 20 cm). The standard shoulder MRI protocol at our radiology department is obtained with the patient in the supine position with the arm in neutral position. The coil and non-magnetic pillow positioners are used to support the position and prevent movement of the shoulder. Digital image viewer with standard calibrated measurement tools was used (Synapse 3D; Fujifilm Corp., Tokyo, Japan) for the measurements.

**Measurements**

**Glenoid version**

Glenoid version measurements were performed according to the method described by Friedman et al.\(^\text{13}\) as the angle between the line connecting the medial tip of the scapular spine and the center of the glenoid fossa and the line drawn tangential to the glenoid rim on the axial image (Fig. 1).

**Axial coracohumeral distance**

Axial coracohumeral distance was measured as described by Gerber et al.\(^\text{14}\) The narrowest point between the coracoid tip and the humeral head was measured on the axial image (Fig. 2).

**Coracoglenoid angle**

Coracoglenoid angle measurements were performed according to the method described by Asal and Sahan\(^\text{4}\) as the angle between the line tangential to the glenoid rim and the line projecting from the anterior edge of the glenoid to the coracoid tip on the axial image (Fig. 3).

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**Fig. 1.** Glenoid version was measured as the angle between the line connecting the medial tip of the scapular spine and the center of the glenoid fossa and the line drawn tangential to the glenoid rim on the axial image. First, a line is formed by connecting the medial tip of the scapular spine and the center of the glenoid fossa. Second, a line is drawn perpendicular to the first line. Third, a line is the tangential line to the glenoid rim. Asterisk shows the glenoid version as the angle between the second and third lines.

**Fig. 2.** Axial coracohumeral distance was measured as the narrowest point between the coracoid tip and the humeral head on the axial image. The line is drawn from the coracoid tip to the closest point of the humeral head on the axial image and the measured length of the line shows the axial coracohumeral distance.
Coracoid index

Coracoid index was measured as described by Gerber et al.\textsuperscript{14} as the perpendicular distance from the coracoid tip to the line drawn tangential to the glenoid rim on the axial image (Fig. 4).

Fig. 3. Coracoglenoid angle was measured as the angle between the line tangential to the glenoid rim and the line projecting from the anterior edge of the glenoid to the coracoid tip on the axial image. First, a line is drawn tangential to the glenoid rim. Second, another line is formed by connecting the anterior edge of the glenoid to the coracoid tip. Asterisk shows the coracoglenoid angle as the angle between the first and second lines.

Fig. 4. Coracoid index was measured as the perpendicular distance from the coracoid tip to the line drawn tangential to the glenoid rim on the axial image. The first line is the tangential line to the glenoid rim. The second line is the line starting from the coracoid tip and running perpendicular to the first line. The distance between the coracoid tip and the intersection point of the first and second lines is the coracoid index.

Fig. 5. Sagittal coracoid-glenoid tubercule distance (CGD) was measured as the distance between the coracoid tip and the supraglenoid tubercule on the sagittal image. In cases where the coracoid tip and the supraglenoid tubercule were not in the same line, measurements were made using the sagittal projection of the coracoid tip at the level of the supraglenoid tubercle. The first line is drawn to bisect the glenoid on sagittal image. The most superior point of the glenoid crossed by the line bisecting the glenoid is marked as the supraglenoid tubercule. The length of the line connecting coracoid tip to the supraglenoid tubercule is the sagittal coracoid-glenoid tubercule distance.

Axial coracoacromial inclination-glenoid version (CA-GV) difference was measured as the angle between the line connecting the axial projection of acromion tip and coracoid tip and the line drawn tangential to the glenoid rim on the axial image. The repoints are used to figure axial projection of the acromion at the level of the coracoid tip. First, a line is drawn from the tip of projected acromion to the coracoid tip. Second, another line is drawn tangential to the glenoid rim. Asterisk is the angle between the first and second lines as the axial coracoacromial inclination-glenoid version difference.
**Sagittal coracoid-glenoid tubercule distance**

Sagittal coracoid-glenoid tubercule distance measurements were performed based on the method described in the study of Porter et al.\(^{15}\) as the distance between the coracoid tip to the supraglenoid tubercle on the sagittal image (Fig. 5). In cases where the coracoid tip and the supraglenoid tubercle were not in the same sequence, measurements were made using the sagittal projection of the coracoid tip at the level of the supraglenoid tubercle.

**Axial coracoacromial inclination glenoid version difference**

Axial coracoacromial inclination glenoid version difference was measured as the angle between the line connecting the axial projection of acromion tip and coracoid tip and the line drawn tangential to the glenoid rim on the axial image (Fig. 6). To our knowledge, this measurement has not been previously described and it was created by the authors.

**Statistical Analysis**

All statistical analyses were performed using the IBM SPSS ver. 25 software (IBM Corp., Armonk, NY, USA). Categorical variables were given as absolute and percentage values. Continuous variables were presented as means and standard deviations. Chi-square test was used to assess differences for categorical variables and independent \(t\)-test was used for comparison of continuous variables between the groups (presence or absence of subscapularis tendon pathologies). Pearson correlation analysis was performed for age and radiologic measurements (glenoid version, axial coracohumeral distance, coracoglenoid angle, and coracoid index). A \(p < 0.05\) was considered statistically significant for all tests.

**RESULTS**

A total of 298 patients, 107 women (35.1%) and 191 men (64.9%), were examined in the study. The mean age of the study group was 34.46 ± 10.10 years (range, 18–55 years). Subscapularis tendon pathology was noted in 85 patients (28.5%) with a mean age of 38.08 ± 9.08 years. The diagnosed pathologies were tendinosis in 48 patients (56.5%), partial tears in 28 (32.9%) and total tears in 9 (10.6%). Of the patients with subscapularis tendon pathology, 23 (27.1%) were women and 62 (72.9%) were men. Subscapularis tendon was noted normal in 213 patients (71.5%) with a mean age of 33.02 ± 10.14 years. Of the patients with normal subscapularis tendon, 84 (39.4%) were women and 129 (60.6%) were men. There was a statistically significant relation between increasing age and subscapularis tendon pathology (\(p = 0.001\)). Tendon pathologies were significantly more common in male sex (\(p = 0.040\)). Demographic features of the study population were given in Table 1.

The mean glenoid version angle was \(-2.93° ± 3.48°\) in the whole study group, \(-3.19° ± 3.45°\) in the group with subscapularis tendon pathology, and \(-2.83° ± 3.50°\) in the group with normal subscapularis tendon. The mean axial coracohumeral distance was 11.87 ± 3.59 mm, 11.76 ± 3.03 mm, and 11.92 ± 3.79 mm in the whole study group, pathologic group, and normal group, respectively. The mean coracoglenoid angle of the whole study group,

| Variable | Pathologic (n = 85) | Normal (n = 213) | Total (n = 298) | Value |
|----------|---------------------|------------------|----------------|-------|
| Age (yr) | 38.08 ± 9.08        | 33.02 ± 10.14    | 34.46 ± 10.10  |       |
| Sex      |                     |                  |                |       |
| Female   | 23 (27.1)           | 84 (39.4)        | 107 (35.9)     |       |
| Male     | 62 (72.9)           | 129 (60.6)       | 191 (64.1)     |       |
| Side     |                     |                  |                |       |
| Right    | 55 (64.7)           | 134 (62.9)       | 189 (63.4)     |       |
| Left     | 30 (35.3)           | 79 (37.1)        | 109 (36.6)     |       |

\(^{1}\)Values are presented as mean ± standard deviation or number (%).
\(^{t}\): Independent \(t\)-test, \(\chi^2\): chi-square test.

\(^{*}\)Statistically significant at the 0.05 level.
Table 2. Radiologic Measurements of the Subscapularis Tendon and Their Relationships with the Subscapularis Tendon Pathology

| Subscapularis tendon                  | Pathologic (n = 85) | Normal (n = 213) | Total (n = 298) | Value               |
|--------------------------------------|---------------------|------------------|----------------|---------------------|
| Glenoid version (°)                  | –3.19 ± 3.45        | –2.83 ± 3.50     | –2.93 ± 3.48   | t = 0.798           |
|                                      |                     |                  |                | p = 0.426           |
| Axial coracohumeral distance (mm)    | 11.76 ± 3.03        | 11.92 ± 3.79     | 11.87 ± 3.59   | t = 0.327           |
|                                      |                     |                  |                | p = 0.744           |
| Coracoglenoid angle (°)              | 136.33 ± 10.11      | 136.32 ± 11.52   | 136.32 ± 11.12 | t = 0.007           |
|                                      |                     |                  |                | p = 0.994           |
| Coracoid index (mm)                  | 15.79 ± 3.44        | 15.47 ± 3.85     | 15.56 ± 3.73   | t = –0.654          |
|                                      |                     |                  |                | p = 0.514           |
| Sagittal coracoid-glenoid tubercule distance (mm) | 26.01 ± 3.60        | 26.03 ± 3.80     | 26.02 ± 3.74   | t = 0.034           |
|                                      |                     |                  |                | p = 0.973           |
| Axial coracoacromial inclination-glenoid version difference (°) | 28.41 ± 6.55        | 28.36 ± 7.53     | 28.38 ± 7.25   | t = –0.054          |
|                                      |                     |                  |                | p = 0.957           |

Values are presented as mean ± standard deviation.

Table 3. Correlation Analysis of Age and Radiologic Measurements

| Variable                  | Age       | Glenoid version | Axial coracohumeral distance | Coracoglenoid angle | Coracoid index |
|---------------------------|-----------|-----------------|------------------------------|---------------------|----------------|
| Age                       | Pearson correlation | 1     | –0.239*         | –0.160*           | 0.067           |
|                           | Significance (two-tailed) | 0.134 | 0               | 0.006             | 0.245           |
|                           | Number    | 298             | 298              | 298                | 298             |
| Glenoid version           | Pearson correlation | 0.087 | 1              | –0.259*           | –0.175*         | 0.165*         |
|                           | Significance (two-tailed) | 0.134 | 0               | 0.002             | 0.004           |
|                           | Number    | 298             | 298              | 298                | 298             |
| Axial coracohumeral distance | Pearson correlation | –0.239* | –0.259*         | 1                 | 0.656*          | –0.521*         |
|                           | Significance (two-tailed) | 0    | 0               | 0                 | 0               |
|                           | Number    | 298             | 298              | 298                | 298             |
| Coracoglenoid angle       | Pearson correlation | –0.160* | –0.175*         | 0.656*            | 1               | –0.730*         |
|                           | Significance (two-tailed) | 0.006 | 0.002           | 0                 | 0               |
|                           | Number    | 298             | 298              | 298                | 298             |
| Coracoid index            | Pearson correlation | 0.067 | 0.165*         | –0.521*           | –0.730*         | 1               |
|                           | Significance (two-tailed) | 0.245 | 0.004           | 0                 | 0               |
|                           | Number    | 298             | 298              | 298                | 298             |

*Correlation is significant at the 0.05 level (two-tailed).
pathologic group, and normal group was 136.32° ± 11.12°, 136.33° ± 10.11°, and 136.32° ± 11.52°, respectively. The mean coracoid index was 15.56 ± 3.73 mm in the whole study group, 15.79 ± 3.44 mm in the pathologic group, and 15.47 ± 3.85 mm in the normal group. The mean sagittal coracoid-glenoid tubercle distance was 26.02 ± 3.74 mm in the whole study group, 26.01 ± 3.60 mm in the pathologic group, and 26.03 ± 3.80 mm in the normal group. The mean axial coracoclavicular inclination-glenoid version difference of the whole study group, pathologic group, and normal group was 28.38° ± 7.25°, 28.41° ± 6.55°, and 28.36° ± 7.53°, respectively. The measurement results of glenoid version, axial coracohumeral distance, coracoglenoid angle, coracoid index, sagittal coracoid-glenoid tubercle distance, and coracoacromial inclination-glenoid version difference are given in Table 2. There was no statistical relationship between subscapularis pathology and calculated measurements.

Correlation analysis of age and radiologic measurements (glenoid version, axial coracohumeral distance, coracoglenoid angle, and coracoid index) are given in Table 3. A statistically significant negative correlation was observed between axial coracohumeral distance and coracoglenoid angle measurements and age (p < 0.001 and p = 0.006, respectively). There was no correlation between glenoid version and coracoid index measurements and age. The calculated measurements showed a significant correlation with each other (p < 0.05). A statistically significant positive correlation was observed between axial coracohumeral distance and coracoglenoid angle measurements (p < 0.001). Also, a positive correlation was found between glenoid version and coracoid index measurements (p = 0.004). Axial coracohumeral distance and coracoglenoid angle measurements showed a negative correlation with glenoid version and coracoid index measurements (p < 0.05).

**DISCUSSION**

In this study, it was found that the calculated radiologic variables were not related with subscapularis tendon pathology in 18–55 years age group. It was observed that the subscapularis pathology was related with increased age. It was also demonstrated that the coracohumeral distance and coracoglenoid angle had a negative correlation with age.

In a cadaver study in which the coracoid structures of young and elderly patients were evaluated, structural changes were observed in the coracoid bone in the elderly patient group. They reported a decreased coracohumeral distance, increased coracoid index, and a more hooked coracoid morphology in older specimens compared to young specimens. In our study, coracohumeral distance and coracoglenoid angle were negatively correlated with age. We assume that the difference in radiological measurement findings with increasing age is due to the morphological changes in the coracoid defined by Dugarte et al.7

There are studies in the literature that defined the relationship between subcoracoid impingement and radiological measurements. Previous studies investigated the relationship between radiological measurements including the coracohumeral interval and pathological changes of the subscapularis tendon. Asal and Sahan evaluated the radiologic variabilities in subcoracoid impingement. Contrary to our findings, they found that the coracohumeral distance and the coracoglenoid angle were associated with the subscapularis tendon pathology. Unlike us, they studied patients in the older age group with a mean age of 51.1 years (range, 18–80 years). The different findings of our study probably arose from the difference in the age group studied. In another study, Leite et al. reported the relationship of lower coracohumeral distance and higher coracoid overlapped with increased subscapularis and long head of biceps tendon pathologies. However, no information was given about the ages of the patients in the study group. On the other hand, Tollemar et al. reported that coracohumeral distance, coracoid overlap, and caudal extent of the coracoid process were not associated with subscapularis tears in their study in patients over 45 years of age with an average age of 56.5 years. The findings of Tollemar et al. are consistent with the results of our study. Balke et al. reported that the reduction of the coracohumeral distance was associated with degenerative subscapularis tendon tears, but not with traumatic tears. However, they mentioned that the mean age of patients in the degenerative tear group was 63 years (range, 37–79 years) and they were significantly older than those in the traumatic tears group and control group.

In our study, a significant relationship was observed between tendon pathology and male sex. Leite et al. also found a significant relationship between subscapularis tendon pathology and male sex. However, in our study, we do not think that this finding is significant because the age distribution between both sexes was not homogeneous and the number of male and female patients was not balanced.

In the literature, two theories about the relationship between coracohumeral distance and subscapularis tendon degeneration are advocated. The first theory is that primary stenosis of the coracohumeral distance is a risk factor for subscapularis and anterosuperior rotator cuff tears. The counter theory is that the anterosuperior trans-
lation of the humeral head and reduced coracohumeral distance are due to degenerative changes in the rotator cuff tendons. Micro-traumas caused by provocative repetitive movements can cause subscapularis degeneration, as well as morphological changes in the coracoid. In this study, we observed increased subscapularis pathology and decreased coracohumeral distance with increased age. Our theory is that subscapularis degeneration and coracohumeral distance narrowing are not caused by each other, but both are the result of advanced age and recurrent microtraumas.

To the best of our knowledge, this is the first study to evaluate the relationship between radiological parameters of subcoracoid impingement and subscapularis tendon pathologies in a young and limited age group. In this younger cohort, no significant relationship between radiological measurements and subscapularis lesions was found. We did however find that advanced age was associated with the development of subscapularis lesions. We therefore conclude that there is not a causative relationship between subcoracoid impingement and the development of subscapularis lesions in this population. We suggest that further studies are necessary to evaluate the relationship between radiological measurements of subcoracoid impingement and subscapularis tendon pathology in terms of a causal relationship or coincidence in older age groups.

There are some limitations to this study, which include inherent limitations of the retrospective study design, the lack of arthroscopic correlation of the rotator cuff lesions, possible variation in patient arm position during imaging, and lack of information on whether subscapularis lesions were traumatic or degenerative based on patient history. Another limitation of the study is the low diagnostic value of the 1.5 T MR imaging used in our study in the diagnosis of subscapularis tendon pathologies.

In this study, the coracohumeral distance and coracoglenoid angle decreased and the incidence of subscapularis tendon lesions increased as the age progressed. However, no relationship was found between radiological measurements and subscapularis tendon lesions. We suggest that further studies are necessary to evaluate the relationship between radiological measurements of subcoracoid impingement and subscapularis tendon pathology in terms of a causal relationship or coincidence in older age groups.

**CONFLICT OF INTEREST**

No potential conflict of interest relevant to this article was reported.

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**REFERENCES**

1. Osti L, Soldati F, Del Buono A, Massari L. Subcoracoid impingement and subscapularis tendon: is there any truth? Muscles Ligaments Tendons J. 2013;3(2):101-5.
2. Freehill MQ. Coracoid impingement: diagnosis and treatment. J Am Acad Orthop Surg. 2011;19(4):191-7.
3. Brunkhorst JP, Giphart JE, LaPrade RF, Millett PJ. Coracohumeral distances and correlation to arm rotation: an in vivo 3-dimensional biplane fluoroscopy study. Orthop J Sports Med. 2013;1(2):2325967113496059.
4. Asal N, Sahan MH. Radiological variabilities in subcoracoid impingement: coracoid morphology, coracohumeral distance, coracoglenoid angle, and coracohumeral angle. Med Sci Monit. 2018;24:8678-84.
5. Tempelhof S, Rupp S, Seil R. Age-related prevalence of rotator cuff tears in asymptomatic shoulders. J Shoulder Elbow Surg. 1999;8(4):296-9.
6. Yamamoto A, Takagishi K, Osawa T, et al. Prevalence and risk factors of a rotator cuff tear in the general population. J Shoulder Elbow Surg. 2010;19(1):116-20.
7. Dugarte AJ, Davis RJ, Lynch TS, Schickendantz MS, Farrow LD. Anatomic study of subcoracoid morphology in 418 shoulders: potential implications for subcoracoid impingement. Orthop J Sports Med. 2017;5(10):2325967117731996.
8. Balke M, Banerjee M, Greshake O, Hoeher J, Bouillon B, Lien D. The coracohumeral distance in shoulders with traumatic and degenerative subscapularis tendon tears. Am J Sports Med. 2016;44(1):198-201.
9. Richards DP, Burkhart SS, Campbell SE. Relation between narrowed coracohumeral distance and subscapularis tears. Arthroscopy. 2005;21(10):1223-8.
10. Patte D. Classification of rotator cuff lesions. Clin Orthop Relat Res. 1990;(254):81-6.
11. DeOrio JK, Cofield RH. Results of a second attempt at surgical repair of a failed initial rotator-cuff repair. J Bone Joint...
12. Lee H, Ahn JM, Kang Y, et al. Evaluation of the subscapularis tendon tears on 3T magnetic resonance arthrography: comparison of diagnostic performance of T1-weighted spectral presaturation with inversion-recovery and T2-weighted turbo spin-echo sequences. Korean J Radiol. 2018;19(2):320-7.

13. Friedman RJ, Hawthorne KB, Genez BM. The use of computerized tomography in the measurement of glenoid version. J Bone Joint Surg Am. 1992;74(7):1032-7.

14. Gerber C, Terrier F, Zehnder R, Ganz R. The subcoracoid space. An anatomic study. Clin Orthop Relat Res. 1987;(215):132-8.

15. Porter NA, Singh J, Tins BJ, Lalam RK, Tyrrell PN, Cassar-Pullicino VN. A new method for measurement of subcoracoid outlet and its relationship to rotator cuff pathology at MR arthrography. Skeletal Radiol. 2015;44(9):1309-16.

16. Leite MJ, Sa MC, Lopes MJ, Matos RM, Sousa AN, Torres JM. Coracohumeral distance and coracoid overlap as predictors of subscapularis and long head of the biceps injuries. J Shoulder Elbow Surg. 2019;28(9):1723-7.

17. Tollemar VC, Wang J, Koh JL, Lee MJ, Shi LL. Coracoid morphology is not associated with subscapularis tears. J Shoulder Elbow Surg. 2020;29(6):1162-7.