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ORIGINAL ARTICLE

Tendon vascularity in overhead athletes with subacromial pain syndrome and its correlation with the resting subacromial space

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Background: Supraspinatus tendinopathy is one of the common causes of subacromial pain syndrome (SAPS) in overhead athletes. Changes in tendon vascularity have been reported in painful tendons; however, the prevalence and distribution have not been investigated in young overhead athletes.
Methods: We conducted a cross-sectional study of 47 overhead athletes (male, 31; female, 16) aged 18 to 36 years with SAPS for >3 months. A sonographer graded the severity of the tendinopathy and area of vascularization. Ultrasound imaging was used to measure supraspinatus tendon thickness, vascularity, and resting subacromial space. A self-written program was used to semiquantify the intensity of vascularity, expressed as the vascular index.
Results: The majority (87.2%) of the participants had signs of tendinopathy in the supraspinatus tendon, and 40 (85.1%) of the tendinopathic tendons had vascularity. The majority (66.0%) of the vascularized subjects presented with minimal increase in vascularity, and 19.1% had moderate to severe vascularization. Most (79.2%) of the vascularization was observed in the pericortical region. The vascular index was negatively correlated with the resting subacromial space in male athletes with a reduced subacromial space ($\rho = -0.63$; $P = .038$).
Conclusion: Of overhead athletes with SAPS, 87.2% had supraspinatus tendinopathy with minimal to moderate vascularization, with the majority of vascularization occurring in the pericortical region. In male athletes with a reduced subacromial space, greater vascularity in the supraspinatus tendon was associated with a smaller resting subacromial space.
Level of evidence: Level III; Cross-Sectional Design; Epidemiology Study

Keywords: Vascularity; subacromial space; subacromial pain syndrome; supraspinatus tendon thickness; overhead athletes; pathology of supraspinatus tendon

Subacromial pain syndrome (SAPS) is the most commonly diagnosed problem around the shoulder, particularly in athletes participating in overhead sports.[22] The pathologic changes of the rotator cuff muscle and tendon are considered the primary source of pain.[11] Therefore, alterations in tendon structure and vascularity are used to diagnose and to monitor rotator cuff tendinopathy.[8,19]

The study protocol was approved by the Human Subjects Ethics Subcommittee of the Department of Rehabilitation Sciences of The Hong Kong Polytechnic University.

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Rotator cuff tendinopathy refers to the tendon degradation[6] that is associated with the inferior mechanical properties resulting in damage from tensile or shear loads[16] in addition to the natural process of aging.[23] Increased vascular response was found in degenerated and small tendon tears,[13,15,18] and it was hypothesized to be a healing response to tissue microtrauma. More recently, power Doppler ultrasonography has been used for in vivo assessment of vascularity. Lewis et al[28] observed a higher prevalence of vascularization in painful shoulders compared with the nonpainful side in 20 subjects with a mean age of 50 years. If overload is one of the mechanisms for supraspinatus tendinopathy, the prevalence of vascularity changes would be greater in young overhead athletes with repeated loading of the cuff muscle and tendon.

Aside from tendon loading, a narrowed subacromial space or a thickened tendon might increase the potential for compression of the supraspinatus tendon and lead to vascular changes. A resting subacromial space of <7 mm is associated with complete cuff tears.[39,42] However, no study has been conducted to assess a possible relationship between the pathologic changes of the supraspinatus tendon and the resting subacromial space. As not all subjects who suffer from SAPS have a reduced subacromial space,[40] it would be interesting to see whether there are any vascular differences in athletes with SAPS between those with and those without a reduced subacromial space.

The aims of our study were as follows: (1) to detect the prevalence, intensity, and region of vascularity in the supraspinatus tendon with SAPS; and (2) to evaluate any associations between tendon vascularity, the resting subacromial space, and tendon thickness in overhead athletes with SAPS with a reduced and nonreduced subacromial space.

We hypothesized that only athletes with a reduced subacromial space and thickened tendons have increased vascularity in the supraspinatus tendon. The findings from this study will improve our understanding of the pathologic changes in tendons suffering from tendinopathy and their relationship with the subacromial space.

Materials and methods

This was a cross-sectional observational study conducted at a university-based rehabilitation clinic. We recruited amateur overhead athletes with SAPS from local volleyball and baseball teams for the study through means of convenience sampling. The inclusion criteria were volleyball and baseball players involved in regular training at least twice a week and aged 18 to 40 years who had been clinically diagnosed with SAPS for at least 3 months. In this study, SAPS was defined as positive findings in 3 of 5 of the following tests: Hawkins-Kennedy, Neer, painful arc, empty can, and resisted external rotation test.[31] Subjects who had previous shoulder surgery, history of dislocation or fracture of the affected shoulder or arm, symptoms referred from or related to the spine, conservative therapy including cortisone injection within the last 6 months before inclusion, full-thickness tear in the supraspinatus tendon based on ultrasonography findings, positive relocation test result, positive laxity test result in the shoulder, or a Beighton score[24] of >4 were excluded.

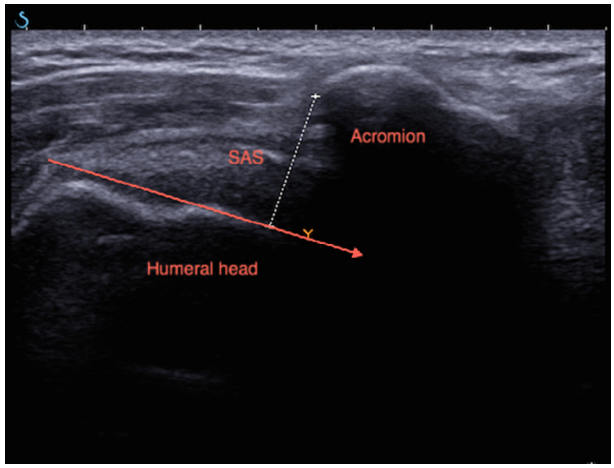

Figure 1 The subacromial space (*SAS*, *dotted line*) was defined as the tangential distance between the humeral head and the lateral edge of the acromion.

Participants were informed about the procedure before written consent was obtained. Demographic data, including age, height, weight, years of participating in baseball or volleyball, and intensity of training per week, were collected.

Subacromial space and tendon thickness

We used an Aixplorer ultrasound machine in conjunction with an 8-12 MHz linear transducer (SuperSonic Imagine, Aix-en-Provence, France) for measuring each participant's subacromial space. The participants assumed a sitting position with the head in a neutral position. We placed the ultrasound transducer on the lateral surface of the shoulder along the longitudinal axis of the humerus to take measurements of the subacromial space. A total of 3 measurements were taken on both shoulders. The subacromial space was defined as the tangential distance between the humeral head and the lateral edge of the acromion (Fig. 1),[10] and the mean value of the subacromial space of each shoulder was recorded. From the preliminary data, the test-retest reliability on 20 healthy subjects was found to be 0.88 (0.69-0.95). The difference in subacromial space between the painful and nonpainful sides was calculated by subtracting the subacromial space of the nonpainful side from that of the painful side; those with a negative value were defined as having a reduced subacromial space.

For the measurement of supraspinatus tendon thickness, we used the transverse view of the supraspinatus tendon. Subjects were asked to put their hand in their back pocket. Measurements were made at 10, 20, and 30 mm lateral to the long biceps tendon with an online caliper (Fig. 2).[5] Averaged values from the 3 measurements were computed offline. Test-retest reliability was excellent (intraclass correlation coefficient, 0.92; 95% confidence interval, 0.90-0.99).[25]

Tendon pathology and vascularity

A sonographer (V.Y.F.L.) with >20 years' experience conducted a second ultrasound imaging session in a regional hospital using the same machine and ultrasound probe to measure the degree of tendinosis and the vascularity of the supraspinatus tendon. To scan the supraspinatus tendon, she asked each subject to place the back