Osteotomy for Sigmoid Notch Obliquity and Ulnar Positive Variance

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Abstract

Background Several causes of ulnar wrist pain have been described. One uncommon cause is ulnar carpal abutment associated with a notable distally facing sigmoid notch (reverse obliquity). Such an abnormality cannot be treated with ulnar shortening alone because it will result in incongruity of the distal radioulnar joint (DRUJ).

Case Description A 23-year-old woman presented with ulnar wrist pain aggravated by forearm rotation. Ten years earlier she had sustained a distal radius fracture that was conservatively treated. Examination revealed mild tenderness at the DRUJ and decreased wrist flexion and grip strength on the affected side. Radiographic examination demonstrated 1 cm ulnar positive variance, ulnar styloid nonunion, and a 37° reverse obliquity of the sigmoid notch. The patient was treated with ulnar shortening and rotation sigmoid notch osteotomy to realign the sigmoid notch with the ulnar head.

Literature Review Sigmoid notch incongruity is one of several causes of wrist pain after distal radius fracture. Traditional salvage options for DRUJ arthritis may result in loss of grip strength, painful ulnar shaft instability, or reossification and are not acceptable options in the young patient. Sigmoid notch osteotomy or osteoplasty have been described to correct the shape of the sigmoid notch in the axial plane.

Clinical Relevance We report a coronal plane osteotomy of the sigmoid notch to treat reverse obliquity of the sigmoid notch associated with ulnar carpal abutment. The rotation osteotomy described is particularly useful for patients in whom a salvage procedure is not warranted.

Keywords
- DRUJ
- sigmoid notch
- distal radius
- DRUJ instability

It is generally accepted that ulnar positive variance is a risk factor to the development of ulnar carpal abutment. Three different shapes of the sigmoid notch have been described in the coronal plane.[1] In the presence of a distally facing sigmoid notch (reverse obliquity), ulnar shortening in these patients, as noted by De Smet and Fabry[1] and Sagerman et al,[2] is potentially hazardous, as it may lead to articular incongruity or ulnar impingement of the distal radioulnar joint (DRUJ). Several salvage options exist for the treatment of DRUJ arthritis and instability. These include the Darrach procedure, Sauvé-Kapandji procedure, and interposition arthroplasty. Adverse outcomes of these procedures include loss of grip strength, painful ulnar shaft instability or reossification, and extensor tendon attrition ruptures.[3,4] For these reasons such procedures are not ideal in young or high-demand patients.

The purpose of this report is to describe a method of addressing reverse obliquity of the sigmoid notch associated with notable ulnar positive variance. We present a case of a young female patient with wrist pain associated with ulnar positive variance and sigmoid notch reverse obliquity corrected by ulnar shortening osteotomy and sigmoid notch rotation osteotomy.

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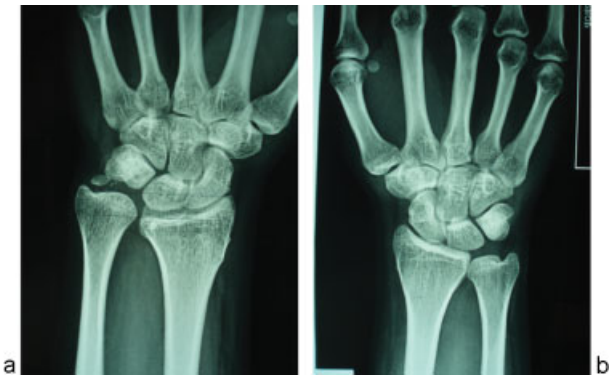

Fig. 1 (a) Radiograph showing 1 cm ulnar positive variance and ulnar styloid nonunion. (b) Radiograph of normal contralateral wrist.

Case Report

A 23-year-old female farm worker presented with persistent pain on the ulnar side of her right wrist. She had fractured her distal radius 10 years prior, at age 13, and was treated by cast immobilization. Her symptoms were worsened in the cold and with forearm rotation, and they affected her continued work as a farm hand. Clinical examination revealed wrist motion of 70° flexion and 50° extension (contralateral left wrist motion of 80° of flexion and 60° of extension) and grip strength of 27 kg (contralateral left wrist grip strength of 34 kg). There was mild tenderness of the DRUJ and a positive ulnar carpal abutment test performed with axial stress and passive pronation and supination to the maximally ulnar-deviated wrist. There was no clinical instability of the DRUJ when tested with the forearm in pronation, supination, or neutral rotation and when compared with the contralateral unaffected DRUJ.

Initial X-ray images (►**Fig. 1a**) and computed tomography (CT) scan (►**Fig. 2a**) demonstrated ulnar positive variance of 1 cm, an ulnar styloid nonunion, and a distally facing sigmoid notch (reverse obliquity) of 37° in the coronal plane and ulnar seat angle of 26°. Axial images showed "C-shaped" sigmoid notch (►**Fig. 2b**) and sagittal images showed radial tilt of 0° (►**Fig. 2c**). A radiograph of the contralateral wrist (►**Fig. 1b**) showed ulnar neutral variance and an ulnarly facing (neutral) sigmoid notch. Magnetic resonance imaging (MRI) revealed an attenuated triangular fibrocartilage complex (TFCC) (►**Fig. 3**), moderate increased T2 hyperintensity of its ulnar attachment, suggestive of strain-type injury, and cystic changes of the triquetrum consistent with ulnar carpal abutment. There was no obvious damage to the lunotriquetral ligament.

Because of the long-term implications of untreated ulnar carpal abutment, which may result in tearing of the triangular fibrocartilage and disruption of the lunotriquetral ligament, and the limitations caused by the patient's symptoms, an ulnar shortening osteotomy was considered. Shortening the ulna to neutral variance alone, however, would result in the ulnar head resting on the inferior angle of the sigmoid notch and notable risk for DRUJ arthritis from the resulting incongruity (►**Fig. 4a**). It was necessary to re align the sigmoid notch by rotation osteotomy in the coronal plane to accommodate the articular surface of the ulnar head (►**Fig. 4b–d**).

Under tourniquet control a longitudinal incision was made over the ulnar border of the right forearm for the ulnar shortening osteotomy. An extraperiosteal dissection was performed and a six-hole fixation plate was applied with screws to its distal three holes. An external fixator was then applied and the fixation plate removed. A 12-mm segment of the ulna was removed using an oscillating saw and the two ends of the ulna opposed with the external fixator. The ulnar variance was then checked by fluoroscopy to ensure slight overcorrection to a 2-mm negative variance (►**Fig. 3a**) and the six-hole plate reapplied.

The sigmoid notch osteotomy was performed through a longitudinal incision over the fourth extensor compartment. The DRUJ was exposed by incising the dorsal capsule proximal to the dorsal radioulnar ligament. The position of the osteotomy was outlined with an osteotome and confirmed by fluoroscopy. The DRUJ was distracted with a lamina spreader placed at the neck of the ulna and the ulnar head protected with an elevator. A square-shaped osteotomy was made with a 4-mm oscillating saw, 2 mm beneath the lunate fossa (►**Fig. 3b**). Sharp edges were removed, and the sigmoid notch was rotated to fit the inclination imposed by the shortened ulnar head. The sigmoid notch was internally fixed by a 1.7-mm locking

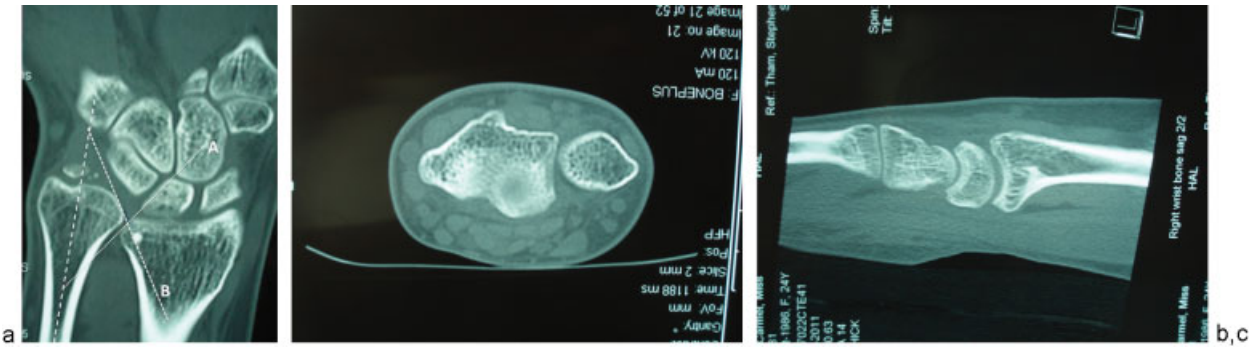

Fig. 2 (a) Coronal CT scan showing reverse obliquity of the sigmoid notch and ulnar styloid non union. (b) Axial CT scan showing C-shaped sigmoid notch. (c) Sagittal image showing radial tilt of 0 degrees.

Fig. 3 MRI showing attenuated triangular fibrocartilage.

fixation plate and its position confirmed with intraoperative fluoroscopy. The osteotomy gaps were filled with synthetic bone graft substitute. To prevent possible attrition rupture, the extensor pollicis longus tendon was released from its compartment. The wound was closed and an above-elbow plaster splint applied.

At 5 weeks postoperative, active and passive range of motion exercises were initiated. Follow-up radiography at 5 months (►**Fig. 5**) showed healing of the radius and ulna, and the radial plate was removed by patient request. A CT scan performed 9 months postoperative showed consolidation of the osteotomy site without evidence of vascular compromise of the sigmoid notch or lunate fossa. The coronal view showed correction of the reverse obliquity (►**Fig. 6a**). At 3 years the patient had returned to normal activities without restriction but noticed some discomfort when exposed to the cold or with overhead activities. Her follow-up CT scan remained unchanged, demonstrating minor irregularity of the sigmoid notch (►**Fig. 6b**).

Discussion

Distal radius fractures are a common injury and are associated with direct or indirect disruption of the DRUJ in at least 20% of cases.[5] An anatomically reduced distal radius fracture in the developing skeleton may be complicated by interference with bone growth if the epiphyseal plate is traumatized.

Posttraumatic arthritis of the DRUJ may result from joint incongruity arising from intra-articular malunion, radial malunion not involving the sigmoid notch, or instability.[6] The salvage options for DRUJ arthritis include the Sauvé-Kapandji procedure, Darrach procedure, and hemiresection interposition arthroplasty. Unfortunately, each of these procedures may result in loss of grip strength and may cause painful instability of the ulnar shaft,[6] so they are not acceptable options in the young patient. Sigmoid notch osteotomies or osteoplasty have been described to correct the shape of the sigmoid notch in the axial plane.[5,8–10]

In our patient, a fracture of the distal radius resulted in notable ulnar positive variance and reverse obliquity of the sigmoid notch. These alterations are likely to have been

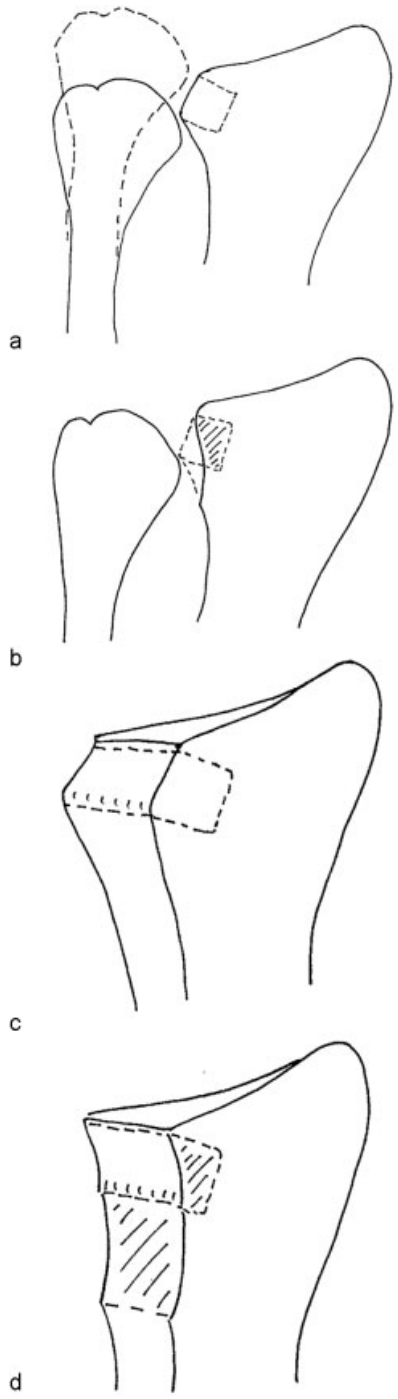

Fig. 4 (a) Diagram showing negative ulnar variance and DRUJ incongruity after ulnar shortening osteotomy. (b) Diagram showing rotation of sigmoid to match articular surface of ulnar head. (c) Oblique drawing of the intended osteotomy. (d) Drawing of the sigmoid notch after repositioning.

caused by a combination of malunion and premature growth plate arrest. It is also probable that adaptive changes occur in a growing bone to accommodate the longer ulnar head. A radiograph of the patient's unaffected wrist showed neutral alignment of the sigmoid and a similarly shaped ulnar head. Ulnar shortening alone would result in incongruity of the sigmoid notch or ulnar impingement as the ulnar head rested

Fig. 5 Radiograph 5 months after surgery.

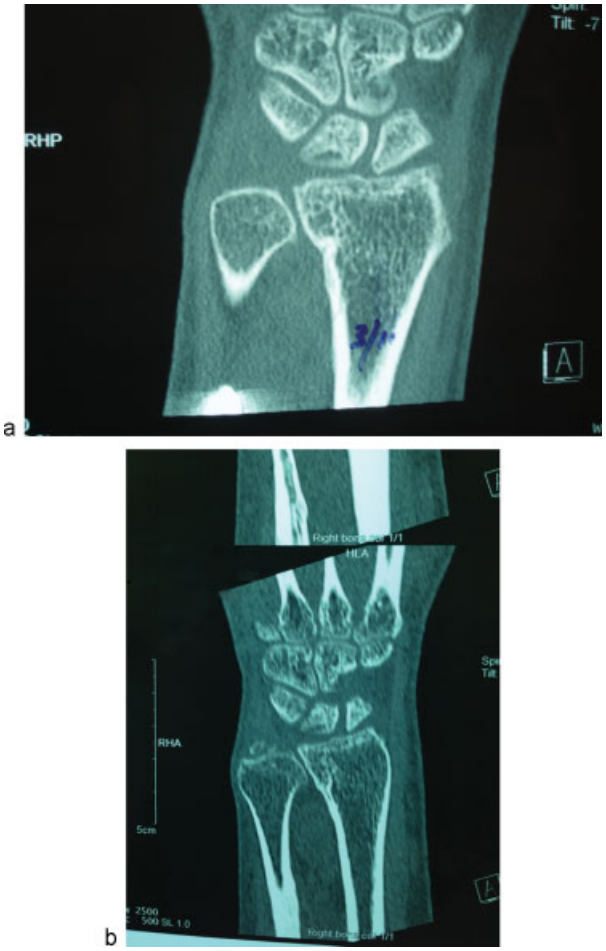

Fig. 6 (a) Coronal CT image 9 months after osteotomy. (b) Coronal CT image 3 years after osteotomy.

on the inferior angle of the sigmoid notch. One option to correct the reverse obliquity is by radial opening wedge osteotomy; however this would excessively increase the radial inclination by 37°. The wafer procedure[11] is another option for treating ulnar carpal abutment in the presence of a reverse oblique sigmoid notch; however, the senior author has not been satisfied with his results by either open or arthroscopic technique.

Osteotomy of the sigmoid notch could affect its vascularity, and it is important that the palmar soft tissues are kept intact. Another concern was instability of the DRUJ after ulnar shortening, as the distal radioulnar ligaments were attenuated by the ulnar positive variance. This did not eventuate and was perhaps mitigated by the negative ulnar variance after corrective ulnar osteotomy.

Ulnar shortening osteotomy is an effective treatment for ulnar carpal abutment[12] and though spur formation may occur, it has been advocated irrespective of the DRUJ morphology. In this case, there was notable reverse obliquity of the sigmoid notch of 37° and ulnar shortening alone would result in ulnar impingement. In a situation similar to ours, Sagerman et al treated the resultant ulnar impingement by resection arthroplasty. Rotation osteotomy of the sigmoid notch is an option if articular incongruity can be anticipated after ulnar shortening.

Conflict of Interest
None

Location
All work was completed at Victoria Hand Surgery Associates and St.Vincent's Hospital Hand Unit.

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