Interobserver Reliability and Intraobserver Reproducibility in Suprascapular Notch Typing

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Abstract

The size and shape of the suprascapular notch may be a factor in suprascapular nerve entrapment. The suprascapular notches of 623 scapulae were digitally photographed and used to determine notch type and area. Three researchers used two different classification systems for suprascapular notch typing. These systems were compared for interobserver reliability and intraobserver reproducibility using the kappa test. The mean kappa value for the classification used by Rengachary and colleagues was 0.468 and for the classification used by Ticker and associates was 0.531 for the inferior border of the notch and 0.736 for the superior border of the notch. The classification system used by Ticker and associates was more reliable and reproducible and produced both a superior and an inferior classification, making it possibly more clinically relevant than the classification system used by Rengachary and colleagues.

Suprascapular nerve entrapment occurs when the nerve is impinged at a point along its length, resulting in a loss of conductivity and function. Two anatomical sites described in literature where the suprascapular nerve can be entrapped are at the level of the suprascapular notch and at the spinoglenoid notch. Entrapment at the spinoglenoid notch was first described by Aiello and colleagues and later by Kaspi and associates and Mestdagh and coworkers. Entrapment of the suprascapular nerve at the suprascapular notch was first described by Thompson and Koppel in 1959. They reported that abduction or horizontal adduction of the shoulder exerted traction on the suprascapular nerve, which led to its compression against the superior transverse scapular ligament.

Rengachary and colleagues conducted an extensive anatomical, clinical and comparative study of the possible etiology of suprascapular nerve entrapment, suggesting that a “sling effect” causes traumatic kinking of the suprascapular nerve against the superior transverse scapular ligament. They classified the suprascapular notches into six types. This classification focused on the inferior shape of the suprascapular notch as well as the degree of ossification of the superior transverse scapular ligament. Several other investigators have used this classification system in their studies.

In 1998, Ticker and colleagues conducted a cadaveric research study using a different classification system, separating the suprascapular notches into two types, namely a U-type and a V-type. The degree of ossification of the suprascapular ligament was evaluated separately.

The aim of this current study was to quantify suprascapular notches and reevaluate the two different systems of suprascapular notch classification, focusing on interobserver reliability and intraobserver reproducibility.

Materials and Methods

A total of 623 scapulae from 322 individuals were selected from the collection of the anthropology department of the American Museum of Natural History in New York. The sample consisted of 32 female and 288 male individuals having an average age of 58 (range: 18 to 90).

A photographic technique was used for measurements and typing. The camera and scapula positions were standardized for all images to obtain an anterior view of each scapula. The scapula was held with an adjustable clamp and ring stand at a fixed distance from the camera. The angle of the scapula...
was adjusted to align the plane of the notch perpendicular to the axis of the camera. A metric scale was taped onto the scapula to provide a measurement reference. Photographs of the suprascapular notch were then taken with a digital camera using at a resolution of 640 x 480 pixels.

The digital images were imported into AutoCAD 2002 (AutoDesk, San Rafael, CA) and the dimensions and areas of the suprascapular notches were measured. The type of suprascapular notch was determined first by using the classification system defined by Rengachary and colleagues.\textsuperscript{7,8} This classification system is based on the shape of the inferior border of the notch as well as the degree of ossification of the superior transverse scapular ligament, dividing the suprascapular notches into six different types (Fig. 1).

Then the notches were classified using the system used by Ticker and associates,\textsuperscript{2} which examines the inferior border of the suprascapular notch separately from the superior transverse scapular ligament. This system classifies the suprascapular notch into two distinct types, namely the U-shaped suprascapular notch, defined as having approximately parallel sides with a rounded base, and a V-shaped suprascapular notch, defined as having medial and lateral sides which converge toward a narrow base.\textsuperscript{2} After this was done the degree of ossification of the superior transverse scapular ligament was determined classifying the notches into three groups: no ossification, partial ossification, and complete ossification (resulting in a bony foramen) as shown in Figure 2.

Three different researchers in our laboratory served as observers who classified the suprascapular notches individually, to measure the interobserver reliability. One of these observers reclassified the suprascapular notches again three weeks later without access to his previous classifications, to measure the intraobserver reproducibility.

All measured data and specimen demographics were entered into an Excel spreadsheet (Microsoft, Redburn,}

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**Figure 1** Notch classification system used by Rengachary and colleagues.\textsuperscript{7,8} **Type I**, The entire superior border of the scapula showed a wide depression from the medial superior angle of the scapula to the base of the coracoid process. **Type II**, This type showed a wide, blunted V-shaped notch occupying nearly one third of the superior border of the scapula. The widest point in the notch was along the superior border of the scapula. **Type III**, The notch was symmetrical and U-shaped with nearly parallel lateral margins. **Type IV**, The notch was small and V-shaped. Frequently a shallow groove representing the bony impression by the suprascapular nerve was visible adjacent the notch. **Type V**, This type was very similar to Type III, with partial ossification of the medial part of the ligament resulting in a notch with the minimal diameter along the superior border of the scapula. **Type VI**, The ligament was completely ossified, resulting in a bony foramen of variable size located just inferomedial to the base of the coracoid process.

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**Figure 2** Classification of the superior transverse scapular ligament as used by Ticker and associates; \textsuperscript{2} **A**, Type I. No ossification; **B**, Type II. Partial ossification; **C**, Type III. Complete ossification.
WA) for statistical comparison. The data included the suprascapular notch type distributions and average notch area. The kappa values for interobserver reliability between the three observers and kappa value for the intraobserver reproducibility were calculated for the two classification systems using Landis and Koch’s method.¹¹

### Results

The mean kappa for interobserver reliability using the classification system of Rengachary and colleagues was 0.468 (range: 0.443 to 0.518) with a 95% confidence range of 0.418 to 0.519. The kappa for the intraobserver reproducibility was 0.431, with a 95% confidence range of 0.381 to 0.482. According to the Landis and Koch guidelines¹¹ these kappa values represent a “moderate” strength for both reliability and reproducibility. The distribution of the notch types and the mean areas of each type of notch are shown in Table 1.

The mean kappa for interobserver reliability for the inferior border of the notch using the classification used by Ticker and associates was 0.531 (range: 0.454 to 0.650) with a 95% confidence range of 0.444 to 0.604; the mean kappa for interobserver reliability for the superior border of the notch was 0.736 (range: 0.724 to 0.749) with a 95% confidence range of 0.665 to 0.807. For the inferior border of the notch the kappa for the intraobserver reproducibility was 0.578, with a 95% confidence range of 0.503 to 0.654. For the superior border of the notch the kappa for the intraobserver reproducibility was 0.865 with a 95% confidence of 0.814 to 0.916. According to Landis and Koch,¹¹ this reliability and reproducibility is of “moderate” strength for the inferior border of the notch and of “substantial” strength for the superior transverse scapular ligament. The mean percentage of V-shaped notches was 27% and that of U-shaped notches was 73%. This distribution and the mean areas of each type of notch are shown in Table 2.

There did not seem to be any relation between age and the degree of ossification of the superior transverse scapular ligament, when the scapular types were compared as two groups less than or equal to 50 years old and greater than 50 years old (p = 0.566).

### Discussion

Although it has been hypothesized that suprascapular nerve entrapment is more likely to be associated with a narrow V-shaped notch, no direct correlation between notch type and suprascapular nerve entrapment has been shown clinically.¹² In contrast, variations in the morphology of the superior transverse scapular ligament have been identified and associated with suprascapular nerve entrapment in several case reports.²,¹³⁻¹⁵ For this reason we feel one should look at the inferior border of the suprascapular notch separately from the superior transverse scapular ligament.

Rengachary and colleagues described transitions between Type II, Type III, or Type IV within their classification. They used a mathematical formula involving the width at the superior border of the notch, the widest point within the notch,

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Mean Areas and Distribution of Notch Types Using the Classification by Rengachary and Colleagues³,⁸</th>
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<tbody>
<tr>
<td>Notch type</td>
<td>Dunkelgrun</td>
</tr>
<tr>
<td></td>
<td>Area (mm²)</td>
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<tr>
<td>I</td>
<td>8 ± 4.9</td>
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<tr>
<td>II</td>
<td>33 ± 13.6</td>
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<tr>
<td>III</td>
<td>31 ± 13.9</td>
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<td>IV</td>
<td>6 ± 1.3</td>
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<td>V</td>
<td>18 ± 2.9</td>
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<td>VI</td>
<td>5 ± 0.5</td>
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<th>Table 2</th>
<th>Mean Areas and Distribution of Notch Types Using the Classification by Ticker and Associates¹</th>
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<td>Notch type</td>
<td>Dunkelgrun</td>
</tr>
<tr>
<td></td>
<td>Area (mm²)</td>
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<tr>
<td>Inferior border of suprascapular notch</td>
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</tr>
<tr>
<td>U-shaped</td>
<td>43.4 ± 21.7</td>
</tr>
<tr>
<td>V-shaped</td>
<td>32.0 ± 18.9</td>
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<tr>
<td>Ossification of superior transverse scapular ligament</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>29.2 ± 14.2</td>
</tr>
<tr>
<td>Partial</td>
<td>40.6 ± 20.9</td>
</tr>
<tr>
<td>Complete</td>
<td>42.6 ± 26.4</td>
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and the depth of the notch, to determine how to classify the notch. We also encountered transitions between these types. Type V is similar to Type III, yet has partial ossification of the medial part of the ligament, according to Rengachary. However, we encountered notches with partial ossification of the lateral part of the ligament as well as partial ossification from both ends. This has also been found by other investigators. We found cases of V-shaped notches with partial or complete ossification which were not mentioned in Rengachary’s typing. Rengachary states that the Type V is the only type where the superior border is not the widest part of the notch. However, in our study we also observed notches with no apparent ossification, where the superior border became narrower than the medial part of the notch. It is unclear into which type this notch should be placed. The classification system used by Ticker and associates separates the superior transverse scapular ligament from the inferior border of the notch, resulting in less transitional and ambiguous notches.

The size of the suprascapular notch is thought to play a part in the predisposition for suprascapular nerve entrapment, assuming that a small notch gives a larger chance of nerve impingement than a large notch. The average areas of the notches we found were similar to Rengachary’s findings, with the smallest areas in Type IV notches. He hypothesizes that due to the infrequency of this type of notch one would encounter Type III more often with suprascapular nerve entrapment, because of its frequency and relative small notch size. We found that the area of Type III was actually larger than that of Type II and occurred less frequently, making it in no way more likely to be associated with nerve entrapment. In the classification used by Ticker, the U-shaped notches had a larger area than the V-shaped notches, leading to the assumption that a V-shaped notch would be more likely to be found with nerve entrapment.

There are some limitations to this study. The scapulae that were examined were dried specimens and dimensions may have changed. In specimen preparation the amount of osteophytes in the superior transverse scapular ligament may have been changed. Because of the use of dried specimens, the effects of other soft tissue structures on suprascapular nerve entrapment could not be evaluated. Also, where the superior transverse scapular ligament was absent, we had to estimate how thick it was in order to calculate the notch area.

Conclusions

The suprascapular notch classification used by Ticker and associates is more reliable and reproducible than the system used by Rengachary and colleagues, resulting in higher kappa values. Even though the kappa value is still considered “moderate” for the inferior border in the classification system used by Ticker and associates, it is still higher than the kappa value for the system used by Rengachary and colleagues. The kappa value for the superior transverse scapular ligament in the classification system used by Ticker and associates is considered “substantial,” which is the only part of the suprascapular notch to have been directly linked to suprascapular nerve entrapment in the literature and therefore the most important factor to assess correctly. Therefore, if a clinical study is done evaluating the suprascapular notch, the classification system used by Ticker and associates should be used.

Acknowledgments

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References
