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The morphology and function of the quadrate ligament

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There is a paucity of information in the literature regarding the quadrate ligament and the information that does exist is extremely conflicting. We dissected 30 cadavers (60 sides) to determine the morphology and function of this enigmatic ligament. A quadrate ligament (thickening of the elbow joint capsule) was found in all specimens. In all specimens this band was distinct from the circumferential fibres of the annular ligament. The length, width, and thickness of the quadrate ligament were found to be 11 mm, 8 mm, and 1 mm respectively. This ligament not only aided in securing the neck of the radius to the ulna but also resisted excessive supination and, to a lesser degree, pronation of the forearm. Following transection of the quadrate ligament, the head of the radius was secured to the ulna considerably less firmly and supination and pronation increased by 10 to 20 degrees and 5 to 8 degrees respectively. The quadrate ligament contributes to proximal radioulnar stability, limits the "spin" of this joint, and should be considered in manipulation, surgery, or imaging of the proximal forearm.

Key words: anatomy, elbow, forearm, stability, radius, ulnar

INTRODUCTION

The ligaments of the proximal radioulnar joint have been well studied, less so the quadrate ligament (ligament of Denucé) (Fig. 1). This ligament was first described [3] by Denucé in 1854 in his thesis on dislocations of the elbow. A review of the few brief descriptions of this structure found in the literature shows that the anatomy, function and even the presence of the ligament are often disputed. When reported, the quadrate ligament is often briefly described as a thickening of the fibrous capsule of the elbow joint inferior to the radial notch of the ulna and connecting laterally to the neck of the radius [2, 8]. Some have described this as a stout ligament [5], while others have found no evidence as to the existence of this ligament [4]. Williams [8] depicted this ligament as thin and cribriform in nature.

MATERIAL AND METHODS

Dissection of the proximal forearm was performed on 30 formalin-fixed cadavers (60 sides) aged 50 to 85 years (with a mean age of 77) with special attention given to the proximal radioulnar joint. Following removal of the overlying musculature (such as the brachialis), the anterior wall of the elbow joint

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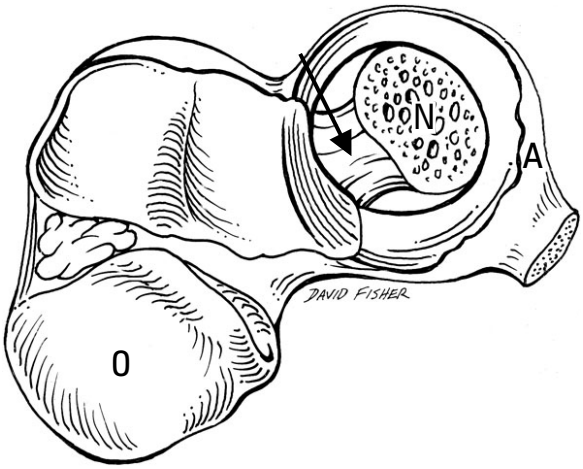

Figure 1. Schematic drawing of the proximal radioulnar joint. Note the arrangement of the quadrate ligament (arrow) in this depiction, where the head of the radius has been removed. For reference, note the olecranon process of the ulna (O), annular ligament (A), and neck of the radius (N).

capsule was identified and opened and the annular ligament transected and retracted laterally. The proximal radius was gently retracted laterally so that the proximal radioulnar joint was separated. Observations and measurements were then performed on the quadrate ligament. Next, the ranges of motion of the proximal radioulnar joint were tested and simultaneous tension on the quadrate ligament observed. A protractor was used to calculate the degrees of supination and pronation. The quadrate ligament was then cut and these same ranges of motion tested. ANOVA was performed for statistical analysis of differences with respect to side and gender ($p < 0.05$).

RESULTS

A quadrate ligament was found in all specimens. These were uniform in thickness and were not cribriform in nature. The length, width, and thickness of the quadrate ligament ranged from 8 to 14 mm, 4 to 11 mm, and 1 to 2 mm respectively. The mean measurements for these distances were 11 mm, 8 mm, and 1 mm respectively. The quadrate ligament was always found to attach the medial neck of the radius to the area of the lateral ulna just inferior to the radial notch (Fig. 1, 2). Laterally the quadrate ligament had attachments into the annular ligament as it attached into the anterior and posterior aspects of the radial notch. Disarticulation of the head of the radius from the proximal radioulnar joint was resisted by the quadrate ligament. Moreover, supination was limited by this ligament as was, to a lesser degree, pronation. The quadrate ligament became most taut with 85 to 98 degrees (a mean of 95 degrees) of supination and 20 to 35 degrees (a mean of 30 degrees)

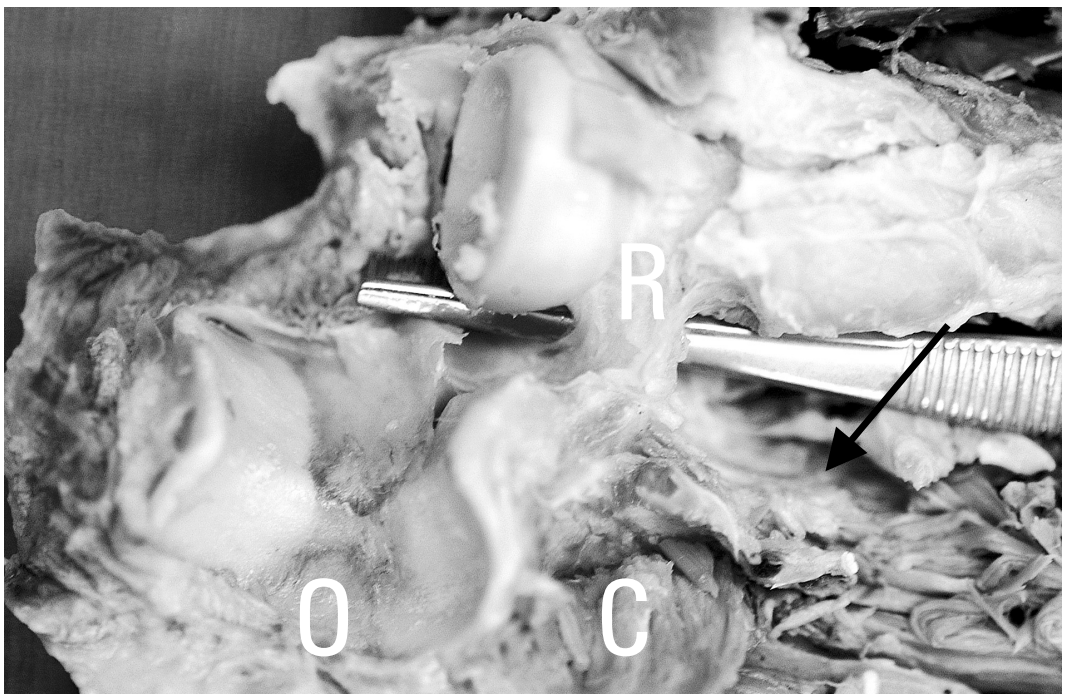

Figure 2. Cadaveric image of the quadrate ligament. Note the olecranon process of the ulna (O), the coronoid process of the ulna (C) and the head of the radius (R); the quadrate ligament (arrow) is seen travelling over the forceps.

of pronation. Following the transection of the quadrate ligament, the head of the radius was much less firmly secured to the ulna and supination and pronation increased by 10 to 20 degrees (with a mean of 12 degrees) and 5 to 8 degrees (a mean of 6 degrees), respectively. No significant difference was found between sides or genders ($p > 0.05$).

DISCUSSION

The annular (coronary, orbicular) ligament plays a significant role in the stability of the proximal radioulnar joint, in particular inhibiting disarticulation of this joint and restricting distal distraction of the head of the radius [5]. A thickening of the inferior aspect of the proximal radioulnar joint capsule (i.e. the quadrate ligament), as seen in all our specimens, indicates its importance for stability at this site. Kaplan [3] stated that the quadrate ligament is 12 to 15 mm in length and 8 to 10 mm in width. This may be compared to our findings of 8 to 14 mm and 4 to 11 mm respectively. With regard to its morphology, Spinner and Kaplan [6] have described an anterior and posterior border of the quadrate ligament, the anterior border being thicker. These same authors [6] described the quadrate ligament as lacking in tautness in the neutral position. Our findings support this functional finding but we did not observe a difference in thickness between the anterior, middle and posterior parts of the quadrate ligament, the entire ligament being of more or less the same thickness.

Neumann [5] stated that the quadrate ligament is a stout band that arises just inferior to the radial notch of the ulna and attaches to the medial surface of the neck of the radius. This author goes further to say that this ligament lends structural support to the capsule of the proximal radioulnar joint. Kaplan [3] stated that in dislocations and fractures involving the proximal end of the radius and ulna an intact quadrate ligament facilitates the reconstruction of the annular ligament. Bert et al. [1] stated that the release of the quadrate ligament led to an improvement in patients treated for idiopathic loss of supination. These authors concluded that a contracted quadrate ligament may be an important deterrent to supination of the forearm but that distortion of the radial head, curvature of the ulna, and contracted soft tissues in the interosseus space and distal radio-ulnar joint also are contributory factors. Terzhumanov and Stavrev [7] have also confirmed the quadrate ligament's role in limiting supination. In our study the quadrate ligament became most taut at a mean of 95 degrees of supination and a mean of 30 degrees of pronation. Following transection of the quadrate ligament, the head of the radius was much less well secured to the ulna and the range of supination and pronation increased.

CONCLUSIONS

A quadrate ligament was found in each of our specimens. This ligament resisted disarticulation of the proximal radioulnar joint. Additionally, both supination and, to a lesser degree, pronation were limited by the quadrate ligament. This anatomical structure should be considered in manipulation, surgery or imaging of the proximal forearm.

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