Dorsal Capsuloplasty for Dorsal Instability of the Distal Ulna

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Abstract

Background Dorsal instability of the distal ulna can lead to chronic wrist pain and loss of function. Structural changes to the dorsal radioulnar ligaments (DRUL) of the triangular fibrocartilage complex (TFCC) and the dorsal capsule around the ulnar head with or without foveal detachment can lead to volar subluxation of the distal radius e.g., dorsal instability of the distal ulna.

Purpose Is to evaluate the post-operative results of reinstituting distal radioulnar joint (DRUJ) stability through reefing of the dorsal capsule and dorsal radioulnar ligaments, with and without a foveal reattachment of the TFCC.

Methods A total of 37 patients were included in this retrospective study. Diagnosis and treatment was based strictly on dry wrist arthroscopy. In 17 patients isolated reefing of the DRUL and their collateral tissue extension was performed. In 20 patients an additional foveal reinsertion was performed. Postoperative results were evaluated with the DASH questionnaire, VAS scores, grip strength and range of motion. These findings were extrapolated in the Mayo wrist score. The two subgroups were compared.

Results Mayo wrist scores of the whole population had a mean of 73. There was no difference between the group that was treated with reefing of the DRUL only and the group that was treated with a combined foveal reinsertion.

Conclusion This relatively simple 'dorsal reefing' procedure, with foveal reinsertion when indicated, is a reliable method to restore volar-dorsal DRUJ stability with a significant decrease in pain sensation, good DASH scores and restoration of functional grip strength and ROM.

Type of Study/Level of Evidence Therapeutic, Level IV.

Keywords

- capsuloplasty
- DRUL
- DRUJ
- instability
- TFCC

Instability of the distal radio-ulnar joint (DRUJ) is a cause for loss of wrist function and chronic pain on the ulnar side of the wrist. Several recent investigations have highlighted the diagnosis and treatment of this disorder.^{1–3}

A variety of structures contribute to stability of the DRUJ, which include the pronator quadratus muscle, ulnocarpal ligament, extensor carpi ulnaris (ECU) subsheath, dorsal radio-ulnar ligaments (DRUL), volar radio-ulnar ligaments (VRUL), interosseous membrane, the osseous anatomy and DRUJ capsule.^{4–10} The triangular fibrocartilage complex (TFCC) is considered the major stabilizer of the DRUJ. The

TFCC consists of a tensesgrity of an articular disc, the meniscus homologue, the palmar and dorsal ligament subsets; the dorsal and volar radioulnar ligaments (DRUL-TFC, VRUL-TFC) with a superficial and a deep portion which are conjoined at the radius attachment and in continuation with the dorsal capsule around the ulnar head.¹¹ The superficial portion of the DRUL surrounds the articular disc but has no clear definable insertion into the ulnar styloid. The fibers of the deep portion which are also referred to as the subcrucium ligaments form a conjoined tendon as they converge toward their insertion to the fovea at the base of the ulnar

styloid along with the ulnocapitate ligament. DRUJ stability is dependent upon the integrity of these structures but the relative contribution of each structure is still debatable.^{7,12-15} Hagert clarified the biomechanical effect of each component of the TFCC. He noted that in maximum pronation DRUJ stability is based almost entirely on the restraining action of the volar radioulnar ligaments whereas in maximum supination DRUJ stability is based almost entirely on the restraining action of the dorsal radioulnar ligaments.¹⁶ Hence attenuation of these structures, including the dorsal capsule around the ulnar head, allows the distal radius to sag volarly resulting in apparent dorsal instability of the distal ulna. This may cause chronic ulnar sided wrist pain.¹⁷

Different procedures have been described for restoring stability of the DRUJ. These techniques can be grouped into the following categories -1.- a radio-ulnar tether, extrinsic to the joint,¹⁸ -2.- an indirect radio-ulnar link consisting of an ulnocarpal sling or tenodesis,¹⁹ -3.- direct reconstruction of the distal radio-ulnar ligament^{2,3,17,20} and -4- fixation of the disrupted TFCC to the fovea.²¹

Koch and de Jong¹⁷ observed dorsal instability of the DRUJ caused by isolated laxity of the dorsal capsule over the ulnar head originating from the DRUL, which was amenable for capsuloplasty. The purpose of this study is to report our experience with a dorsal capsuloplasty for the treatment of dorsal subluxation of the ulnar head as an isolated procedure or in combination with a reattachment of the deep foveal fibers.

Materials and Methods

A review of our computerized database of operation registrations revealed that from January 2003 to December 2009, 58 consecutive patients were treated for painful volar subluxation of the distal radius with dorsal instability of the distal ulna. All patients were invited for re-evaluation of the treated wrist after informed consent. The response rate was 88%. Fourteen patients were excluded, as is shown in ►Fig. 1. The

course of 37 consecutive patients treated for chronic ulnar wrist pain due to DRUJ instability, was analyzed (►Fig. 1). Seventeen patients were treated with reefing of the DRUL only, 20 were treated with a combined reefing of the DRUL and foveal reinsertion of the TFCC. Due to the retrospective nature of this study no approval of the local ethics committee was needed.

All patients had a history of chronic ulnar sided wrist pain, typically with acute traumatic onset, pain during forceful rotation and ulnar deviation. Patients could localize the pain over the dorsal rim of the ulnar head, often radiating to the forearm. There were clinical signs of volar-dorsal DRUJ instability during an orientating physical examination (DRUJ translation test, TFCC compression test, pain increasing during supination, piano key sign), compared with the contralateral side. These tests were never considered conclusive but assess possible pathology around the DRUJ. Until now there is no reliable diagnostic test to diagnose DRUJ instability. But the combined findings and the severity and duration of the complaints justified a diagnostic arthroscopy, our standard of reference for analyzing chronic ulnar wrist pain. No CT or MRI scans were performed. Standard bilateral X-rays (PA and true lateral) were only evaluated for orientation of the osseous structures around the wrist and for guidance to determine the location of the portals preceding arthroscopy. Despite any earlier appearance of pathology, the definite diagnosis in every patient in this study was based solely on dry wrist arthroscopy, through the 3/4 and 6R portals. No midcarpal portals were used in this patient group. Arthroscopy was performed as an outpatient procedure. The surface of the TFCC was inspected, including the dorsal surface of the proximal collateral soft tissue, originating from the DRUL. The trampoline test was used to determine the overall tension on the TFCC by pressing the central cartilaginous disc gently with the hook and is indicative for peripheral TFCC lesions. Tension on the DRUL in a dorso-proximal direction was tested with the probe through the 6R portal, by hooking the tissue just proximal of the DRUL and pulling it in a proximal

Fig. 1 Flow chart of patient inclusion.

Table 1 Palmer classification for TFCC lesions; the classification does not include rupture or attenuation of the DRUL

1. Traumatic
A Central perforation
B Ulnar avulsion with or without ulna fracture
C Distal avulsion
D Radial avulsion with or without sigmoid notch fracture
2. Degenerative
A TFCC wear
B TFCC wear with ulnar and/or lunate chondromalacia
C TFCC perforation with lunate and/or ulnar chondromalacia
D TFCC perforation with lunate and/or ulnar chondromalacia and LT ligament perforation
E TFCC perforation with lunate and/or ulnar chondromalacia, LT ligament perforation, and ulnocarpal arthritis

direction. This test was considered positive when the DRUL was easily brought over the distal rim of the ulnar head thus creating more tension on the TFCC. We consider this indicative for attenuation and laxity of the DRUL and dorsal capsular tissue. An impression of the attachment of the deep foveal fibers was obtained through the hook test as described by Atzei.²² Our preferred method for assessing foveal attachment was to insert a needle from ulnar, just volar to the ulnar styloid process, in a plane between the ulnar head and TFCC. Excess mobility of the TFCC when lifting the needle tip at the location of the fovea, made foveal detachment probable. Abnormalities of the TFCC were recorded according to the Palmer classification.²³ However, the Palmer classification (►Table 1) does not classify attenuation or rupture of the dorsal radioulnar ligaments, hence these findings were recorded as such. No abnormalities of the volar ligamentous structures were seen. Localized fibrous hypertrophy or synovitis was debrided. All patients in the study group underwent diagnostic arthroscopy. The effect of the debridement was evaluated over the course of several months before deciding to perform a reconstruction. Reconstruction was advised, when symptoms persisted. Patients that improved from debridement are not represented in this study.

Surgical Procedure: Dorsal Capsuloplasty

All patients were admitted for an outpatient ambulatory surgery procedure with axillary block or general anesthesia under bloodless condition with the forearm in neutral position. Every patient was treated by the same surgeon (RK). The elbow is flexed to 90 degrees with the forearm in neutral rotation, which is maintained throughout the case. An L-shaped 5 cm incision is made along the dorsal side of the extensor carpi ulnaris (ECU) tendon sheath from proximal to distal curving 5 mm distal to the ulnar styloid process ending just radial of the fifth extensor sheath. Sensory branches of the ulnar nerve are treated with care to prevent painful neuromas. The skin is lifted from the extensor retinaculum along the fifth and sixth extensor tendon sheaths, which are opened (►Fig. 2). The floor of the sixth extensor sheath is preserved and inspected for tears.

To expose the DRUL capsule the extensor carpi ulnaris (ECU) and extensor digiti quinti (EDQ) tendons were retracted radially and ulnarward respectively. The ulnar head was pushed volarly to locate the attenuated DRUL-dorsal capsule over the distal end of the ulnar head, which is identified as the wrinkling tissue just proximal to the distal ulnar head (►Fig. 3). Just proximal to the DRUL a small soft tissue flap was created, released from the ulnar head but in continuity with the DRUL (►Fig. 4). By lifting this flap, the dorsal aspect of the ulnar head and DRUL were exposed and inspected. Any adhesions between the TFCC and the ulnar head were released, the cartilage and the deep foveal fibers were assessed. Then a transverse incision just distal to the dorsal radio-ulnar ligament was made, to enhance later reefing of the DRUL and its dorsal capsular extension and visually confirm the position of the DRUL and collateral tissue at the dorsal rim of ulnar head.

When the foveal attachment is certain, an isolated reefing of the DRUL and its capsular soft tissue extension was performed. The ulnar head was pushed slightly volarly, and the dorsal capsular soft tissue around the ulnar head was plicated with PDS 3-0 without too much tension to avoid

Fig. 2 Ulnar head is exposed after incision and opening of the fifth and sixth extensor sheath. ECU: extensor carpi ulnaris, EDM: extensor digiti minimi.

Fig. 3 Wrinkling of the dorsal capsular tissue (*) when depressing the ulna.

Fig. 4 Opening the dorsal capsule just proximal to the DRUL, exposing the ulnar head.

Fig. 5 The dorsal radioulnar ligaments and originating capsule held in forceps.

Fig. 6 With the forearm in neutral position, advancing the DRUL over the ulnar head.

restricting supination (► **Figs. 5, 6**). The dorsal capsular tissue was advanced proximally and then sutured (► **Fig. 7**). The fifth and sixth extensor sheaths were then closed with resorbable sutures and the skin with a subcuticular running suture. When a foveal detachment was identified the foveal fibers were reattached with pull-through stitches (PDS 2-0), through two oblique drill holes, passing from the ulnar side of the ulnar head to the fovea, using a 1.4mm K-wire. With the forearm still in neutral position and the elbow flexed, a long forearm plaster splint was applied.

Rehabilitation

After two weeks the plaster splint was replaced by a circular long arm cast for another four weeks. When removing the cast, patients were encouraged to start mobilizing their wrist, with assistance of a hand therapist to restore strength and mobility. Three months after surgery, patients were allowed to use the wrist and hand under all conditions.

Patients that responded were invited to attend our clinic. A detailed history of the pre- and postoperative wrist function

was performed and the DASH (disabilities of arm, shoulder and hand) questionnaire and VAS (visual analogue scale) scores were taken and compared with the pre-op values. The Physical examination included wrist range of motion

Fig. 7 DRUL secured on the dorsal ulna proximal to its origin, however under little tension.

(ROM) and grip strength of both the operated and opposite side (JAMAR), compression pain of the UCC, DRUJ translation test and examination for scar sensitivity or neuromas. Both ROM and grip strength (JAMAR) were electronically measured with e-link (Biometrics, Gwent, UK). All recorded findings were analyzed using SPSS (IBM, Chicago, USA), statistical software. (12.0.1). Mayo Modified Wrist scores on postoperative results were calculated as well. The results of the patient group that was treated with reefing of the DRUL

only and the group that was treated with a combined reinsertion were compared using an unpaired *t*-test.

Results

The study included 17 male and 20 female patients (mean age 34 years, ranging from 9–69, SD 13.5) (► **Table 2**). The mean time between the onset of complaints and date of surgery was 30 months (range 2–156, SD 4.8). Eighteen (49%) patients

Table 2 Descriptive statistics and results of patients treated with “selected soft tissue repair” of the TFCC (*DRUJ translation test and two or more of the following: TFCC compression test, pain increasing during supination, and piano key sign; 5/37 patients did not have significant signs of dorsal instability of the distal ulna compared with the contralateral wrist, but reported pain during the tests; **patient’s experience in retrospect)

Variable	Outcome (N = 37 patients)	Addendum
Sex	Female: 20, male: 17	
Age (years)	Mean: 34 (9–64, SD 13.5)	
Signs and symptoms at time of presentation	37/37 patients had chronic ulnar wrist pain and severe pain at supination. 32/37 patients had clear signs of dorsal instability of the distal ulna.* 37/37 patients had a positive TFCC-compression test.	
Evident trauma in history	28/37 (76%)	
Fractures of the wrist	16/37 (43%)	
Ability to work at time of presentation	13/37 patients fully unable to work, 19/37 patients partially unable (can’t perform on pre-complaint level), but still working. 5/37 patients fully able to maintain occupation.	
VAS pre-operative**	Mean: 7.3 (4–10, SD 1.6)	
Findings at dry arthroscopy	2/37 clear rupture of DRUL, 11/37 isolated laxity of DRUL, 1/37 laxity of DRUL + Palmer 1A, 20/37 laxity of DRUL + Palmer 1B, 3/37 laxity of DRUL + Palmer 2A 20/37 laxity of DRUL + foveal detachment	
Procedure	17/37 (46%) reefing of DRUL only, 20/37 reefing of DRUL + foveal reinsertion TFCC.	
Follow-up time (months)	Mean: 19 (5–46, SD 11.9)	
Signs and symptoms at follow-up	37/37 patients regained clinical DRUJ stability (100%).* 1/37 patients had a positive TFCC-compression test.	
VAS at follow-up	Mean: 1.8 (0–8, SD 2.1)	Mean difference: 5.5 (95% CI: 4.7–6.4, <i>p</i> < 0.001)
DASH at follow-up	Mean: 17 (0–60, SD 15.4)	
Loss ROM (rotation) post-operative	Mean: –7 degrees pronation (–45–13, SD 12.7) Mean: –7 degrees supination (–50–40, SD 13.4)	
Grip-strenght	Mean: 35.9 kg/cm ² (7.2–57.7, SD 11.9)	91% of control side
Grip-strenght control side	Mean: 39.5 kg/cm ² (10–69.3, SD 13.4)	
Ability to work	27/37 patients fully able to work at pre-complaint level. 8/37 patients partially unable (can’t perform on pre-complaint level), but still working. 2/37 patients were not able to maintain work.	
Satisfied	36/37	
MAYO wrist score	Mean: 73 (25–90, SD 16.7)	Satisfactory
Complications	7/37 patients have hypersensitivity of the scar

Fig. 8 Distribution of Mayo Wrist Scores; 90–100: excellent, 80–89: good, 65–79: fair, <65: poor.

were treated on the dominant side. The DRUJ translation test combined with one or more other signs of DRUJ instability was positive in 32 patients (86%), compared with the contralateral wrist. In five patients these differences were less specific. No gross abnormalities were detected on standard bilateral X-ray examination. Patients with pathology requiring additional procedures related to the distal ulna were not represented in this study. Laxity of the DRUL and dorsal capsule was apparent in all patients as well as the presence of local synovitis of the proximal collateral tissue originating from the DRUL. In 11 wrists (30%), arthroscopy revealed isolated laxity, degeneration and local synovitis or tearing of the DRUL.

In 20 patients (54%) a Palmer IB lesion combined with pathology of the DRUL was seen. In three patients a Palmer IIA injury and in one Palmer IA, combined with evident laxity of the DRUL. In 20 patients Atzei's hook test combined with the 'needle test' were positive, indicative for a detachment of the deep foveal fibers. These arthroscopic findings were confirmed peroperatively.

Isolated reefing of the DRUL and dorsal capsule was performed in 17 (46%) of the cases, in 20 cases there was a reattachment of the deep foveal fibers. The mean follow up time after surgery was 19 months (range 5–46, SD 11.9). All patients had a clinically stable DRUJ during physical examination at the time of follow up (e.g., negative DRUJ translation test), equal to- or even more than the contralateral wrist. No postoperative X-rays or CT scans were made due to their clinical insignificance. Seven patients experienced transient hypersensitivity of the scar. No infections or reflex dystrophy were observed.

VAS scores for pain improved from a mean score of 7.3 before surgery (range 4–10, SD 1.6) to a mean VAS score of 1.8 (range 0–8, SD 2.1) at the time of follow up. The difference in overall VAS scores preoperative and at the time of evaluation (5.5) was significant: $p < .001$ and 95% CI of 4.7–6.4 (paired t -test). The mean DASH was 17 after treatment (range 0–60, SD 15.4). The mean results in range of movement (ROM) and grip

strength are shown in ►Table 2. Combining these results in the Mayo wrist score, show a mean of 73 (range 25–90, SD 16.7) and can be interpreted as satisfactory overall (►Fig. 8). Thirty-six (97%) patients were satisfied and would again choose the same therapy if they were in the same position as before surgery. Four professional sport athletes were included in the study population: one tennis player, a jiu-jitsu fighter and two golf professionals (one playing the European Tour). Only one of them had a history of wrist trauma. They were all diagnosed with isolated laxity of the DRUL and dorsal capsule. The postoperative Mayo wrist scores were 80 for the tennis player, 75 and 80 for the golf professionals respectively and 90 for the jiu-jitsu fighter.

Twenty-seven patients fully reintegrated in their profession at a pre-complaint level, eight patients returned with limitations or adjustments. Two patients were still not able to find a job suitable for their situation (►Table 2). All parameters of the two subgroups were compared (independent sample t -test), none of these demonstrated a significant difference (►Table 3).

Discussion

Dorsal instability of the distal ulna can cause severe functional impairment and pain. Still, little has been written on capsular plication to restore volar-dorsal DRUJ instability. This study describes a surgical procedure to treat this condition without the complexities of tendon grafts and tethers commonly used for restoration of DRUJ instability.²⁴ Physical examination and X-ray examination in patients with chronic ulnar sided wrist pain are in our opinion useful indicators in diagnosing dorsal instability of the distal ulna. However, diagnosis should be confirmed with wrist arthroscopy. The results are promising. There was a significant decrease in postoperative VAS scores in comparison to the situation before treatment ($p < .001$, 95% CI: 4.7–6.4). Most of the known procedures to restore volar-dorsal stability may significantly reduce pronation and supination.¹ Our

Table 3 Subgroup analysis of the results of patients treated with “dorsal capsular plication” of the TFCC (*patient’s experience in retrospect)

Variable	Reefing DRUL only (N = 17 pt)	Reefing DRUL + Foveal reinsertion (N = 20 pt)	Difference (t-test)
Sex	Male: 10, female: 7	Male: 7, female: 13	
Age (years)	Mean: 32 (SD 14.1)	Mean: 35 (SD 13.2)	3 (p = .48)
VAS pre-operative*	Mean: 7.1 (SD 1.8)	Mean: 7.5 (SD 1.4)	0.4 (p = .48)
Follow-up time (months)	Mean: 20 (SD 12.1)	Mean: 18 (SD 10.6)	2 (p = .55)
VAS at follow-up	Mean: 1.8 (SD 1.8)	Mean: 1.8 (SD 2.4)	0 (p = .92)
DASH at follow-up	Mean: 15 (SD 12.5)	Mean: 19 (SD 17.6)	4 (p = .44)
Loss ROM (rotation) post-operative	Mean: -7 degrees pronation (SD 13.0) Mean: -4 degrees supination (SD 14.2)	Mean: -7 degrees pronation (SD 12.8) Mean: -9 degrees supination (SD 12.4)	0 degrees pronation (p = .84) 5 degrees supination (p = .22)
Grip-strenght	Mean: 38.9 kg/cm ² (SD 13.2)	Mean: 33.3 kg/cm ² (SD 10.4)	37.4 kg/cm ² (p = .16)
Grip-strenght control side	Mean: 41.8 kg/cm ² (SD 15.7)	Mean: 37.4 kg/cm ² (SD 11.1)	37.4 kg/cm ² (p = .34)
Grip-strenght difference	Mean: 2.9 kg/cm ²	Mean: 4.1 kg/cm ²	1.2 kg/cm ² (p = .60)
Satisfied	37/37		

technique of dorsal capsuloplasty resulted in a mild, average loss of 7° degrees pronation and 7° degrees supination. The slight reduction in rotation did not seem to adversely affect the patients. We found a mild reduction in flexion and extension and radial and ulnar deviation as well in nearly half of the patients. This might be due to scar tissue. Johnston et al.³ treated 6 patients with a volar-ulnar capsular plication to restore function of the DRUJ. After a mean follow up period of 16 months they observed an average loss of supination of 17° degrees. Adams and Berger² responded that at a minimum of one year postoperatively the ROM of pro- and supination was 70–90% after reconstruction of the radio-ulnar ligaments with a palmaris longus auto graft. Wong et al.²⁰ report in a case series of 6 patients that there was no loss of forearm rotation at a mean follow up time of 16 months with exception of one patient. The treatment consisted of a dorsal capsuloraphy with Mitek anchors. They reported a mean grip strength of 80% of the opposite side. Adams and Berger² and Johnston et al.³ reported a mean grip strength 85% and 83% of the opposite side respectively. This study found a mean grip strength of 91% of the control side and is favorable over what has been reported in literature for TFCC/DRUJ reconstruction.^{2,3,11,20} In this study the grip strength was corrected for dominance before comparing the outcomes with a -2,2 kg penalty for the dominant arm, treated and non-operated side indifferently. No other reports included DASH scores in their results, except Johnston et al. They found a mean DASH score of 13 (SD 17) compared with a mean DASH score of 17 in this study. The follow up period and number of patients of this study is comparable with the numbers found in literature.²

Possible limitations include the retrospective nature of this research. There was no control group which introduces

bias. The lack of preoperative DASH questionnaires, grip strength and ROM makes it difficult to gauge the effect of the surgery. The absence of statistical significance between the two groups reflects the fact that the numbers were too small to detect any clinical significance hence no conclusions can be drawn from this. A 3rd group consisting of an isolated foveal reattachment along with a power analysis to determine the minimally clinically important difference (MCID) would be necessary to determine the true effect of this procedure on the outcomes. Another limitation could be the mean follow-up time of 19 months with the longest follow up period not exceeding 6 years.

Further cadaver studies of the dorsal collateral capsule around the ulnar head may clarify its relation to the DRUL and its role of stabilizing the DRUJ.

Note

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Conflict of interest

None

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