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ORIGINAL ARTICLE

Shoulder activity level and progression of degenerative cuff disease

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Background: This study prospectively examined the relationship of direct and indirect measures of shoulder activity with the risks of tear progression and pain development in subjects with an asymptomatic degenerative rotator cuff tear.

Methods: A cohort of asymptomatic degenerative rotator cuff tears was prospectively monitored annually, documenting tear size progression with ultrasound imaging and potential shoulder pain development. Shoulder activity level, self-reported occupational and physical demand level, and hand dominance were compared with risks of tear enlargement and future pain development.

Results: The study monitored 346 individuals with a mean age of 62.1 years for a median duration of 4.1 years (interquartile range [IQR], 2.4-7.9 years). Tear enlargement was seen in 177 shoulders (51.2%), and pain developed in 161 shoulders (46.5%) over time. Tear presence in the dominant shoulder was associated with a greater risk of tear enlargement (hazard ratio, 1.40; $P = .03$) and pain development (hazard ratio, 1.63; $P = .002$). Shoulder activity level ($P = .37$) and occupational demand level ($P = .62$) were not predictive of tear enlargement. Occupational demand categories of manual labor ($P = .047$) and "in between" ($P = .045$) had greater risks of pain development than sedentary demands. The median shoulder activity score for shoulders that became painful was lower than for shoulders that remained asymptomatic (10.0 [IQR, 7.0-13.0] vs. 11.0 [IQR, 8.0-14.0], $P = .02$).

Conclusions: Tear enlargement and pain development in asymptomatic tears are more common with involvement of the dominant shoulder. Shoulder activity level is not related to tear progression risks. Pain development is associated with a lower shoulder activity level even though patients with higher occupational demands are more likely to develop pain.

Level of evidence: Level II; Prognosis Study

Keywords: Rotator cuff; degenerative; cuff tears; activity level; occupation; enlargement

Degenerative rotator cuff tears are commonly seen in the aging population. Although most of these tears are asymptomatic, many tears progress in size and may become painful at a later time. Recent data have demonstrated tear size progression in 51% and pain development in 49% of subjects

The Washington University in St. Louis Institutional Review Board approved this study (approval #201103230).

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with asymptomatic degenerative rotator cuff tears monitored longitudinally for a period of 5 years.[11] Although tear progression has been linked to new pain development, this relationship is not absolute.[14,15] Other potential causative factors related to tear progression and pain development in shoulders with asymptomatic rotator cuff tears warrant further investigation.

Many predisposing factors have been linked to the development of degenerative rotator cuff disease, including advancing age,[13,22] smoking,[2] family history,[19] and elevated cholesterol.[1] Little information is known regarding the potential influence of activity level on the risks of tear progression and pain development in shoulders with asymptomatic tears. Occupational health data have shown that physically demanding work tasks are an independent risk factor for the development of symptomatic rotator cuff disease.[3,4,16,18] Hand dominance has also been shown to be a risk factor for tear progression in subjects with asymptomatic rotator cuff tears,[11] indirectly suggesting activity level may be a risk factor for disease progression. However, one study showed no association of shoulder activity level with tear severity in a cohort of painful rotator cuff tears undergoing nonoperative treatment.[6]

The ability to better predict which degenerative cuff tears are at greatest risk for tear progression and pain development would be beneficial in counseling and managing patients with rotator cuff disease. This study prospectively examined the relationship of direct (shoulder activity scale[5]) and indirect (hand dominance and self-perceived occupational demands) measures of activity level with the risks of tear progression and pain development in individuals with asymptomatic degenerative rotator cuff tears.

Materials and methods

This study represents a retrospective analysis of longitudinal, prospective data. The cohort consists of subjects with asymptomatic rotator cuff tears identified from bilateral shoulder ultrasound examinations after presentation for evaluation of painful rotator cuff disease.

Inclusion criteria were (1) bilateral shoulder ultrasonography investigating unilateral shoulder pain, (2) painful rotator cuff disease in the symptomatic shoulder, (3) rotator cuff tear presence documented in the asymptomatic shoulder (full-thickness, partial-thickness, or no tear [control]), (4) verified as asymptomatic at study enrollment in the asymptomatic shoulder, (5) no history of trauma to either shoulder and remained free of trauma throughout the study.

Exclusion criteria for this study were (1) any past or current pain in the asymptomatic shoulder, (2) continuous use of narcotic or nonsteroidal anti-inflammatory medication from 3 months before to enrollment, (3) traumatic episode to the asymptomatic shoulder, (4) inflammatory arthritis, (5) radiographic osteoarthritis in the asymptomatic shoulder, (6) upper extremity weight-bearing demands, and (7) isolated subscapularis tendon tears in the asymptomatic shoulder. In addition, 8 shoulders with massive rotator cuff tears at the time of enrollment were excluded because of difficulty in measuring tear enlargement over time.

Study protocol

Once enrolled, study subjects were monitored annually. Baseline demographic variables, including age, hand dominance, and self-described occupational/physical demands were collected. Occupational/physical demand categories included a designation of labor, sedentary, or "in between." If a subject was not employed, this question was answered to reflect his or her self-perceived general activity level. Baseline and annual examinations were performed consisting of the following outcomes: (1) trained research nurses performed physical examinations assessing shoulder active range of motion and rotator cuff strength, (2) questionnaires were completed consisting of numeric pain scale (0-10 in whole integers) and components of the American Shoulder and Elbow Society (ASES) score and the Simple Shoulder Test (SST).

Activity level was quantified using the Shoulder Activity Scale (SAS), which has been validated as an accurate method of assessing upper extremity activity demands across a variety of shoulder disorders[5] (Table I). For the purpose of this study and of particular relevance to the study cohort, the 2 qualifier questions regarding sports activity were simplified as "yes" or "no" rather than descriptive regarding the level of competition. We initiated collection of the SAS 3.5 years after initiation of the first subject recruitment period. For the current study, the activity level data for an individual was used only when collected within 3 years ± 3 months from the time of study enrollment. If the initial SAS data for a subject was collected after this time, then that individual's data were excluded from the SAS analysis only.

One of 4 experienced radiologists, according to a previously described protocol, performed shoulder ultrasound examinations at baseline and annually.[20,21] The maximum anteroposterior dimension of the tear was measured in transverse views (perpendicular to the long axis of the cuff) and designated as the tear width. The maximum degree of retraction was measured in longitudinal views (parallel to the long axis of the cuff) and designated as the tear length.

The primary outcome for this study was the development of tear progression, which was determined by sequential interpretation of annual ultrasound reports. Tear progression was defined as tear enlargement or conversion to a more severe tear type (partial to full-thickness tear or control to partial or full-thickness tear). Partial and full-thickness cuff tears were considered enlarged if the tear size increased 5 mm or greater in any dimension compared with baseline. Five millimeters was chosen to account for the inherent variability in the accuracy of ultrasonography and was felt to represent clinically meaningful enlargement.[21] A partial-thickness tear was considered enlarged when converted to a full-thickness defect (even in the absence of increased tear size), defined as a complete disruption of tendon continuity at the insertion. Likewise, control shoulders were considered enlarged if a partial or full-thickness defect of at least 5 mm in any dimension developed.

Assessment of shoulder pain was performed at study enrollment and at each subsequent study examination. The definition of significant pain included any of the following: (1) shoulder pain ≥3 on a 10-point scale lasting ≥6 weeks, (2) pain considered to be greater than that experienced as a part of daily living (as determined by the patient), (3) pain requiring narcotic or nonsteroidal anti-inflammatory medications, (4) pain prompting physician evaluation, and (5) night pain affecting sleep. Subjects were instructed to contact the study coordinator if new shoulder pain developed between visits, prompting an immediate repeat evaluation. Participants were retained in the yearly protocol for ongoing evaluation regardless of pain development or tear enlargement.