Distal Radioulnar Joint Volar Instability After Ligament Reconstruction Failure Treated with Sigmoid Notch Osteotomy

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abstract

Because osseous abnormalities result in distal radioulnar joint instability, a sigmoid notch osteotomy is used to restore stability. This article describes a case of distal radioulnar joint volar instability treated with sigmoid notch osteotomy of the volar rim.

A 22-year-old man presented with a 9-month history of right wrist pain with volar instability after a fall, which was treated conservatively. He reported a history of remote trauma when he was 7 years old but had been asymptomatic since then. Four months later, he underwent anatomical distal radioulnar joint ligament reconstruction at another hospital after a diagnosis of distal radioulnar joint instability, but the instability had persisted.

Computed tomography revealed dynamic volar subluxation of the ulnar head with hypoplasia and a flattened volar lip of the sigmoid notch. Therefore, a sigmoid notch osteotomy of the volar rim was performed. Postoperatively, an above-elbow cast was applied with forearm pronation for 6 weeks. Six months later, the patient had regained 60° of supination and 70° of pronation. He reported minor pain and no instability. Computed tomography scan at 6 months postoperatively revealed union of the osteotomy site and confirmed the maintenance of reduction. The patient returned to work.

Figure: Diagram of the 3 osteotomies performed 2 mm proximal to the radiocarpal joint and 5 mm radial to the sigmoid notch.

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The sigmoid notch of the radius contributes to distal radioulnar joint stability because the normal curvature of the sigmoid notch plays an important role as a mechanical restraint to dorsal and volar instability.\(^1\)\(^,\)\(^2\) This article describes a case in which congruency had been restored to the distal radioulnar joint via osteotomy of the sigmoid notch, and bony abnormalities in the distal ulnar head had resulted in joint instability. This article also describes the osseous cause of joint instability and the pitfalls of soft tissue reconstruction for distal radioulnar joint volar instability associated with a hypoplastic ulnar head.

A sigmoid notch osteotomy was performed to reconstruct the distal radioulnar joint volar rim for a hypoplastic ulnar head with persistent distal radioulnar joint volar instability after a failed distal radioulnar joint soft tissue reconstruction.

**Case Report**

A 22-year-old right-handed man presented with right wrist pain after a fall on his right hand. He reported a history of remote trauma at age 7 years but had been asymptomatic. He was treated conservatively with immobilization for 3 weeks. Four months later, he underwent anatomical distal radioulnar joint ligament reconstruction at another hospital under a diagnosis of distal radioulnar joint volar instability (Figure 1), but the instability had persisted postoperatively. He reported pain arising from the ulnar side of the wrist. Physical examination revealed volar subluxation of the ulnar head when he pushed his hand down on a table in forearm pronation and relocation of the ulnar head if the downward force was relieved.

Plain radiographs prior to ligament reconstruction showed an absence of ulnar styloid, including the styloid base with minus ulnar variance on the lesion side, but no bony abnormality existed on the contralateral side. The ulnar head was small, but alignment was within normal range. Magnetic resonance imaging revealed a dorsally subluxated ulnar head when he pushed his hand down on a table in forearm pronation and relocation of the ulnar head if the downward force was relieved.

Computed tomography scan revealed dorsal subluxation of the hypoplastic ulnar head, particularly in pronation, compared with the contralateral side according to criteria reported by Kihara et al.,\(^1\) where the ulnar head in a normal distal radioulnar joint should lie between 2 lines marking the dorsal and palmar borders of the radius (Figure 3). A flattened sigmoid notch was also measured by the sector angles of the articulating surface of the sigmoid notch of the radius. The corresponding surface of the ulnar head facing toward the sigmoid notch was measured by the method of tangents, as reported by af Ekenstam and Hagert.\(^3\)

**Figures**

1. Anteroposterior (A) and lateral (B) plain radiographs showing anatomical distal radioulnar joint ligament reconstruction 4 months after presentation.

2. Three-dimensional fat suppression spoiled gradient echo (A) and T1 fat suppression magnetic resonance imaging revealing an intact reconstructed distal radioulnar ligament (B).
Therefore, the patient underwent sigmoid notch osteotomy. The palmar articular surface of the sigmoid notch was exposed through the volar approach between the ulnar neurovascular bundle and long flexor tendons. The reconstructed palmar distal radioulnar ligament was intact. Three osteotomies were performed at 2 mm proximal to the radiocarpal joint, the proximal articular margin of the sigmoid notch of the radioulnar joint, and 5 mm radial to the sigmoid notch (Figure 4). As the osteotomy was opened and reconstructed, the palmar distal radioulnar ligament tightened, the distal radioulnar joint was stable. The resulting defect was filled with a bone graft from the volar radius and fixed with two 1.1-mm Kirschner wires.

Postoperatively, an above-elbow splint was applied in pronation for 4 weeks before range of motion exercises were started. At 6 months postoperatively, the patient had regained 60° of supination and 70° of pronation and reported minor pain.

The patient reported occasional episodes of clicking but no instability. A computed tomography scan at 6 months postoperatively showed union of the osteotomy site and restored continuity of the sigmoid notch volar rim and confirmed the maintenance of reduction and congruency of the distal radioulnar joint (Figure 5). At 1-year follow-up, the patient had maintained range of motion with minor discomfort and no symptoms of instability. He returned to work and resumed recreational activities.

**DISCUSSION**

Distal radial fractures are associated with injuries to the distal radioulnar joint. Injury of the ligamentous stabilizers and sigmoid notch can cause distal radioulnar joint instability. The radioulnar ligaments are the primary stabilizers of the wrist joint, and the ulnocarpal complex, extensor carpi subsheath, and interosseous membrane are the secondary stabilizers. Although the primary ligamentous supports were sectioned, distal radioulnar joint stability can be maintained with intact secondary stabilizers, meaning bony and ligamentous restraints contribute to distal radioulnar joint stability. A flattened anatomic variant of sigmoid notch shape is associated with an unstable distal radioulnar joint. Distal radioulnar joint volar instability with a flat sigmoid notch can be treated with sigmoid notch osteoplasty. Although distal radioulnar ligament reconstruction can be performed, persistent instability occurs if the sigmoid notch is deficient. Many salvage procedures to treat symptomatic and degenerate distal radioulnar joints have been described, including the Darrach procedure, hemiresection interposition arthroplasty, and the Sauve-Kapandji procedure. These procedures may result in reduced grip strength, painful ulnar shaft instability, and reossification.

This article describes a case of a distal radioulnar joint volar instability after failure of a distal radioulnar joint ligament reconstruction using sigmoid notch osteotomy. Due to the patient’s young age and the integrity of the soft tissue joint supports, joint reduction was performed to avoid salvage procedures. The patient was treated initially with distal radioulnar joint ligament reconstruction to reduce the ulnar head into the sigmoid notch. Distal radioulnar joint subluxation persisted postoperatively when the patient attempted to push his hand downward on a
table in forearm pronation. Distal radioulnar joint ligament stability can be achieved by appropriate bony dimension of the distal radioulnar joint. Although the ulnar head and sigmoid notch come in contact in normal forearm rotation, the relative range of contact points per ulnar head dimension between the normal and hypoplastic ulnar head is different. A hypoplastic ulnar head does not match its sigmoid notch, which has a wider range of contact points with the sigmoid notch. Therefore, sigmoid notch ostetomy can reduce its relative bony dimension corresponding with the ulnar head. In addition, it increases distal radioulnar joint ligament tension by lateralization of the center of rotation.

Many soft tissue reconstruction procedures for distal radioulnar joint instability are complicated and require a donor graft tendon. The current bony procedures for distal radioulnar joint instability are salvage procedures that aim to maximize function and minimize pain and are indicated for patients with degenerative arthritis. Movement at the distal radioulnar joint consists of rotation. A gliding component is necessary to achieve complete pronation and supination range of motion. This gliding component is evident because the curvature radius of the sigmoid notch articular surface and that of the distal ulna are different.

Tolat et al8 reported that the average radius of the seat of the sigmoid notch in 50 cadaveric wrists was 19 mm, which is in contrast to that of the ulnar surface, which was 10 mm. At extreme supination, the joint has a small area of contact at the volar aspect of the sigmoid notch.2 This area is <10% of the total joint surface. Tolat et al8 classified the osseous anatomy of the distal radioulnar joint into 12 types based on the angle of inclination of the joint surface relative to the ulnar shaft and the cross-sectional shape of the sigmoid notch. This study suggested that a flat face would be more unstable than the other shapes, which had more pronounced volar lips. However, they were able to identify a discrete palmar osteocartilaginous lip in all but 1 specimen in this group. The palmar radioulnar ligament attaches to this prominence and is extra-articular. A subset of 10 wrists with a large lip underwent mechanical testing. The lip provided a stable buttress to volar dislocation in all rotation positions. The stability was preserved except when complete disruption of the interosseous ligament and palmar radioulnar ligament occurred or when the volar lip was fractured.

Osteoplasty reconstitutes the volar lip so that it acts as a buttress against volar instability. The volar radioulnar ligament is preserved and is effectively tightened by augmenting the volar cortical lip. The indications for this procedure are limited. The patients should have pure volar instability in supination, a flat sigmoid notch with a deficiency in the volar osteocartilaginous lip, and no secondary degeneration. Osseous reconstruction of the volar buttress is an option for volar instability and may be used in other pathologies, such as distal radius fractures or combined with other procedures, such as triangular fibrocartilage complex repair.9,10

**CONCLUSION**

The volar lip of the sigmoid notch plays an important role as a bony restraint to volar distal radioulnar joint instability associated with distal ulnar hypoplasia. The current patient, whose symptoms were not relieved by anatomical distal radioulnar joint ligament reconstruction, was treated with a sigmoid notch osteotomy to restore distal radioulnar joint stability.

**REFERENCES**


