SCIENTIFIC ARTICLE

Efficacy of Dorsoradial Capsulodesis for Trapeziometacarpal Joint Instability: A Cadaver Study

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Purpose To test the biomechanical properties of the dorsoradial capsulodesis procedure.

Methods Six cadaveric hands were used. After exposing the trapeziometacarpal (TMC) joint, we placed Kirschner wires in the distal radius and thumb metacarpal. The rotation shear test was then performed to test the joint axial laxity, and angular measurements using Kirschner wires as reference points were documented. The dorsoradial (DR) ligament and capsule were released, followed by the intermetacarpal (IM) ligament; angular measurements were obtained. Finally, the DR capsulodesis procedure was performed, and final measurements were obtained. Comparisons were made among the various stages of ligament integrity to determine the amount of stability provided by DR capsulodesis.

Results All cadavers demonstrated axial laxity with transection of the DR ligament; an increase in stability was obtained after DR capsulodesis. Transection of the capsule and IM ligament caused increased laxity relative to the native joint (median, 24° and 35°, respectively, on rotational testing). After we performed DR capsulodesis, rotational stability improved by a median of 41° compared with DR ligament transection, 49° compared with DR and IM ligament transection, and 18° relative to the native joint.

Conclusions Dorsoradial capsulodesis restores rotational stability for TMC joint after division of the DR and IM ligaments. The stability achieved was statistically significant compared with both an intact native TMC joint and induced laxity of the TMC joint.

Clinical relevance The DR capsulodesis procedure may improve rotational stability to the TMC joint. *(J Hand Surg Am. 2017;42(1):e25–e31. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Dorsoradial capsulodesis, joint instability, trapeziometacarpal joint.

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THE THUMB TRAPEZIOMETACARPAL (TMC) joint is a complex anatomic structure between the trapezium and thumb metacarpal, forming an unstable double-saddle articulation, which is supported by 16 ligaments.[1] This configuration gives the thumb ray a wide range of motion that is crucial for opposition as well as pinch and grasp. Instability of the TMC joint may result from congenital disorders such as osteogenesis imperfecta, Ehlers Danlos, and Down syndromes, or it may be encountered in inflammatory

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FIGURE 1: Kirschner wires were placed into the radial styloid and thumb metacarpal to allow rotational range of motion measurements.

arthritic conditions such as systemic lupus erythematosus. Acute trauma may also cause TMC joint dislocation and subsequent residual instability, just as chronic repetitive forces of pinch may contribute to TMC joint ligament laxity. Other, less frequently described conditions include thenar muscle atrophy and anomalous insertion of the abductor pollicis longus tendon into the thenar muscles.[2–4] Trapeziometacarpal instability alters joint kinematics and increases contact stress within the joint.[5] This can cause substantial pain and disability and, if left untreated, has been shown to result in articular wear and TMC arthritis.[6,7]

Anatomic studies have shown the dorsoradial (DR) ligament to be the thickest and strongest supporting ligament compared with the longer and thinner deep anterior oblique (volar beak) ligament.[1,8] Among the many supporting ligamentous structures of the TMC joint, the volar beak ligament was previously hypothesized to be the primary stabilizer and its reconstruction was used by Eaton and Littler[12] for stabilization of the TMC joint with satisfactory clinical results. Recent biomechanical cadaver studies performed by Strauch et al[9] and Van Brenk et al[10] on TMC instability showed the DR ligament to be the primary stabilizer in preventing dorsal dislocation of the thumb metacarpal base. Edmunds[11] described the transition from resting position to opposition during power pinch or grasp as the reason why the volar beak ligament becomes lax and the thumb metacarpal is compressed into its recess area in the trapezium. At the same time, the DR ligament becomes taut with this motion. In contrast, in the resting position, the DR ligament becomes lax. Based on this concept, he concluded that the volar beak ligament has no role in the pathogenesis of TMC arthritis. Although these data offer support for the DR ligament being the strongest stabilizer of the TMC joint, other ligamentous structures are important to TMC joint stability, including the intermetacarpal (IM) and volar beak ligaments.

In 1973, Eaton and Littler[12] described a procedure for reconstruction of the volar beak ligament using a slip of the flexor carpi radialis tendon. Other surgical options to treat TMC instability include open ligament reconstruction, metacarpal osteotomy,[13] and arthrodesis. Both ligament reconstruction and metacarpal osteotomy have produced satisfactory results while maintaining range of motion. Rayan and Do[14] described the technique of DR capsulodesis to treat TMC instability. This technique uses imbrication of the DR ligament to achieve stability. Birman et al[15] subsequently performed a similar case series employing a proximal or distal suture anchor to imbricate the capsule, instead of performing a midsubstance repair, and showed similar results. The clinical efficacy of the DR capsulodesis as described by Rayan and Do has not yet been studied.

In this study, we used a cadaver model to produce laxity of the TMC joint followed by the DR capsulodesis procedure, with the hypothesis that the procedure would improve joint stability. To assess stability, we used the rotation shear test, which involves stabilizing the patient's forearm with one hand. With the other hand, the patient's thumb proximal phalanx is rotated from full pronation to full supination. In the presence of both traumatic dorsal instability and general medical causes of pathologic instability, the test provokes pain and "shoulder" sign, and laxity greater than the normal contralateral side is demonstrated. This test does not particularly examine instability in the sagittal plane (ie, dorsal subluxation), but it reflects axial stability. The shoulder sign is probably caused by dorsal subluxation but also by rotational subluxation of the joint and prominence of the base of the thumb metacarpal. It is our clinical experience and part of our experimental design that patients presenting with TMC instability would also demonstrate increased