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Original research

The relationship between subacromial bursa thickness on ultrasound and shoulder pain in open water endurance swimmers over time

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ABSTRACT

Objectives: To help clinicians understand the clinical relevance of subacromial bursa (SAB) thickness on ultrasound investigations in marathon swimmers.
Design: A prospective, observational cohort study.
Methods: Twenty two open-water marathon swimmers entered in a 19.7 km open-water event received comprehensive, bilateral, shoulder ultrasounds on three occasions: 4 months prior to the race, 2 weeks prior to the race and within 1 week after the race. The SAB thickness was measured in the longitudinal plane of supraspinatus, with other abnormailities also recorded. The swimmers completed questionnaires detailing presence and severity of shoulder pain, volume of swimming completed that week and their breathing pattern.
Results: SAB thickness increased with season progression: mean of 1.55 (± 0.68) 4 months prior to the race, 1.63 (± 0.68) 2 weeks prior to the race and 1.86 (± 0.69) 1 week after the race. SAB thickness is significantly ($p = 0.05$) correlated ($\beta = 0.11$) with kilometres swum in the pool in the preceding week. SAB thickness was not significantly correlated with pain when measured prior to the race. However, at 1 week post race, SAB thickness of shoulders with pain were significantly greater than those without pain, p-value = 0.032.
Conclusions: SAB thickness increases with increasing swimming training. Commonly, this increase is not correlated to pain, suggestive of a painless adaptive process. The significant correlation between pain and SAB thickness soon after an exacerbating event suggests that painful acute SAB thickening is a different entity to chronic, painless adaptive SAB thickening. These two entities can only be differentiated by clinical history and examination.

1. Introduction

Shoulder pain is the most common musculoskeletal complaint in swimmers.[1–3] Studies have reported the prevalence of shoulder pain in swimmers to be between 38 and 91%[3,4] with incidence rates of 0.3 episodes of shoulder pain per 1000 km of swimming.[4] The most commonly identified causes of shoulder pain in swimmers are periarticular disorders from structures within the subacromial region.[1,2,5] The subacromial region refers to the anatomical space created by the acromion, acromioclavicular joint and coracoacromial ligament superiorly; and the humeral head inferiorly.[6] It contains the subacromial bursa (SAB) and the rotator cuff muscles (principly supraspinatus) which move within the space during glenohumeral and shoulder girdle movements.[6,7]

The most common disorders in swimmers to involve the subacromial region are supraspinatus tendinopathy, subacromial impingement syndrome (SAIS) and subacromial bursitis (SABi).[4,8,9] It is difficult to reliably differentiate between these disorders or to be certain of the process causing the shoulder pain. Furthermore, each of these conditions can be identified on ultrasound in asymptomatic shoulders which creates uncertainty as to the significance of the finding when the subject does indeed have pain.[10–12]

SAIS occurs due to anatomical impingement of structures within the subacromial region during shoulder movement.[13–15] SABi has been widely described as both a potential cause and effect of SAIS.[7,13,16] Pain from SAIS has been strongly correlated with large volumes of swimming training.[3] It has also been widely suggested that SABi can be a cause of pain without contributing to SAIS.[9,13,16]

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SABi is a term frequently used on ultrasonography reports. This term is a subjective descriptor of the appearance of the bursa judged by the radiologist based on abnormal fibrotic thickening of the bursa or on the presence of abnormal amounts of fluid.[7] Furthermore, there is inconsistency in diagnostic terminology,[7,10,17] a lack of universally accepted diagnostic classification criteria[7,10,17] and an inconsistent correlation between ultrasound findings and the presence of pain.[7,11,12] A commonly used, but not universally accepted, upper-limit to normal SAB thickness is 2 mm.[9,16] However, abnormal amounts of fluid within the SAB can result from communication with the glenohumeral joint space via a rotator cuff tear.[7]

The physiological function of the bursa is to protect the rotator cuff by dissipating friction and allowing free motion between the rotator cuff and the overlying acromion and deltoid.[7] Subsequently, thickening of the SAB may result from chronic SAIS or may potentially be a physiological adaptation rather than pathological.[7] This may be reflective of the protective function of the bursa in sports or occupations involving repetitive and forceful upper limb activities.[7] Competitive marathon swimming is performed exclusively using an over arm freestyle technique resulting in repetitive overhead shoulder movement.

Previous studies have demonstrated the prevalence of SAB thickening in asymptomatic males to be 29–78%.[7,17] In a 2011 study, abnormalities were detected on ultrasound in 96% of asymptomatic subjects.[12] It is therefore widely accepted that shoulder ultrasound reports should be interpreted in the context of expert clinical history and examination.[18–20] Currently in Australia there is an increasing trend towards non-medical health practitioners directly referring for diagnostic shoulder ultrasounds[21] which may lead to an increased reliance on sonography reports over expert clinical examination. This has the potential to misguide clinical management given the subjective and inconsistent terms used in those reports, the uncertain significance of those terms in attributing a cause of shoulder pain and the potential variability in bursa appearances in populations involved in repetitive shoulder activities.

The purpose of this study is to aid clinicians and radiologists in interpreting the appearance of the SAB in marathon swimmers; with a secondary aim of assessing any association between ultrasound grading of rotator cuff quality and the presence of pain. To our knowledge there have been no peer-reviewed reports on normative measurements of SAB thickness in marathon swimmers. Anecdotally, our clinical experience has suggested that marathon swimmers develop increasing rates of pain as the swimming season progresses. In our clinical practices, we commonly see ultrasound reports describing marked abnormalities that do not necessarily correlate to the clinical presentation. When there is unilateral pain, there is often no comparative ultrasound performed on the asymptomatic side. By examining the relationships between bursa thickness, shoulder pain, swimming volume and swimming technique on bilateral shoulders in swimmers at various times during a competitive season, we hope to develop a better understanding of the relevance of those parameters to guide appropriate patient care.

2. Methods

Ethics board approval was obtained from the Australian Institute of Sport prior to the study and written patient consent was obtained. The subject sample consisted of 44 shoulders (22 individual subjects; 15 male, 5 female, with a mean age of 37.27 ± 9.68 years age. Subjects were recruited via an email sent to all entrants in the solo category of the 2013 Rottnest Channel Swim: a 21 km open ocean swimming race in February 2013. Volunteers were eligible to participate by meeting the inclusion criteria of intending to complete an unassisted channel crossing in the 2013 event and being aged between 18 and 65 years. Subjects were excluded if they experienced any shoulder pain at the time of recruitment or had received a subacromial corticosteroid injection in the 6 months prior to the commencement of the study. Subjects who failed to start the race were also excluded. Resources for this study were limited to examining 44 shoulders and volunteers were therefore selected based on order of response with no preference given to standard or speed of the swimmer. A solo crossing of the Rottnest Channel is a challenging event that usually takes between five to fourteen hours of unassisted open-water surf swimming. The abilities of participants ranged from elite to competitive and experienced amateurs. Descriptive statistics for the study are provided in Table 1.

Diagnostic ultrasounds were performed on both shoulders of each subject on three separate occasions: 4 months prior to the race, 2 weeks prior to the race and within 1 week after the race. Each ultrasound was performed by the same senior musculoskeletal radiologist with 28 years of experience, using a consistent machine (Phillips IU22 with linear 5–12 MHz probe) and settings. Bursa thickness was measured in the longitudinal plane of supraspinatus. The radiologist completed a standard shoulder investigation and reported on all other findings. Rotator cuff tendinopathy, when present, was rated on a scale of mild, moderate and severe, and abnormalities within the acromioclavicular joint, glenohumeral joint and long head of biceps tendon were also recorded. On each occasion, subjects completed a questionnaire (appendix A) relating to the presence and severity of shoulder pain, the distance swum in the preceding week and their favoured breathing pattern while swimming. The sonographer performed the assessment blinded to the details of the questionnaire. Two subjects failed to attend the second pre-race scan and one further subject did not attend the post-race scan. Their results remained in the study with the data treated as missing.

For the purposes of performing the analyses the presence and severity of shoulder pain was coded as an ordered categorical variable from zero to six, with: zero representing no pain; one representing occasional pain with swimming; two representing regular pain with swimming; three representing regular pain which impacts training; four representing regular pain that prevents training, five representing pain that affects daily life and six representing debilitating pain that is worsening.

Descriptive statistics including means, standard deviations and frequencies were calculated across the different time points. Analysis of Variance (AOV)[22] was used to assess differences in measures between the three different time points. AOV of the results from Linear Mixed Effects Models as well as the model details were used to assess longitudinal relationships between measures (accounting for repeated measures and within subject correlations between left and right shoulders). For assessing the level of pain, an alternative version of linear mixed models appropriate for ordered categorical data was implemented, Cumulative Link Mixed Models[23] Minimum Detectable Change at 95% confidence (MDC_{95}) is calculated as a function of the Standard Error of the Measure (SEM): $MDC = 1.96 \times \sqrt{2} \times SEM$. SEM was calculated as $\sqrt{(\text{Mean Squared Error})}$ from an AOV of data from the two pre-race time points. All analyses were performed in the R statistical software environment, version 3.0.1.[24]

3. Results

SAB thickness for the 44 shoulders over the three time points (122 measurements; 10 missing measures) had a mean of 1.65 mm with a standard deviation of 0.69 mm, with 95/122 (77.87%) of the SAB thicknesses of the marathon swimmers in this study falling