The Subscapularis Footprint: An Anatomic Description of Its Insertion Site

David P. Richards, M.D., Stephen S. Burkhart M.D., Armin M. Tehrany, M.D. and Michael A. Wirth, M.D.

Published in “Arthroscopy: The Journal of Arthroscopic and Related Surgery” Vol 23, No 3 (March), 2007
The Subscapularis Footprint: An Anatomic Description of Its Insertion Site

David P. Richards, M.D., F.R.C.S.(C), Stephen S. Burkhart, M.D., Armin M. Tehrany, M.D. and Michael A. Wirth, M.D.

Purpose: The purpose of this study was to describe the anatomic footprint of the subscapularis tendon.

Methods: We examined 19 cadaveric shoulder specimens in this study. Dissection was carried out to the level of the subscapularis through a deltopectoral approach. The subscapularis tendon was identified, and the dissection was continued, elevating the tendon, subperiosteally, from its insertion site at the lesser tuberosity. The dimensions of the footprint were measured superior to inferior, as well as medial to lateral, by a single observer.

Results: The insertion of the subscapularis tendon on the lesser tuberosity was trapezoidal in shape. The mean length of the subscapularis tendon footprint was 2.5 cm (range, 1.5 to 3.0 cm). The superior portion of the footprint was the widest part of the subscapularis insertion. The mean width at the most superior aspect of the insertion site was 1.8 cm (range, 1.5 to 2.6 cm). The most inferior aspect of the footprint was much narrower, with a mean width of 0.3 cm (range, 0.1 to 0.7 cm).

Conclusions: The subscapularis insertion footprint has a broad and wide superior attachment that narrows distally to form a trapezoidal shape. We found the mean length of the footprint to be 2.5 cm. The mean superior width of the footprint was 1.8 cm, which was maintained for the upper 60% of the tendon insertion, at which point the footprint began to rapidly narrow to a minimum width of 0.3 cm at its most inferior aspect. The upper 60% of the footprint provided by far the major surface area for tendon insertion, consistent with prior findings of superior load transmission at the superior aspect of the footprint.

Clinical Relevance: This broad attachment site superiorly is likely important in load transmission. Knowledge of the shape of the footprint of the subscapularis, with a broad superior attachment, makes it easier for the surgeon to perform an accurate anatomic surgical reconstruction of the torn subscapularis.

Key Words: Rotator cuff—Subscapularis tendon—Rotator cuff repair.
Despite the integral nature of the subscapularis in rotator cuff function, only recently, with improved arthroscopic techniques, has there been an influx in the literature on its function, pathology, and repair.\(^1\)\(^{17}\) Although early studies reported that the incidence of a torn subscapularis is low,\(^6\)\(^{18}\) the more recent literature suggests otherwise.\(^3\)\(^{19}\) In a cadaveric study approximately half of the shoulders had partial articular-sided subscapularis tears.\(^{19}\) These results are supported by the findings of Bennett,\(^1\) who noted an incidence of subscapularis lesions of approximately 30\% during arthroscopic shoulder reconstructions.

Anatomic studies have described the relationship of the subscapularis to its adjacent anatomic structures.\(^20\)\(^{30}\) Not only has the anatomy of the subscapularis been described, but its mechanical integrity at its insertion on the lesser tuberosity has also been documented.\(^25\) Halder et al.\(^25\) showed that the strongest fixation point of the subscapularis was at the superior aspect of the footprint. Although much has been written on the subscapularis recently, to our knowledge, no previous study has attempted to define the shape and configuration of the insertion of the subscapularis. The purpose of this anatomic study was to describe the anatomic footprint of the subscapularis.

**METHODS**

After appropriate institutional approval was obtained, 19 cadaveric shoulder specimens were obtained for this study. Specimens with evidence of partial or complete subscapularis tears at the time of dissection were excluded. The mean age of the cadaveric specimens was 75.3 years (range, 53 to 90 years). There were 10 female and 9 male specimens. Dissection of these shoulder specimens was carried out to the level of the subscapularis through a deltopectoral approach. The subscapularis tendon was identified, and the dissection was continued, elevating the tendon, subperiosteally, from its insertion site at the lesser tuberosity. All specimens were examined, and an evaluation of the subscapularis footprint was done. There was no evidence of any pathology involving the insertion of the tendon onto the lesser tuberosity. It should be noted that in each specimen, an extra-articular muscular attachment of the subscapularis was found distal to the bony attachment of its tendon, but this muscular attachment was not specifically evaluated in this study.

After verification of a normal insertion into the lesser tuberosity, the footprint of the subscapularis tendon was examined and measured. The dimensions of the footprint were measured superior to inferior, as well as medial to lateral, by a single observer. In addition, the boundary measurements at the perimeter of the subscapularis footprint were recorded. This allowed us to evaluate the variation in the width of the footprint from top to bottom. A precision caliper with a digital readout (Mitutoyo Digimatic Caliper; Mitutoyo, Tokyo, Japan) was used to measure the tendinous attachment. The mean of 3 measurements for each dimension in each specimen was recorded.

**RESULTS**

The subscapularis insertion was normal in all 19 specimens, free of any partial or complete tears. With its broad and wider superior attachment and with the insertion tapering inferiorly, the shape of the subscapularis footprint was trapezoidal (Fig 1). The mean length, superior to inferior, of the subscapularis footprint was 2.5 cm (range, 1.5 to 3.0 cm). The superior portion of the footprint was the widest part of the subscapularis insertion. The mean width at the superior aspect of the insertion site was 1.8 cm (range, 1.5 to 2.6 cm). The width of this broad insertion point was generally maintained for the upper 60\% of the tendon footprint (1.5 cm distal to the upper margin of the tendinous insertion), and then the footprint began to rapidly narrow. The most inferior aspect of the footprint was the narrowest, with a mean width of 0.3 cm (range, 0.1 to 0.7 cm).

**DISCUSSION**

Anatomic studies have described the anatomy of the subscapularis and its relation to other anatomic structures.\(^20\)\(^{30}\) The subscapularis originates from the medial two thirds of the anterior scapula, passing laterally beneath the coracoid and scapular neck and becoming tendinous at the level of the glenoid.\(^23\) At its insertion, the tendinous portion of the subscapularis blends with the fibers of the joint capsule and inserts into the lesser tuberosity.\(^*\)
tuberosity. A second, more muscular attachment, distal to the lesser tuberosity, has also been described, which we too noted in our dissections.\textsuperscript{22,29}

The subscapularis footprint had a broad and wide superior attachment, with the insertion tapering inferiorly to form a trapezoidal footprint. Not only was the superior insertion broader in our study, it has also been noted in a previous study to be the strongest fixation point along the entire length of the subscapularis footprint.\textsuperscript{25}

The mean length of the subscapularis footprint was 2.5 cm (range, 1.5 to 3.0 cm), with a mean superior width of 1.8 cm (range, 1.5 to 2.6 cm) and a mean inferior width of 0.3 cm (range, 0.1 to 0.7 cm). This unique shape of the subscapularis footprint was similar to the shape of the state of Nevada (Fig 1). The widest portion of the insertion of the subscapularis was at the superior aspect of its footprint. This broad attachment site superiorly is likely important in load transmission. Interestingly, this is the site at which subscapularis pathology commonly occurs.\textsuperscript{19,25} Knowledge of the shape of the footprint of the subscapularis, with a broad superior attachment, makes it imperative to examine the footprint thoroughly at the time of arthroscopy and to repair any partial or complete subscapularis tears. With knowledge of the geometry and configuration of the subscapularis footprint, the surgeon should become more capable of delineating the extent of partial- and full-thickness tears, and thus the surgical re-establishment of the normal anatomic footprint should become more reproducible.

We recognize that there are weaknesses to this study. Although 19 specimens seems like a significant number when the findings of the study are extrapolated to the population at large. Nonetheless, there are limits to the number of specimens that are available for an anatomic study. In addition, we did not have access to height and weight data for our specimens. These parameters might independently influence the size of the subscapularis footprint. Another weakness is in our technique of measurement. Our technique, in which 3 consecutive measurements of each dimension were taken by a single investigator and then averaged to determine the mean value, was similar to techniques of most other anatomic studies in the literature. Although our digital calipers provided measurements to the nearest tenth of a centimeter, there was still the possibility of measurement error.

CONCLUSIONS

The subscapularis footprint had a broad and wide superior attachment that narrowed distally to form a trapezoidal shape. In our study we found the mean length of the footprint to be 2.5 cm. The mean superior width of the footprint was 1.8 cm. This footprint width was maintained for the upper 60% (1.5 cm) of the tendon insertion, at which point the footprint began to rapidly narrow. At the inferior aspect of the footprint, the width was at its narrowest (mean, 0.3 cm). In terms of total footprint area, the upper 60% of the footprint provided by far the major area for tendon insertion, consistent with prior findings of superior load transmission at the superior aspect of the footprint.\textsuperscript{25}
REFERENCES


The Subscapularis Footprint: An Anatomic Description of Its Insertion Site

Published in “Arthroscopy: The Journal of Arthroscopic and Related Surgery”
Vol 23, No 3 (March), 2007