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Interobserver reliability of the rotator cable and its relationship to rotator cuff congruity

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Background: This study evaluated the presence of the rotator cable intraoperatively and compared its prevalence according to both patient age and rotator cuff integrity. The study hypothesis was that the cable would be more prevalent in older patients and patients with partial-thickness tears.

Methods: Patients who were undergoing shoulder arthroscopy and were aged at least 16 years were included in this study, whereas those who had a cuff tear of more than 1 tendon or who had a video with poor visualization of the rotator cuff insertion were excluded. Intraoperative videos were collected, deidentified, and distributed to 7 orthopedic surgeons to define rotator cable and cuff tear characteristics.

Results: A total of 58 arthroscopic videos (average patient age, 46 years; range, 16-75 years) were evaluated. The observers were in the most agreement on identifying the presence of a cable, with a κ coefficient of 0.276. Patients with the rotator cable were significantly older than those without it (mean age, 52.1 years vs. 42.5 years; $P = .008$), and a positive and significant correlation was found between rotator cable presence and increasing patient age ($r = 0.27$, $P = .04$). A significant association was noted between tear degree and cable presence ($P = .002$). There was no significant association with cable presence in patients with a full-thickness tear.

Conclusions: In this study, an intraoperative analysis was performed to define the presence of the rotator cable and correlate this with both patient age and rotator cuff integrity. The hypothesis was confirmed in that patients older than 40 years had a significantly higher rotator cable prevalence.

Level of evidence: Level III; Cross-Sectional Design; Epidemiology Study

Keywords: Rotator cable; rotator cuff tear; intraoperative visualization; shoulder arthroscopy; partial rotator cuff tear; full thickness rotator cuff tear

The rotator cable is described as a structure that provides biomechanical support to the tendinous insertion of the superior rotator cuff. The anatomic structure was first described by Clark and Harryman[3] as a thickened continuation of the coracohumeral ligament deep to the supraspinatus tendon and superficial to the joint capsule. The term ‘‘rotator cable’’ was coined by Burkhart et al,[1] equating the structure with the cable support of a suspension bridge, becoming more important with age as the crescent tissue of the rotator cuff tendon degenerates. Burkhart et al further reported that if the cable remained intact, normal shoulder fulcrum mechanics could be maintained.

Multiple cadaveric studies have described the rotator cable to be readily identified. In one of these studies, the cable was described to extend posteriorly to be incorporated with fibers of both the infraspinatus and teres minor.[11] Multiple studies have used ultrasound and magnetic resonance imaging to assess the rotator cable, in which the findings of a cable are less consistent. The results have been variable, demonstrating the presence of the rotator cable in anywhere from 11% to 99% of

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shoulders on imaging.[4,5,7,8] Despite this variability seen between cadaveric and imaging studies, no study has evaluated the presence or prevalence of the rotator cable intraoperatively. In addition, although the cable has been described as a fortifying structure of the rotator cuff, no study has evaluated its correlation with rotator cuff tears, as well as patient age.

This study evaluated the presence of the rotator cable intraoperatively. The goals of the study were to evaluate orthopedic surgeons' ability to identify the rotator cable and to compare rotator cable presence with both patient age and rotator cuff integrity. The study proposed that the rotator cable was in fact a buildup of rotator cuff tissue created from partial-thickness rotator cuff tears. Therefore, the hypothesis was that a visualized rotator cable would be more prevalent in patients with rotator cuff degeneration and would increase with age.

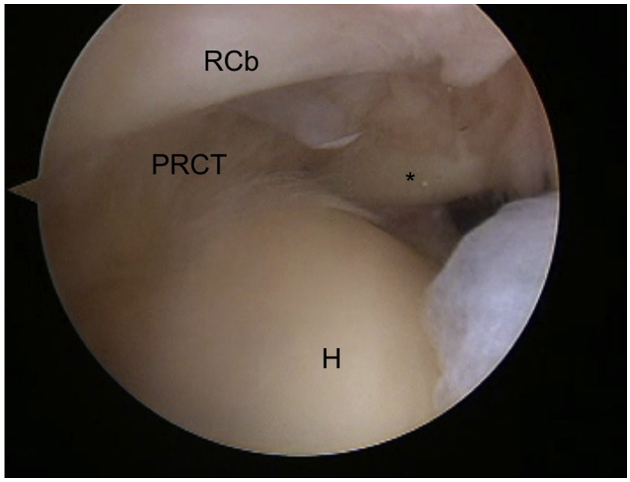

Figure 1 Partial-thickness rotator cuff tear with presence of rotator cable *(RCb)* as agreed on by majority of respondents. *Biceps tendon. *H*, humeral head; *PRCT*, partial rotator cuff tear.

Methods

Patients who were aged at least 16 years and undergoing an arthroscopic shoulder procedure were included. The exclusion criteria were patients who had a cuff tear of more than 1 tendon or who had a video that did not adequately capture the rotator cuff insertion. A video of approximately 15 to 20 seconds was captured, viewing the insertion and undersurface of the rotator cuff from the anterior edge of the supraspinatus extending posteriorly to the infraspinatus. Videos were collected, deidentified, and distributed via a randomized survey to 7 orthopedic surgeons with specialty training in either shoulder and elbow surgery or sports medicine. The surgeons were queried about their arthroscopic shoulder experience and were asked to define the rotator cable as present (Fig. 1), absent (Fig. 2), or ill defined (Fig. 3). The status of the rotator cuff for each video was defined as either intact, a partial tear, or a full-thickness tear by the operative note of the primary surgeon. The survey was randomized again and was distributed to the same group of surgeons a second time and completed with at least a 3-month gap.

For statistical analysis, the rotator cable was considered present if a majority of observers reported it as present. Logistic regression was performed to identify the relationship between the presence of the rotator cable and patient age. Interobserver reliability through the κ coefficient was calculated to identify the ability of surgeons to clearly identify the rotator cable. Intraobserver reliability was then calculated via the κ coefficient with 4 of the 7 original surgeons.

Results

A total of 58 arthroscopic videos were collected and evaluated by 7 orthopedic surgeons, comprising 5 shoulder and elbow–trained surgeons and 2 sports medicine–trained surgeons. Of the respondents, 3 were in practice for 0-5 years; 2, for 11-20 years; and 2, for greater than 20 years. Three surgeons performed between 50 and 100 rotator cuff surgical procedures per year, whereas the remainder performed greater than 100 per year. The observers demonstrated the highest agreement when defining the presence of the cable (κ coefficient, 0.276).

The average patient age was 46 years (range, 16-75 years). In 28 patients (48.3%), no rotator cuff tear was reported, whereas in 15 patients each, partial-thickness tears (25.8%) and full-thickness tears (25.8%) were reported. Patients with the rotator cable were significantly older than those without it (mean age, 52.1 years vs. 42.5 years; $P = .008$), and a positive and significant correlation was found between rotator cable presence and increasing patient age ($r = 0.27$, $P = .04$). In addition, logistic regression confirmed age as an independent variable in predicting the presence of the cable, with the odds of a cable being 1.11 higher per year increase in patient age ($P = .007$). Finally, patients older than 40 years had a rotator cable prevalence of 80%, whereas those aged 40 years or younger had a prevalence of 10%, which was a significant difference by the Fisher exact test ($P = .018$).

A significant association was noted between tear degree and cable presence ($P = .002$), with 55% of patients with the cable having partial-thickness tears. Conversely, 57.9% of patients without the cable did not have a rotator cuff tear. No significant association with cable presence was found in patients with full-thickness tears. For the 4 reviewers who completed the second survey, the κ coefficients for intraobserver reliability were 0.367, 0.262, 0.475, and 0.218.

Discussion

The rotator cable has been described as a distinct anatomic structure that adds to the mechanical stability of the rotator cuff. Previously, the rotator cable has been described only in radiographic or cadaveric studies.[2,4-6,8] Our study used an intraoperative observation analysis to define the presence of the rotator cable and correlate its presence with both patient age and rotator cuff status. The hypothesis was

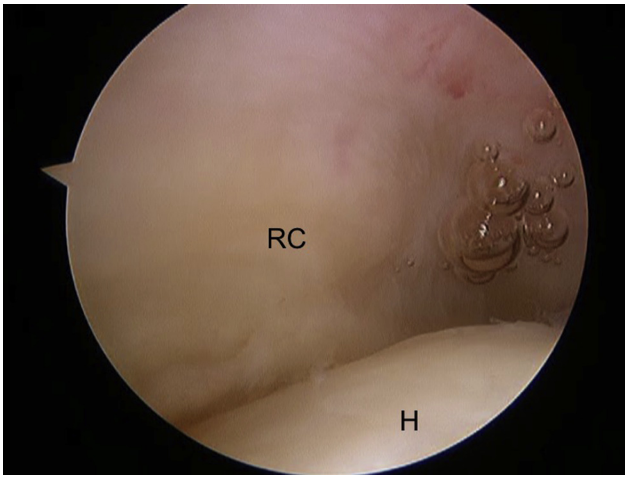

Figure 2 Image in a patient in whom a majority of observers agreed there was no rotator cable. In addition, the patient had no partial- or full-thickness rotator cuff *(RC)* tear. *H*, humeral head.

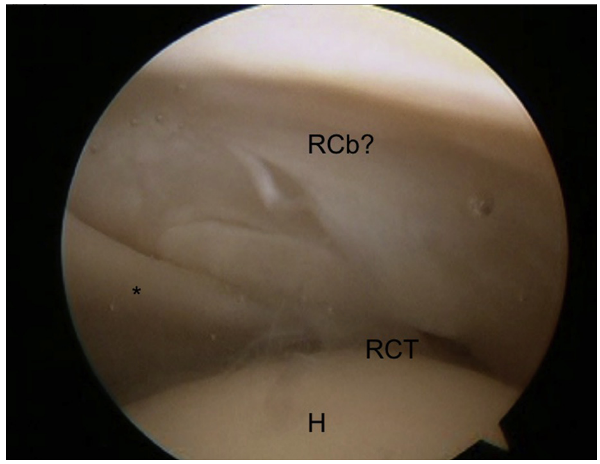

Figure 3 Example of a patient with a full-thickness rotator cuff tear *(RCT)* in whom the majority of respondents found the rotator cable to be ill defined. *Biceps tendon. *H*, humeral head; *RCb?*, questionable rotator cable.

confirmed in that patients older than 40 years had a significantly higher rotator cable prevalence (80% vs. 10%, $P = .018$). In addition, the cable was more commonly seen in patients with partial rotator cuff tears (55%), and patients without the cable were more likely to have an intact rotator cuff (57.9%). However, both intraobserver and interobserver calculations showed that the reliability of the surgeons to accurately identify the rotator cable was poor.

The rotator cable has been described as a suspension bridge type of structure that importantly adds to the strength of the rotator cuff insertion and protects the weaker rotator crescent. Mesiha et al[6] described further tendon retraction of rotator cuff tears that involved the anterior portion of the cable rather than crescent tears, thus pointing to the importance of the load-bearing nature of the rotator cable. Further biomechanical work has been performed demonstrating the improved strength when restoring the cable structure. Nguyen et al[10] showed that securing the anterior rotator cuff to bone in a margin convergence technique demonstrated less gapping than a soft-tissue margin convergence to the rotator cable. Their supposition was that this technique repaired the anterior rotator cable to bone rather than soft tissue, thus providing more strength.

As we demonstrated in this study, however, identification of the rotator cable intraoperatively is not very reliable. Furthermore, it must be done intra-articularly rather than in the subacromial space. Thus, identifying as well as repairing the rotator cable with direct visualization can be achieved but is technically demanding.

In addition, a clinical study by Namdari et al[9] compared small to medium supraspinatus tears with and without disruption of the anterior portion of the tendon. As would be expected and as was shown in the aforementioned biomechanical work, tears involving the anterior supraspinatus demonstrated more retraction. However, at follow-up after repair, no difference was seen in American Shoulder and Elbow Surgeons scores or tendon healing rates.

Studies have reported on the ability to identify the cable on imaging modalities such as ultrasound and magnetic resonance imaging. Choo et al[2] evaluated the presence of the rotator cable as seen on magnetic resonance arthrogram in patients with varying conditions of the rotator cuff (normal, tendinosis, or torn). As the status of the rotator cuff worsened, the rotator cable was found to be thicker. The study did not find a correlation of thickness with patient age. The first finding of Choo et al, however, is consistent with the conclusion of our study in that the visible rotator cable could potentially be a density of tissue created through rotator cuff degeneration or potential intratendinous tearing.

The finding of the rotator cable being a density of tissue was corroborated in an ultrasound study evaluating the shoulders of cadaveric specimens, as well as the shoulders of asymptomatic volunteers.[7] The authors reported the ability to identify the cable in 2 cadaveric specimens and then described a histologic evaluation. Although they reported a separate "cord-like" structure separate from the rotator cuff on histologic evaluation, there is no report of collagen content and orientation. As the rotator cuff tendon is known to have a varying orientation of collagen depending on the depth of the tissue, this could be a normal variant within the tendon rather than a separate structure. Furthermore, among healthy asymptomatic volunteers, the cable was only identified on ultrasound in 11% of the subjects. This finding, again, would be consistent with our finding that if the asymptomatic patient has less rotator cuff pathology, it would stand to reason that he or she would have less of a chance of exhibiting the rotator cable.

There are weaknesses in this study, namely, the findings of the survey are subjective in terms of relying on the observers to help define the presence of the rotator cable. The κ coefficient was used as a statistical means to attempt to limit this subjective bias and create a more objective finding for reliably identifying the rotator cable. The κ coefficient is a statistical method that allows to control for the possibility of agreement occurring by chance. A coefficient closer to 1 shows a higher probability of real agreement rather than just chance. The κ coefficients in this study were all less than 0.5; this finding demonstrates that there may be a higher probability of identifying the cable by chance than by the surgeon observers. We believe that this weakness, however, actually adds to the study by demonstrating how difficult it is to reliably identify the rotator cable. Another weakness is that only 4 of the 7 original surgeons completed the survey a second time. These second-view data were used to calculate the κ coefficient for intraobserver reliability. The results showed that the intraobserver findings were as poor as the interobserver values. Therefore, although it would have been ideal to have all 7 respondents complete the survey a second time, the 3 additional surveys would not likely have changed the poor intraobserver agreement.

Conclusion

The findings of this study suggest that the previously described rotator cable actually may be more related to patient aging or partial-thickness rotator cuff tearing rather than being a distinct developmental anatomic structure. These findings could certainly be called into question based on the poor interobserver and intraobserver agreement in the surgeons' ability to define the presence of the rotator cable. This poor reliability is important as it highlights the inconsistency in the ability of surgeons to accurately identify the rotator cable. The rotator cable has been described as an important structure to identify and restore in arthroscopic rotator cuff surgery; however, the inability to truly identify this structure calls into question how imperative it is to achieve this goal.

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