Ulna Rotation Osteotomy in Complete Dislocation of the Distal Radioulnar Joint

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Abstract

Background Complete dislocation of the distal radioulnar joint (DRUJ) is a rare injury. Dislocation can present as uni- or multidirectional, acute or chronic, reducible or irreducible. It can occur due to isolated loss of ligamentous restraints or more frequent in Galeazzi - or Essex-Lopresti-type fractures.

Case Description A 28-year-old man sustained a distal radius fracture and presented after conservative treatment with blocked supination. Examination revealed a malunion of the distal radius in combination with an irreducible dorsal dislocation of the DRUJ. Corrective osteotomy of the distal radius was performed, the DRUJ was reduced, and the ulnar avulsed triangular fibrocartilage complex (TFCC) refixed with transosseous sutures. Redislocation occurred 8 weeks later. Revision surgery showed a palmar dislocated TFC fixed in a palmar scar formation along the distal interosseous membrane (DIOM). The scar was released and a rotation osteotomy of the distal ulna was performed. At follow-up, the patient was pain-free, had good range of motion, and returned to work and sport activities.

Literature Review For reconstruction of chronic complete dislocations of the DRUJ, ligament plasty procedures are described. In case of additional cartilage damage, salvage procedures are recommended.

Clinical Relevance We report a procedure in which the rotation of the distal ulna is corrected to restore DRUJ congruity in chronic dislocations. The rotation osteotomy described is useful in gross ligamentous instability following loss of constraint by the TFCC and the DIOM.

Keywords

- distal radioulnar joint
- DRUJ instability
- posttraumatic

The triangular fibrocartilage complex (TFCC) includes the articular disc and the radioulnar ligaments (RULs), which serve as principal stabilizers of the distal radioulnar joint (DRUJ). The RULs insert radially at the palmar and dorsal aspect of the sigmoid notch and ulnarly at the fovea and the ulnar styloid.¹ The distal oblique bundle of the distal interosseous membrane (DIOM) of the forearm spans the radius and ulna dorsal to the pronator quadratus muscle. It originates ~5 cm proximal to the ulnar head and inserts at the dorsal rim of the sigmoid notch.² The TFCC is the primary

stabilizer and the DIOM the secondary stabilizer of the DRUJ when the RULs are cut.³ A further tract of the interosseous membrane (IOM) extends from the distal radius to the dorsal capsule of the DRUJ. This dorsal capsular tract of the interosseous membrane is taut in pronation and loose in supination. It strengthens the dorsal capsule of the DRUJ.⁴

In Galeazzi injuries, the fracture of the shaft of the radius is complicated by an additional dislocation or subluxation of the DRUJ. A fracture at the radial head with disruption of the DRUJ is defined as Essex-Lopresti injury. In rare cases, a dislocation

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Fig. 1 Preoperative findings. (A) Dorsal instability of the DRUJ. (B) Three-dimensional CT showing fixed complete dorsal luxation of the ulnar head. (C) Posteroanterior wrist X-ray with significant loss of radial height and nonunion of the ulnar styloid.

of the radioulnar joint without additional fracture can occur. Reports about recurrent dislocations or chronic posttraumatic instability of the DRUJ are seldom.⁵

Concepts to treat a complete dislocation of the DRUJ include a corrective osteotomy of the distal radius, ligament reconstruction procedures, and salvage procedures.

The purpose of this report is to present an alternative method to reestablish DRUJ congruity in a situation when a ligament reconstruction is not feasible. For this purpose, the case of a young man is shown who established a recurrent locked dislocation of the DRUJ after corrective osteotomy of the distal radius with TFCC refixation.

Case Report

A 28-year-old man sustained a distal radius fracture to his left wrist in alpine skiing. After cast fixation for 5 weeks, supination was blocked in a neutral position. Following physiotherapy, the patient presented at our unit at month 8 with forearm pronation of 70 degrees and painful locked supination of 0 degree. Wrist flexion measured 40 degrees and wrist extension 60 degrees. Grip and pinch grip were pain restricted to 50% of the dominant noninvolved right hand. Radiographic examination showed a complete dorsal dislocation of the ulna head out of the sigmoid notch, a shortening of the radius of 8 mm, and a nonunion of the base of the ulnar styloid (►Fig. 1).

Ten months after injury, a corrective osteotomy of the distal radius was performed. During surgery, the correction of radial length was troublesome. A strong soft tissue tension, which did not improve after release of the brachioradialis and the dorsal periosteum, remained. Stabilization was maintained by a palmar locking plate and an additional iliac corticocancellous bone graft. The intraoperative stress test revealed a dislocated but reducible DRUJ (►Fig. 2).

Arthroscopy showed an unstable ulnar tear of the TFCC with positive hook test and push test. Clinically, the ulna head

was reduced in supination but dislocated dorsally in pronation. After microfracturing at the ulnar fovea, anchor fixation was tried but was insufficient due to high tension. Two transosseous sutures for the palmar and dorsal RULs, respectively, were used (PDS 3.0) for TFC reinsertion. The ulnar styloid showed a stable fibrous nonunion and was additionally pinned (K-wire, 1.2 mm) (►Fig. 3). Finally, the DRUJ remained reduced and passive pronation was regained to 60 degrees but with increasing tension attempting further pronation.

An above-elbow cast was applied for 2 weeks, followed by a sugar-tong cast for another 5 weeks. Eight weeks after primary surgery, a complete dislocation of the DRUJ had reoccurred with blocked supination in neutral position. At week 10, revision surgery was performed. The sutures had failed, the TFCC had shifted palmarly, and the palmar capsule was contracted. On the radial palmar side of the distal ulna, a 5-cm-long scar formation extended from distal to proximal in course of the DIOM (►Fig. 4). After transverse release of this longitudinal scar and an additional palmar capsular release, the TFCC could be reduced easily. Revising the foveal insertion showed the dorsal and palmar RULs retracted and too short for reinsertion. During pronation, complete dislocation occurred again. The distal ulna was floating. Digital examination revealed no ligamentous structures connecting the forearm bones at the distal 6 cm.

Following virtual preoperative computed tomography (CT) planning, a horizontal wedge osteotomy was performed 5 cm proximal to the ulna head (►Fig. 5). With the forearm held in neutral position, the ulna head fragment was rotated by 10 degrees and angulated by 4 degrees to fit into the sigmoid notch. The osteotomy was stabilized by a distal ulna fracture plate. No further soft tissue tightening was necessary to maintain reduction during passive rotation within 90-degree supination and 80-degree pronation.

An above-elbow cast for 3 weeks and a sugar-tong cast for further 3 weeks were applied. Physiotherapy started at

Fig. 2 Fluoroscopy after corrective osteotomy of the distal radius. (A) Posteroanterior view of the wrist showing restoration of radial length. (B) In the lateral view, the DRUJ was reducible, (C) but showed dorsal dislocation at stress.

week 3 with sagittal elbow motion and finger exercises. After cast removal, forearm rotation exercises were restricted to 45 degrees of pronation and supination until solid bone union at week 10 was achieved. At month 6 after revision surgery, the patient was pain-free and active in rock climbing again. Supination measured 80 degrees and pronation 70 degrees. Grip strength was normal; wrist flexion measured 50 degrees and wrist extension 65 degrees. The X-ray showed a congruent DRUJ, an ulna plus of 2 mm, and solid bone union (–Fig. 6).

Discussion

Correction of a chronic dislocation of the DRUJ remains a technical challenge, and prognosis is often unpredictable. Therapy has to be based on the patient's subjective impairment. Only a symptomatic laxity should be diagnosed

as instability. Instability of the DRUJ can be complete or partial, uni- or multidirectional. It can be caused by a ligamentous, bony, or combined disorder of the DRUJ. Surgical procedures are designed to address the damaged structures. The performed rotation osteotomy of the distal ulna is a new option to treat severe complex instability of the DRUJ.

Wassink et al⁵ report an acute traumatic dorsal DRUJ dislocation treated with cast immobilization with recurrence of the dislocation after new trauma some months later. At follow-up, the patient experienced no pain and had no restrictions in work or sports-related activities. Surgery was not necessary.

Irreducibility of the DRUJ may occur due to interposition of parts of the TFC or RUL, but also due to an interposition of extensor tendons.^{6,7}

Garrigues and Aldridge⁷ described a block of reduction due to an impacted fracture of the distal ulna at the rim of the

Fig. 3 Intraoperative stabilization of the DRUJ. (A) Arthroscopy revealing a complete ulnar foveal tear (asterisk). (B) Transosseous refixation of the TFCC with additional pinning of the fibrous ulnar styloid nonunion.

sigmoid notch like in shoulder dislocation. The dorsal RUL was ulnarly avulsed and refixed with an anchor. The DRUJ was transfixated with K-wires. At follow-up of 6 months, supination was 80 degrees and pronation 70 degrees. Radiographs showed no subluxation, and the patient had no subjective instability.

The presented patient showed at primary surgery a rupture of the TFCC at the foveal insertion extending to the subsheath of the extensor carpi ulnaris (ECU). The proximal ulna styloid fracture showed a fibrotic nonunion in slight palmar angulation and the radius was shortened. The ulna head was rotated dorsally out of the sigmoid notch and caught between the ECU and the common digital extensors. Although the bone geometry of the distal radius was restored

to near-normal and the TFCC was replaced and refixed, the ulna head redislocated during recovery. The findings at revision surgery let us hypothesize that an additional lesion of the DIOM increased the instability at the DRUJ. The foveal refixation of the TFCC at primary surgery was not stable enough to avoid a palmar dislocation of the TFCC, which finally scarred along the course of the DIOM and palmar capsule. The floating distal ulna after release was a sign of loss of stabilization by the DIOM. Thus, we interpret the primary injury as a form of incomplete Essex-Lopresti lesion but without fracture of the radial head and partial rupture of the IOM.

The RUL and the IOM are relevant structures for DRUJ stability. For their reconstruction in case of a chronic

Fig. 4 Redislocation of the DRUJ after corrective osteotomy of the distal radius. (A) Irreducible dorsal dislocation after primary surgery, (B) with scar formation (asterisk) along the DIOM with palmarly dislocated and fixed TFC.

Fig. 5 Three-dimensional CT planning of the rotation osteotomy of the distal ulna in neutral forearm position. (A) Three-dimensional CT model of the affected side in a view from distal to proximal (orange: radius; gray: most distal 5 cm of the ulna). (B) Rotation of the distal ulna (yellow) in comparison to the current position (gray) to achieve adequate joint configuration. (C) Lateral view showing calculated angulation in the sagittal plane.

instability, various procedures are reported in the literature. Older techniques are mentioned to restore complete dislocation by tendon loops proximal to the DRUJ.

Adams procedure follows the path of instability and reconstructs the RUL using a free palmaris longus tendon graft. Fourteen patients with posttraumatic DRUJ instability were followed 1 to 4 years. The procedure restored stability and relieved symptoms in 12 of 14 patients. One patient with a deficient sigmoid notch and one with ulnocarpal ligament injury did not achieve full stability. All patients attained near-full pronation and supination.⁸

An arthroscopic-assisted modification of the Adams procedure is reported by Tse et al.⁹ In 15 patients, pronosupination increased from 76.6 to 92.1% and grip strength increased from 56.1 to 76.9% compared with the contralateral side.

The reconstruction of the sigmoid notch addresses the osseous pathology of instability of the DRUJ. Sigmoid notch osteotomy is reported in a clinical case to be successful in

reconstruction after a failed prior ligament reconstruction. The patient had a hypoplastic ulnar head and a flattened volar lip of the sigmoid notch. He regained 60 degrees of supination and 70 degrees of pronation and reported minor pain and no instability.¹⁰

Derotation osteotomy of both forearm bones is reported in malunions and synostosis. Corrective osteotomies at the ulna are primarily performed to unload an ulnar impaction syndrome. We found no report in the literature of the use of a rotation osteotomy of the distal ulna to correct chronic DRUJ dislocation.

In the presented case, the leading pathology responsible for the persisting chronic dislocation at revision surgery was an irreparable foveal tear of the TFCC and an additional rupture of the DIOM causing a floating distal ulna. The joint configuration was intact. For rotation of the osseous axis of the ulna, we followed the altered ligamentous constraints for forearm rotation. Finally, the joint was close fit, though the

Fig. 6 Six-month follow-up. (A,B) X-rays showing bony healing. (C,D) Pain-free 150 degrees forearm rotation.

ulnar foveal insertion of the TFCC was left unrepaired. We designed the level of ulna osteotomy distally close to the lesion of the IOM to maintain an intact proximal ligamentous constraint of the forearm bones. For reconstruction of the RULs, we usually perform Adams procedure, arthroscopically assisted. In this case, placing the radial tunnel anatomically would have interfered with the osteotomy site of the distal radius. A sigmoid notch plasty was also excluded due to the recently performed distal radius osteotomy and the risk of fracture and osteonecrosis.

We see the presented rotation osteotomy of the distal ulna as a reconstructive procedure for chronic dislocations of the DRUJ. It was helpful in this gross ligamentous instability caused by insufficient ulnar insertion of the TFCC and partial rupture of the DIOM. Stability of the DRUJ was restored and a pain-free forearm rotation was achieved.

Conflict of Interest
None.

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