

Arthroscopic Management of Intra-articular Malunion in Fractures of the Distal Radius



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KEYWORDS

- Arthroscopic-assisted osteotomy • Inside-out osteotomy • Distal radius malunion
- Arthroscopic arthrolysis • Intra-articular malunion radius

KEY POINTS

- Intra-articular malunions of the distal radius are time sensitive. Delaying treatment for more than 3 months can result in irreversible cartilage damage.
- Arthroscopic treatment of intra-articular malunions allows for better visualization, precision, and preservation of capsular blood supply than open techniques.
- Dry arthroscopy allows for adequate visualization of the wrist joint without excessive edema caused by wet arthroscopy.
- Resection arthroplasty is an acceptable alternative to wrist arthrodesis in certain cases.

INTRODUCTION

Intra-articular malunion after a distal radius fracture can be debilitating. The diagnosis is often elusive and patients may arrive in your office in a delayed fashion. Unfortunately, during the delay, irreversible damage to the cartilaginous surfaces may occur.¹⁻³ Patients are often diagnosed with complex regional pain syndrome, as there is chronic pain after the distal radius fracture that is in fact a malunion and being missed. This is unfortunate because the malunion, when diagnosed early, can be successfully treated and panarthrodesis can be avoided.

Traditional treatment for the malunion of the articular surfaces after a distal radius fracture was pioneered in the 1990s.⁴⁻⁹ Intervention involved re-cutting the displaced fragments and reducing them anatomically under fluoroscopic guidance. Osteotomies were made volarly or dorsally based on the location of the malunion. These are considered “outside-in” techniques.

There are reports of excellent results with the outside-in approach.⁷⁻⁹ However, the capsular window must be made very large to allow for adequate visualization during osteotomy, and even then, it is somewhat blind, especially when treating a volar shear malunion, as the volar ligaments must be maintained. Additionally, once the malunion is reduced, the joint space becomes extremely narrow. Maintenance of reduction can be relied on only with “feeling” and fluoroscopy.¹⁰

Arthroscopic treatment of intra-articular malunions was developed in an effort to better maintain the blood supply to the surrounding tissue and to attain better visualization of the osteotomy sites. At first, “wet” arthroscopy was implemented; however, visualization remained difficult. Dry arthroscopy resulted in a much better visualization and has become our gold standard for the treatment of distal radius malunions.^{11,12}

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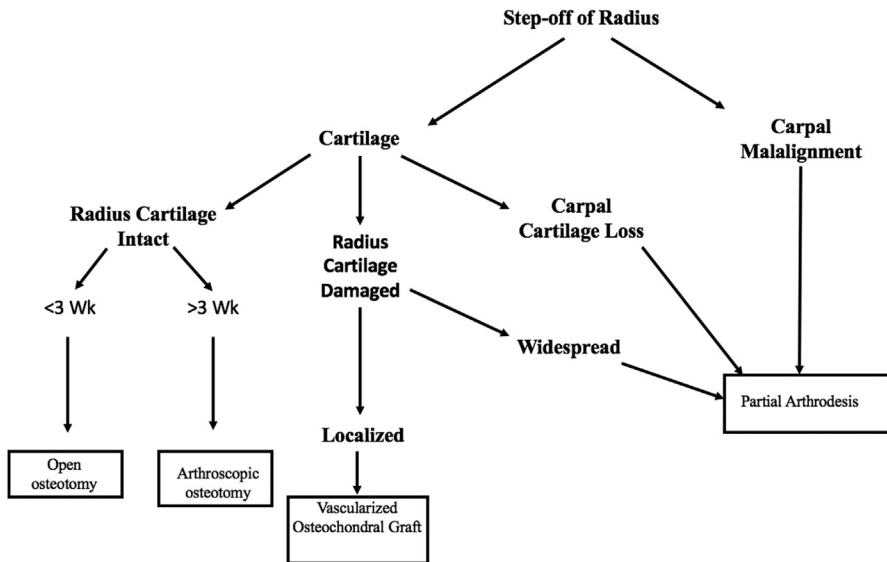


Fig. 1. Decision tree for treatment of intra-articular distal radius malunions.

We describe our arthroscopic method for the treatment of intra-articular malunions of the distal radius.

INDICATIONS AND CONTRAINDICATIONS

Candidates for traditional “outside-in” osteotomies are also eligible for arthroscopic-guided “inside-



Fig. 2. Volar-ulnar and limited Henry approach for a complex multipiece malunion. (© Dr Piñal, 2010.)

out” osteotomy.¹³ A preoperative computed tomography (CT) scan is essential for decision making and operative planning.

Traditionally, a patient with a malunion and an intra-articular step-off of 2 mm or more would be a candidate for an osteotomy, whether there was pain or not.¹ A more controversial approach would include patients with a step-off of 1 mm.^{14,15} In fact, if a patient is young and active, a step-off at the lunate or scaphoid fossa will produce symptoms even if it is only a 1-mm step-off. On the other hand, in a low-demand patient or if the step-off is not at the lunate and scaphoid fossa, but in the sagittal crest, it may be possible to avoid a procedure to correct an area that may not undergo much cartilage wearing. These situations should be considered on a case-by-case basis.

Timing is also important. Beyond 6 to 8 weeks after the fracture, the fracture sites are filled up with mature bone rather than scar and granulation tissue, which makes osteotomies more difficult. Some would suggest waiting and would intervene when the patient finally has symptoms of cartilage wear. However, in our opinion, this treatment approach burns the bridge, as the major contraindication to intra-articular osteotomy is the loss of the radius or carpal articular cartilage. Waiting has no benefit, and solutions have to be sought to prevent further cartilage wear. When the radius cartilage is worn but the carpals are fine, our preferred approach is to reconstruct the radius by means of a vascularized osteochondral graft.^{16,17} If both the radius and carpal bones have loss of cartilage, resection arthroplasty is our best option and we experienced very pleasing postoperative

outcomes.¹⁸ If the damage is widespread, then the only alternative is arthrodesis. In most cases, it is radio-scapho-lunate fusion, which also can be performed arthroscopically.¹⁹⁻²³ Thus, there is no doubt in our opinion that early intervention is superior. However, one should not give up on any patient who presents in a delayed fashion, as surprisingly, some patients still benefit from osteotomy, or other forms of reconstruction (Fig. 1).¹⁸

TECHNIQUE

1. Exsanguinate the arm and stabilize with the table strap.
2. A volar-ulnar incision is used if dealing with a volar-ulnar shear malunion. A Henry approach is used for the typical intra-articular malunion, but both approaches (volar-ulnar

and volar-radial) may be needed to have full access of the volar radius in multipiece malunions (Fig. 2). With the arm flat on the table, the extra-articular callus is removed. Do not attempt to go directly to the joint at this point. This may result in splitting the cartilage in the wrong location.

3. If a plate is the method of fixation, it can be provisionally placed with a single screw.
4. The hand is placed in traction with the fingers upward. We use the system as shown in Fig. 3; 12 to 15 kg of traction is applied. It is important that the hands can be readily placed on the table and quickly put back to the traction system and vice versa. The system we previously described and demonstrated in Fig. 3C allows for sterile transfer of the hand between the table and the traction system any time.¹¹

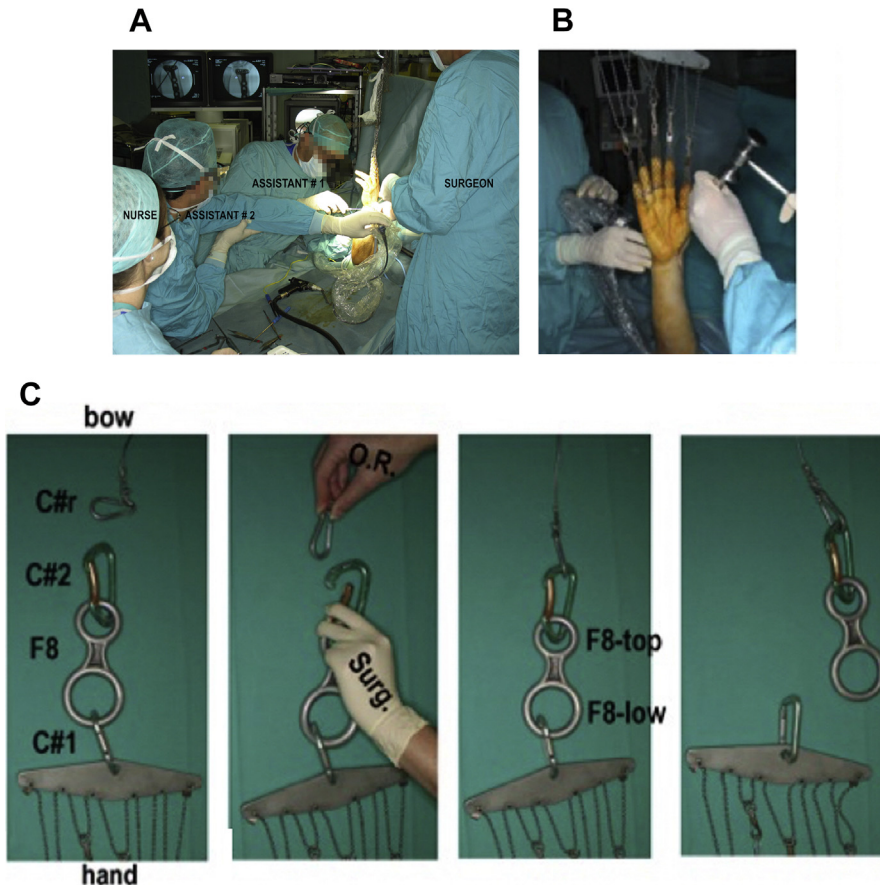


Fig. 3. (A) Arrangement of the surgical team. (B) Hand in finger traps and volar portal in use. (C) Method for maintaining sterility while allowing for rapid transfer of the hand from the vertical traction system to flat on the table, and vice versa. The hand is placed in finger traps. All the components of the vertical traction system are sterile except C#r. The operating room staff connects the hook C#r with the carabiner 2 (C#2) held by the surgeon. After this initial connection, the surgeon can release and reattach carabiner #1 (C#1) from the lower part of the figure of 8 (F8-low) without contamination of the sterile field. C, carabiner; F, figure of 8; OR, operation room staff; Surg, surgeon. (© Dr Piñal, 2006.)

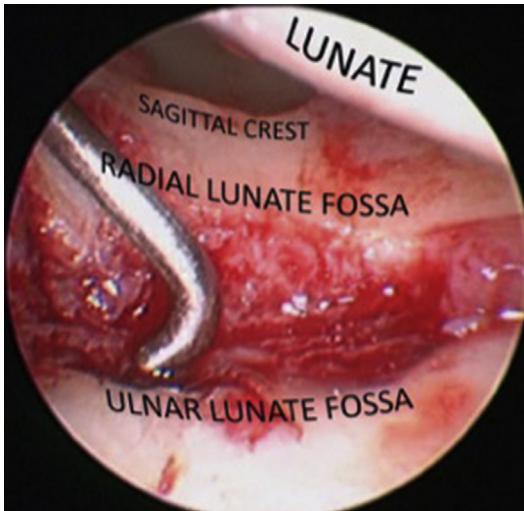


Fig. 4. Shoulder probe evaluation of the step-off and condition of the cartilage. (© Dr Piñal, 2010.)

5. The dorsal 3-4 and 6R portals are made larger than usual to permit passage of the osteotomes. We use a 15' blade to make transverse incisions in the skin only, and then widen the portal sites with scissors to avoid cutaneous nerve injury. The dry arthroscopic technique must be used, otherwise saline will pour out through the portals. We also always place a volar-radial portal, as described by Doi and colleagues,¹⁴ when necessary (Fig. 3B).
6. The scope is placed through the 3-4 portal and the joint is palpated with a shoulder probe (Fig. 4). Condition of the cartilage and degree of step-off are evaluated and correlated with the preoperative CT scan.
7. Once the joint has been deemed salvageable, the camera is moved through the 6R portal and the 3-4 and volar-radial portals are used for instrumentation. Debridement is achieved with shavers (2.9-mm gator microblade TM, ref C9961; ConMed Linvatec, Largo, FL). A clear view will be obtained only if all the scar and debris in and around the joint capsule are removed. The joint will need to be flushed with saline to obtain a better view.
8. Bone is cut with a 15° or 30° shoulder periosteal elevator and straight and curved osteotomes (Fig. 5) Curved osteotomes are necessary, as straight instruments cannot be manipulated in the tight space of the joint.
9. Osteotomes for osteotomy of volar fragments are typically introduced dorsally and dorsal fragments are treated with a volar approach. The osteotome is used to gently but fully mobilize the displaced fragments. The tendons are all under tension due to the traction, thus one must be very careful not to cut the tendon with the sharp osteotomes. Small curettes, shaver, or burr can be used to trim the newly formed bone, callus, and scar tissue that are prohibiting perfect reduction. Fragments can be hooked with a shoulder probe and pulled upward to restore articular alignment.
10. Once a proper reduction is achieved, the plate is applied on the distal radius. One surgeon holds the bones in position while the other secures the plate and the screws as for an acute fracture.²⁴ No grafts are necessary, as the fixation is rigid enough for early mobilization. Various methods of fracture stabilization can be used (Fig. 6).

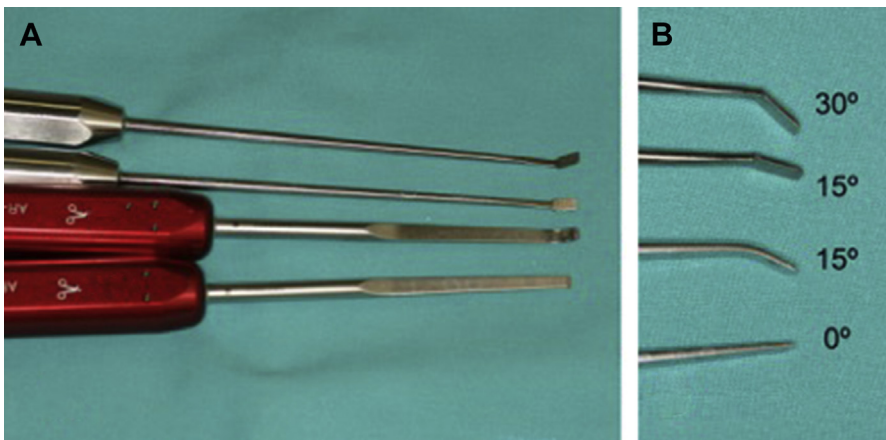


Fig. 5. (A) Two shoulder periosteal elevators and 2 osteotomes. (B) Different degrees of angulation help for making cuts in a narrow space. (© Dr Piñal, 2009.)

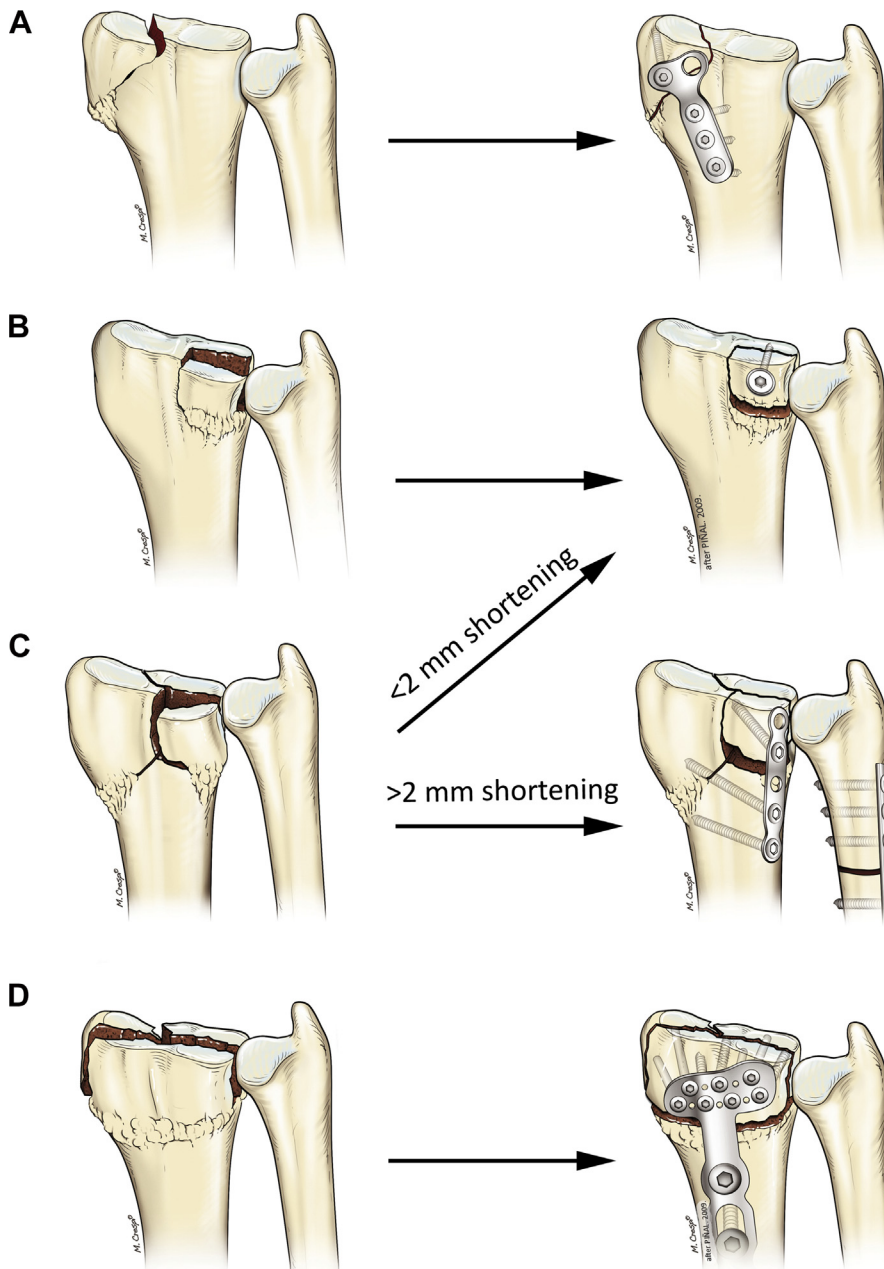


Fig. 6. Fixation methods for treatment of intra-articular malunion. (© Dr Piñal, 2010.)

11. Portals are closed with Steri-Strips. The wrist and hand are immobilized for 48 hours and then gentle range of motion is begun (Fig. 7).

ARTHROSCOPIC RESECTION ARTHROPLASTY

In step 6, the surgeon inspects the cartilage to determine if it is severely damaged. Traditionally, if a load-bearing section of the cartilage is

destroyed, partial or total wrist arthrodesis may be the procedure of choice. However, we advocate a resection arthroplasty.¹⁸

An arthroscopic resection arthroplasty relies on removal of the articular portion of the radius at the location of the step-off, and thus the site of arthritis. The remaining radiocarpal joint and non-traumatized cartilage is preserved. The procedure is similar to other motion-preserving procedures, such as 4-corner fusion and proximal row

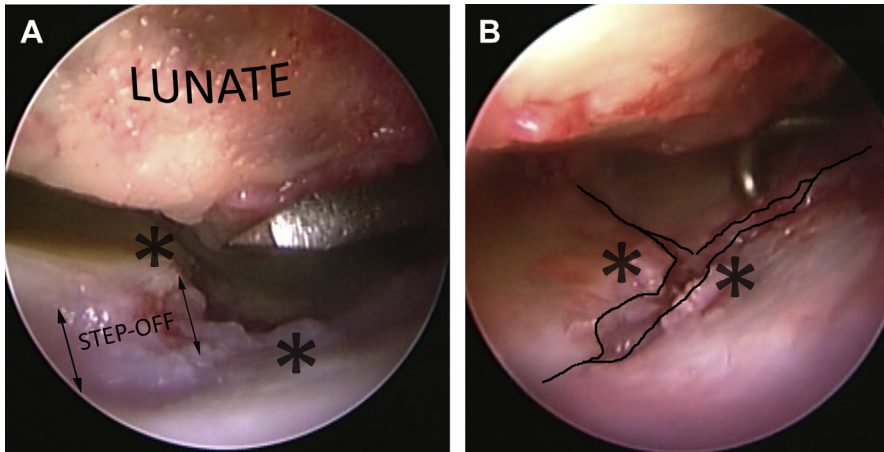


Fig. 7. Correction of a complex old malunion. The asterisks mark the same spots before and after the osteotomy in the lunate fossa. Notice that although step-offs have been leveled, gaps (highlighted by the lines) are unavoidable in old malunions. (A) Pre-reduction. (B) After reduction. (© Dr. Piñal, 2010.)

carpectomy in that the healthy areas remain to serve as the load-bearing surface.

Our experience with this procedure has been favorable and the procedure is less drastic than a total wrist arthrodesis.

PROCEDURE

1. Dry arthroscopy is undertaken through the 3-4 and 6R portals.
2. The radiocarpal joint is debrided with a 2.9-mm shaver until enough space is created to visualize the joint surface.
3. Thick adhesions and scar is encountered and the purpose of aggressive debridement is to create a large working space. Additionally, the natural dorsal sulcus between the capsule and proximal row should be recreated.
4. With a large working space, the articular surface can be clearly assessed. The step-off and denuded area should be clearly visualized.
5. A 2.9-mm burr is used to resect the section of the intra-articular step-off (**Fig. 8**).

6. The depth of resection should be approximately 0.5 mm below the normal joint surface. Care is taken to avoid the volar rim of the radius and the volar carpal ligaments. The mirror image on the opposing carpal bone also should be resected with the shaver. All debris should be irrigated and removed.
7. Range-of-motion exercises should be implemented immediately after the surgery.

DISCUSSION

Distal radius intra-articular malunions must be precisely evaluated. Our opinion is that the most accurate method of evaluation is with dry wrist arthroscopy. The articular deformity is clearly delineated under magnification, and small irregular fragments can be mobilized with delicate instrumentation. Additionally, the capsule and thus fragment blood supply, undergoes minimal disruption with this method. Decreased capsular disruption allows for faster healing and earlier mobilization.

It is important that intra-articular malunions be treated expeditiously. After 3 months, there may

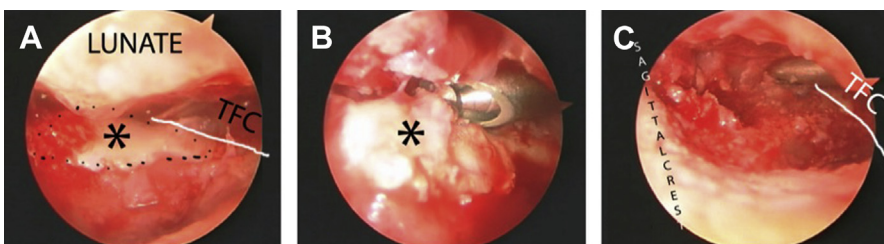


Fig. 8. (A) Damage to lunate caused by the protruding volar-ulnar fragment (*asterisk*). (B) Debridement with 2.9-mm burr. (C) Fifty percent of the anterior lunate fossa has been removed. (© Dr Piñal, 2012.)

be severe cartilaginous damage and thus the realignment of fragments may be of little use. If a patient presents after 3 months, it would be worth evaluating arthroscopically before intervention to gain a better understanding of the damage caused by the prolonged altered joint mechanics. If the cartilage in areas of significant carpal contact is preserved, osteotomies may be undertaken. Otherwise, a reconstructive osteochondral graft or partial arthrodesis should be considered.

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