Dry Wrist Arthroscopy for Radial-Sided Wrist Disorders

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Learning Objectives

Upon completion of this CME activity, the learner should:

- Understand the benefits of dry wrist arthroscopy in the treatment of radial sided disorders of the wrist
- Appreciate the role of dry wrist arthroscopy when performing concomitant open procedures
- Understand indications and outcomes for using dry wrist arthroscopy for radial sided disorders of the wrist

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The development of wrist arthroscopy has been useful in diagnosis, prognosis, and treatment of both ligament and osseous injuries. As the treatment indications and techniques become more refined, this article explores the role of dry arthroscopy to treat radial-sided disorders of the wrist. *(J Hand Surg Am. 2020;45(4):341–353. Copyright © 2020 by the American Society for Surgery of the Hand. All rights reserved.)*

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The use of arthroscopy has become an important tool for the diagnosis and treatment of acute and chronic wrist conditions. It has become the gold standard to explore intra-articular pathology of the wrist. With advancing techniques, it is gaining widespread usage in the treatment of bony injuries such as scaphoid fractures, nonunions, distal radius fractures (DRFs), and associated malunions.[1,2]

Wrist arthroscopy has traditionally been performed with saline insufflation with constant gravity joint irrigation for distension and improvement of intra-articular visualization.[3,4] However, the use of joint insufflation has drawbacks. Concern for fluid extravasation and compartment syndrome limits its role in guiding articular reduction with acute DRFs.[5,6] The distension of the soft tissues with saline also makes it difficult to perform concomitant open procedures. During distal radius corrective osteotomies, the large portals that need to be developed for instrument passage lead to a loss of vision secondary to fluid extravasation. Given this, del Piñal et al[7,8] and Atzei et al[9] advocated for the role of dry wrist arthroscopy (DWA) to mitigate some of these concerns.[6–8,10–12] Moreover, DWA can assist when performing concomitant open procedures such as arthroscopy-assisted management of perilunate fracture dislocations,[13,14] intra-articular osteotomies,[10,15] or arthroscopic arthrodesis.[16] The purpose of this article is to provide an overview of this technique in managing radial-sided disorders of the wrist.

DISTAL RADIUS FRACTURES

Dry wrist arthroscopy is an ideal intervention for the management of intra-articular DRFs given the lack of fluid extravasation that can be seen with traditional wet wrist arthroscopy. Its primary purpose is to ensure anatomical articular reduction, but it can be used secondarily to diagnose and treat, where indicated, associated carpal pathology and to ensure there is no intra-articular hardware placement.[17–19]

The ideal time frame to perform DWA is within 1 week after injury because the hematoma can be readily irrigated from the joint (Fig. 1). In fractures amenable to volar plate fixation under tourniquet control, the first step of the procedure is to reduce the fracture and apply a volar locking plate.[20–22] The plate is typically secured proximally to the shaft of the radius with a nonlocking screw. The distal fragments are reduced and provisionally stabilized with K-wires through the plate (Fig. 2). It is critical that the distal screws are not placed within these fracture fragments at this stage to ensure they can still be reduced if found malaligned during DWA. After the best articular reduction is obtained and confirmed under fluoroscopic imaging, DWA is next performed, in either a horizontal or a vertical position. Traditional bony landmarks for the radiocarpal portals such as Lister tubercle are often lost secondary to the DRF. As such, by palpating the proximal aspect of the triquetrum, the 6R portal is first established using a 22-gauge needle within the radiocarpal joint (Fig. 3).[23]

Often, the distal ulnar head has no osseous injury and so, by using the 6R portal, one is able to look across at the distal radius articular surface without the arthroscope impeding the reduction. It is critical that the surgeon does not rest the arthroscope on the lunate facet of the radius because this can result in fracture displacement (Fig. 4).[21,22] The surgeon next develops the 3-4 radiocarpal portal under direct arthroscopic vision. Once within the radiocarpal joint, the initial view may be obscured by fracture hematoma, which can be seen in 30% of cases.[24] del Piñal et al[7] pioneered an automatic washout procedure to evacuate this hematoma without the need for continuous irrigation and fluid extravasation.

Working from ulnar to radial, the surgeon ensures that the lunate facet is appropriately reduced (Fig. 5). If so, the surgeon or assistant can proceed with placement of the most distal ulnar screws within the volar plate. If the fracture is malreduced, the K-wires that had been placed within the volar ulnar fragment are temporarily withdrawn to permit reduction of the fragments. This can be performed using a shoulder probe, the surgeon's thumb pushing on the fragment, or tenotomy scissors placed from a proximal to distal direction within the fracture fragment itself. Once the lunate facet has been reduced, the K-wires are advanced within the fragment from the volar approach and then replaced with screw fixation (Fig. 6). To ensure adequate reduction, the arthroscope is frequently moved between the 6R and the 3-4 portals to check that the reduction is accurate from different viewpoints. With the lunate facet of the distal radius stabilized,

FIGURE 1: Posteroanterior (left) and lateral (right) radiographs of a patient with a displaced intra-articular DRF.

the reduction of the radial column is confirmed before definitive fixation (Fig. 7). Abe and Fujii[25] noted that, in 248 intra-articular DRFs, despite adequate reduction under fluoroscopic control, 21% of patients had articular stepoff and gap of 2 mm and 9% of patients had unrecognized fracture fragments noted during arthroscopy that were not detected by the preoperative radiographs or computed tomography scans. Forty-one percent of patients had a triangular fibrocartilage complex (TFCC) tear and 33% had a scapholunate (SL) ligament injury. At an average follow-up of 15 months (range, 12−70 months), 76% of patients had excellent, 22% good, 1.5% fair, and 0.5% poor Mayo Wrist Scores.[25] Similar results of articular stepoff and diastasis after fluoroscopic reduction compared with arthroscopy have been noted by others.[26]

With the arthroscope within the 3-4 portal, the surgeon can assess the status of the TFCC using different maneuvers including the hook test, suction test, and trampoline sign.[27,28] Having examined the uninjured distal radioulnar joint (DRUJ) for stability in neutral, pronation, and supination before surgery, the injured DRUJ is examined sequentially. If it is found to be unstable in ulnar deviation, but tightens in radial deviation, the secondary stabilizers of the DRUJ are deemed to be competent and any TFCC tear is ignored. If instability persists with radial deviation, the TFCC is repaired arthroscopically.[29,30] Lindau and colleagues[30,31] studied the natural history of TFCC injuries with concomitant DRFs after 13 to 15 years and noted that 17 of 38 patients had laxity of their DRUJ with worse grip strengths compared with their contralateral side. One patient underwent surgery for painful instability. The authors noted that their sample might have been underpowered.[30,31]

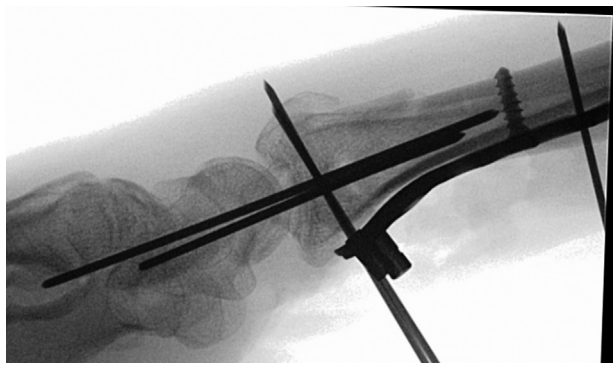

FIGURE 2: Lateral radiograph shows provisional reduction of the fracture using a volar plate. Note that the distal fragments have been stabilized with K-wires alone, after which arthroscopic articular reduction will be performed.

If suspicion exists for an intercarpal ligament injury, the midcarpal radial and midcarpal ulnar portals are created.

RADIAL STYLOIDECTOMY

Radial styloidectomy (RS) can be performed for the treatment of symptomatic styloid scaphoid impingement as seen in scaphoid nonunion advanced collapse (SNAC) and SL advanced collapse of the wrist (SLAC). This can be typically performed through the 1-2 and 3-4 radiocarpal portals. Using DWA, this will prevent engorgement of the synovium that can preclude visualization and also helps in the development of adjunctive portals by mitigating fluid extravasation. The first step of an arthroscopic RS is to debride the capsule and synovium from the entire radial styloid to identify the radioscaphocapitate ligament insertion and to evaluate the amount of radial styloid that is to be

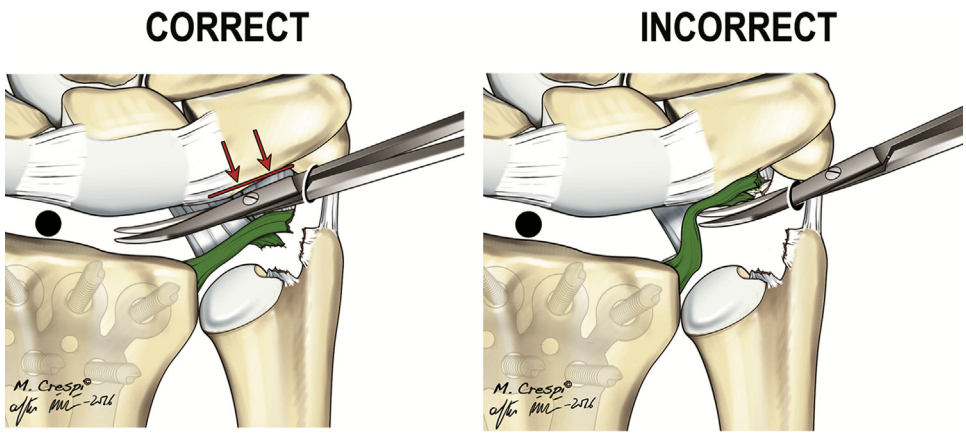

FIGURE 3: Development of the 6R portal shows inadvertent development under TFCC. The surgeon should palpate the proximal aspect of the triquetrum and place the portal just proximal to this. (Reprinted with permission from Pinal, Francisco D. *Atlas of Distal Radius Fractures.* Thieme NY; 2018:51-72.)

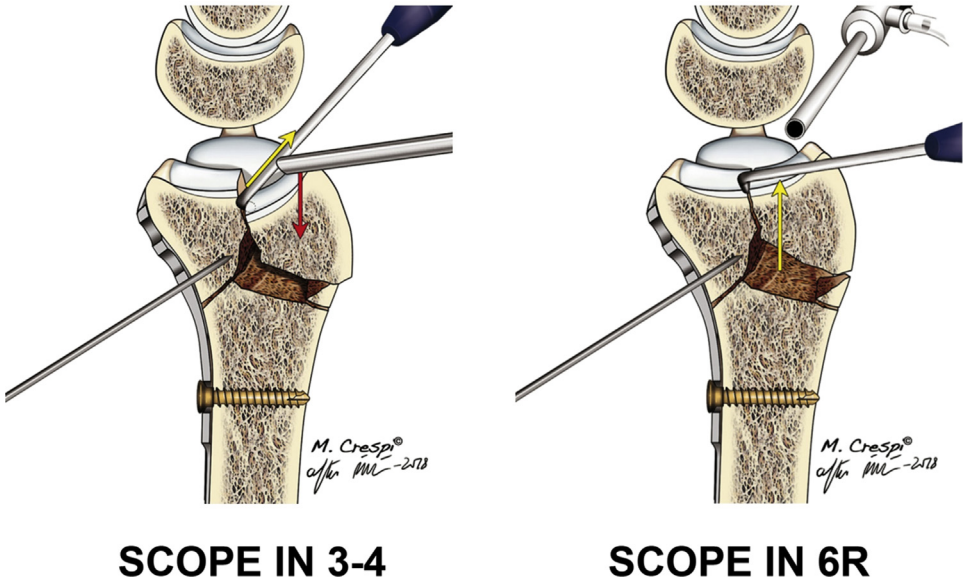

FIGURE 4: Placement of the arthroscope in the 3-4 portal can displace a fracture involving the scaphoid facet of the distal radius. By using the 6R portal as a working portal, the arthroscope provides a view of the distal radius articular surface without impeding fracture fragment reduction. (Reprinted with permission from Pinal, Francisco D. *Atlas of Distal Radius Fractures.* Thieme NY; 2018:51-72.)

resected.[32,33] To prevent overheating of the shavers and burs and to assist with debris removal, the automatic washout procedure is routinely used. To further improve visualization of the dorsal aspect of the RS, we typically develop the volar radial portal.[34] Fluoroscopy may be needed to confirm adequate styloidectomy has been performed.

Herness and Posner[35] reported improved wrist range of motion and pain relief in 26 of 41 patients who underwent concomitant radial styloidectomy after fixation of scaphoid nonunions with bone grafting. Noback et al[33] reported satisfactory outcomes at long-term follow-up in a series of 13 patients treated by arthroscopic synovectomy, radial styloidectomy, and neurectomy for SLAC stage 2 or 3. At a mean follow-up of 5.3 years (range, 1.1—7.9 years), 13 patients achieved a mean flexion-extension arc of 88° and grip strength of 95% compared with the contralateral side. With a mean Disabilities of the Arm, Shoulder, and Hand (DASH) score of 16, all patients were able to return to work without restrictions.

SCAPHOID FRACTURE AND NONUNION

The scaphoid is the most commonly fractured bone within the wrist and accounts for nearly 70% of all carpal fractures. Displaced scaphoid fractures have a

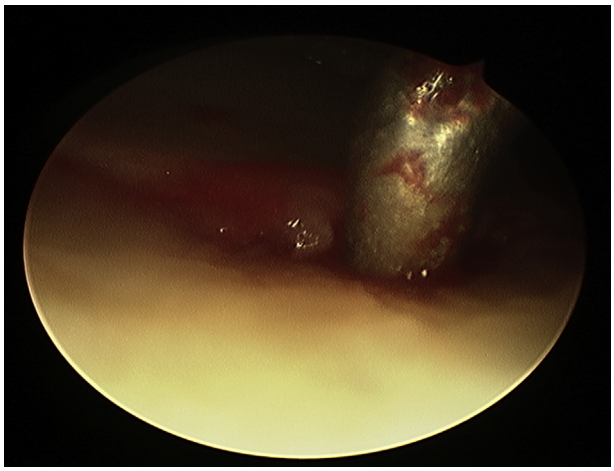

FIGURE 5: Arthroscopic view shows malreduction of the articular surface with articular stepoff and incongruity.

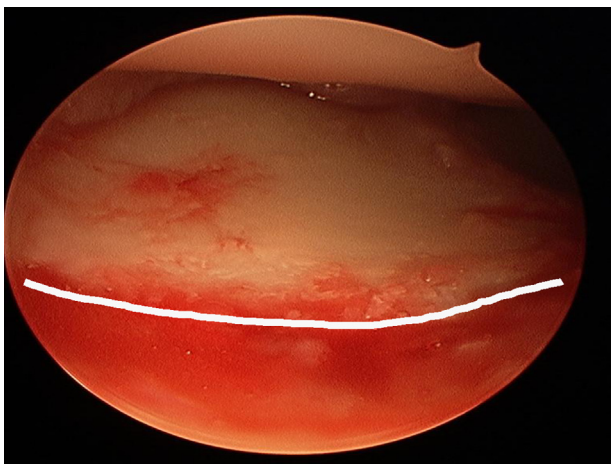

FIGURE 6: Arthroscopic view shows reduction of the articular surface of the distal radius. Note the white line showing correction of the stepoff.

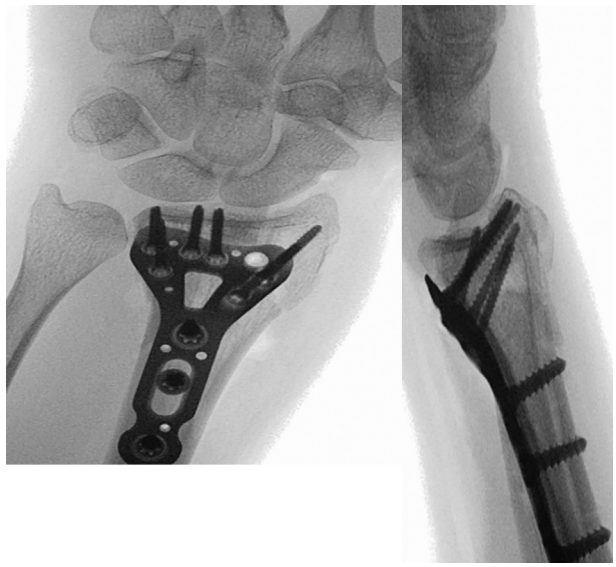

FIGURE 7: Posteroanterior (left) and lateral (right) radiographs show volar plate fixation of the intra-articular DRF.

reported nonunion rate of up to 50% and are typically managed by open reduction internal fixation (ORIF) with the use of cancellous, cortical, or vascularized bone graft as needed.

Wrist arthroscopy provides an unparalleled view of the fracture without the associated soft tissue stripping and potential devascularization that can be seen with open surgery. It allows for the evaluation of the injury, the status of union (nonunion, partial union, fibrous union, fracture stability), permits assessment of the reduction as well as the evaluation of cartilage and intercarpal ligament injuries.[36,37] Whipple[38] was one of the first surgeons to report arthroscopic management of scaphoid fractures. Shih et al[36] reported on the outcomes of 15 acute scaphoid fractures treated by arthroscopy-assisted internal fixation and noted 13% of patients had an associated SL injury, 27% a lunotriquetral injury, 33% TFCC, 33% radioscaphocapitate or long radiolunate ligament injuries, and 40% had chondral fractures. There was a 100% union rate and 11 patients had excellent and 4 had good Mayo Modified Wrist Scores at an average follow-up of 2 years.

Slade et al[39] reported the outcomes of 15 patients with scaphoid nounions without collapse or humpback deformity treated by arthoscopy-assisted internal fixation with 100% union rate at an average of 14 weeks after surgery. Patients who presented with nonunions greater than 6 months old had a slower rate to union.[39] Geissler[40] reported on the outcomes of the management of cystic nonunions without humpback deformity in 15 patients. The author reported union in 14 of 15 cystic nonunions.

Dry arthroscopy presents a distinct advantage in the management of scaphoid nonunions and it permits the delivery of bone graft within the fracture site and retention of its osteogenic factors without fear of losing the graft with irrigation. Oftentimes, these procedures can take a few hours and so, with DWA, there is a distinct lack of fluid extravasation that also assists with instrument delivery through the portals. Disadvantages of DWA include the use of a tourniquet, an inability to assess intraoperative punctate bleeding unless the tourniquet is deflated, and potential heat generation via the light source through the arthroscope.

The procedure is essentially performed as described by Wong et al,[41] with the modification of

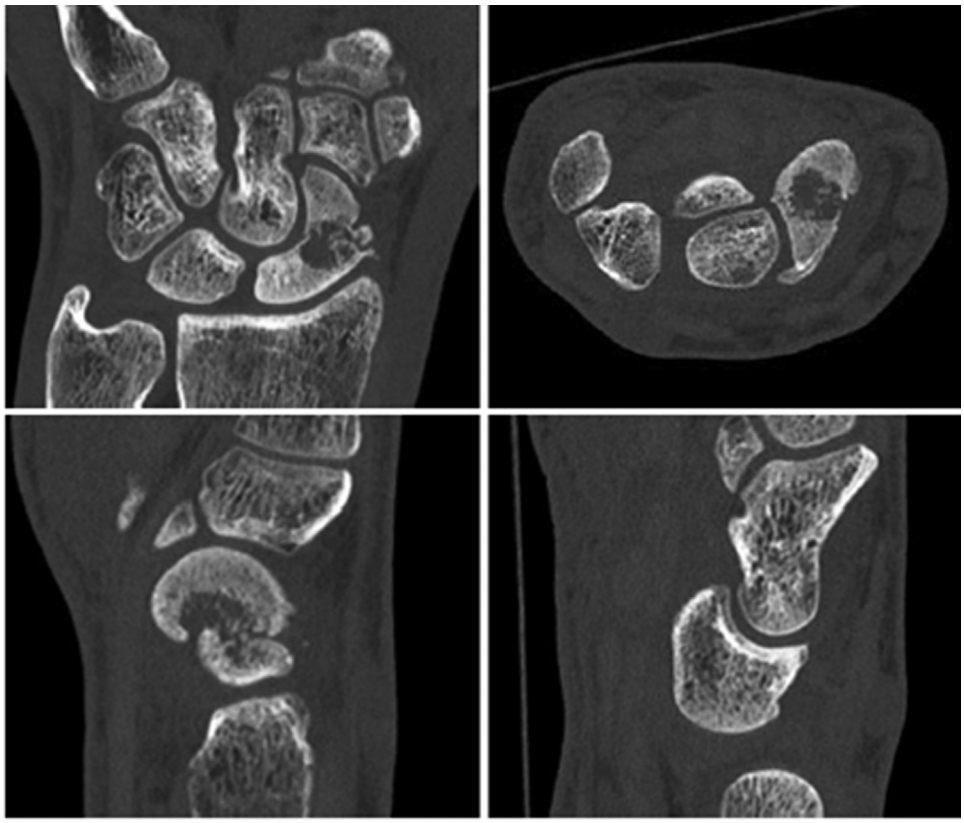

FIGURE 8: Computed tomography scans show a cystic scaphoid nonunion with evidence of humpback deformity and extension of the lunate.

using a dry technique (Figs. 8−14). In their series of 68 scaphoid nonunions using arthroscopy with fluid instillation, at an average follow-up of 39 months, there was a 91% union rate with an average time of radiographic union of 12 weeks (range, 6−39 weeks). Scant intraoperative punctate bleeding of the proximal scaphoid had a union rate of 84%, whereas good bleeding resulted in a union rate of 95%. Four patients underwent revision surgery.

PERILUNATE FRACTURE DISLOCATION

Until recently, ORIF of perilunate dislocations has been considered to be the gold standard to achieve early anatomical reduction and maintain carpal alignment.[42,43] Both clinical and radiological results have proven to be consistently good using ORIF through predominantly dorsal approaches with a 100% scaphoid healing rate in transscaphoid perilunate injuries (PLIs)[42] and 100% normal carpal alignment after pure ligamentous PLIs.[44] However, a large incidence of severe long-term posttraumatic wrist arthrosis has consistently been reported after ORIF for PLIs.[42,45,46] An open approach requires additional surgical trauma, which may increase capsular fibrosis and may lead to severe posttraumatic arthritis.

To preserve blood supply and the important capsular and ligamentous structures, as well as potentially minimize secondary arthritis, arthroscopy-assisted mini-invasive management of PLIs has been suggested by several authors.[46−49] Using an all-arthroscopic wet technique, Kim et al[48,50] placed K-wires into the proximal and distal poles of the scaphoid and used them as joysticks to reduce the fracture. While viewing the reduction of the fracture from the midcarpal portals, percutaneous fixation was performed along the central axis of the scaphoid under fluoroscopic control using Slade et al's technique.[39] Kim et al[48,50] reported on 20 patients that included 5 perilunate dislocations, 12 transscaphoid PLIs, and 3 transscaphoid, transtriquetral PLIs. At an average of 31 months follow-up (range, 18−61 months), they reported excellent or good outcomes in 11 patients with a mean DASH score of 18 and mean Patient-Rated Wrist Evaluation score of 30. Using an all-arthroscopic wet technique, Liu et al[49] published a retrospective review of 31 patients treated with arthroscopy-assisted reduction and percutaneous fixation of PLIs (26 had transscaphoid dorsal and 5 had

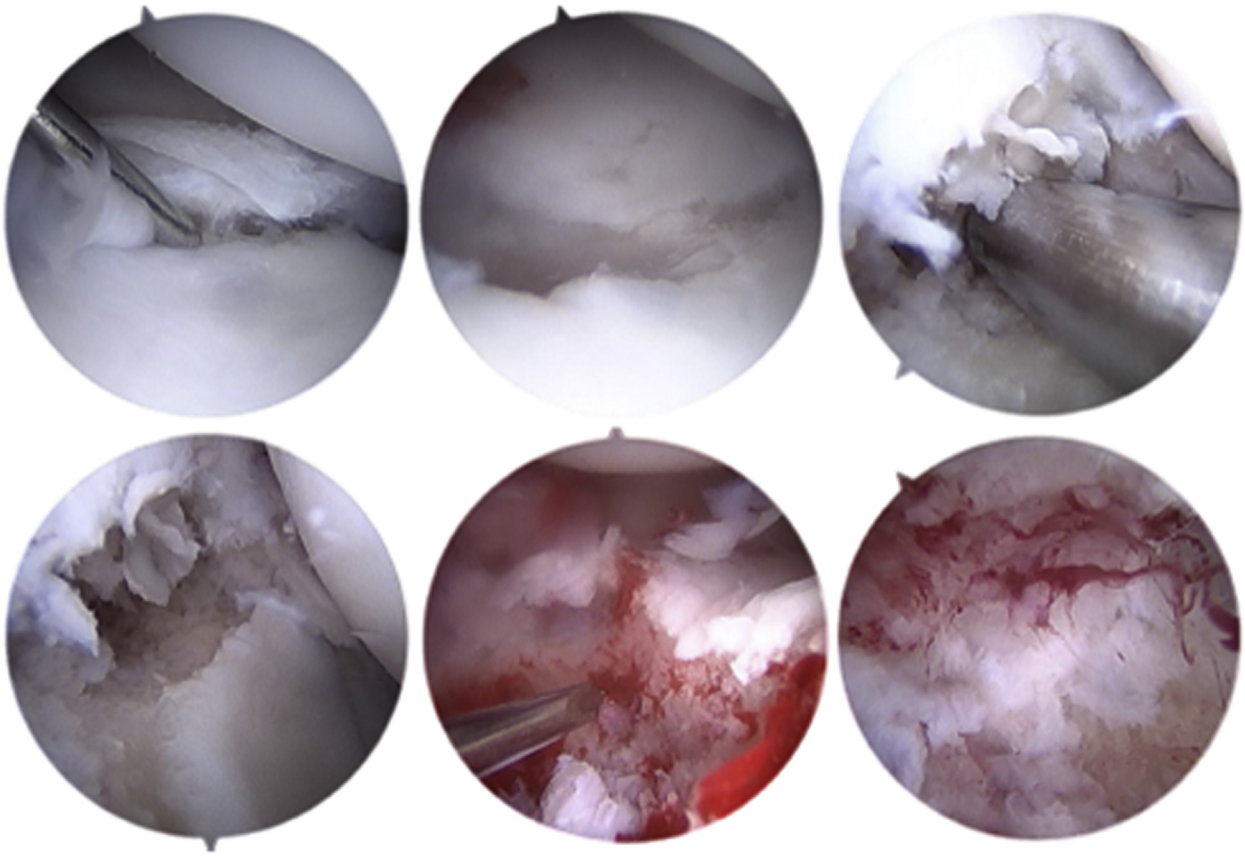

FIGURE 9: Midcarpal arthroscopy demonstrates evidence of scaphoid nonunion. Note after debridement, the maintenance of the cartilage shell of the scaphoid.

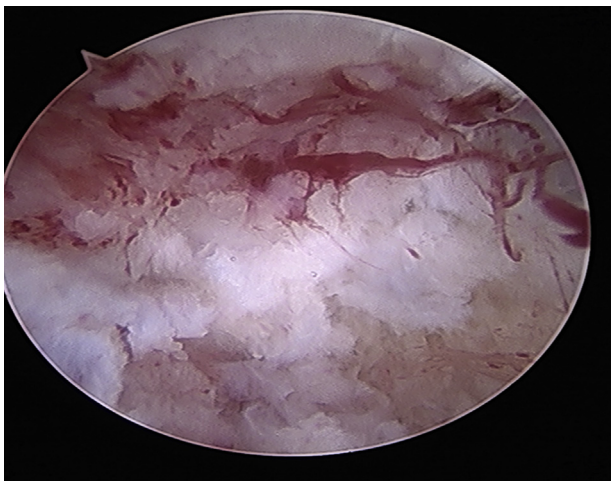

FIGURE 10: With the tourniquet deflated, note the presence of punctate bleeding from the fracture fragments.

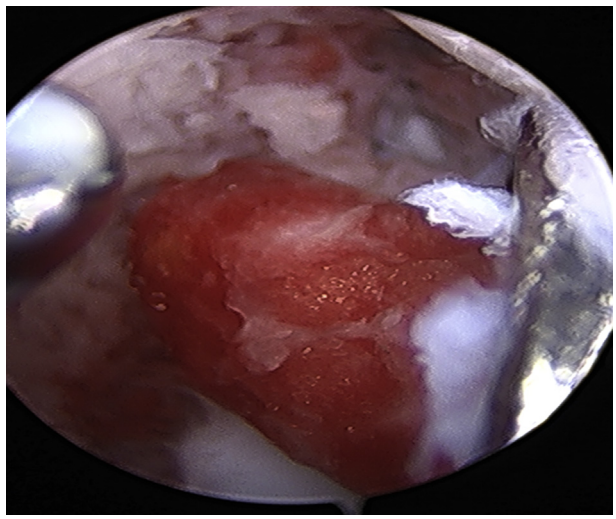

FIGURE 11: Note the delivery of autogenous bone graft through the midcarpal radial portal directly into the nonunion site.

dorsal PLIs). The mean flexion-extension range of motion of the injured wrist averaged 86% with grip strength of 83% of the contralateral wrist. The overall functional outcomes were rated as excellent or good in 79% of the patients. A total of 25 of 26 scaphoid fractures healed at an average of 13 weeks (range, 9–20 weeks) and normal carpal alignment was restored in all patients. Scaphoid nonunion developed in 1 patient.

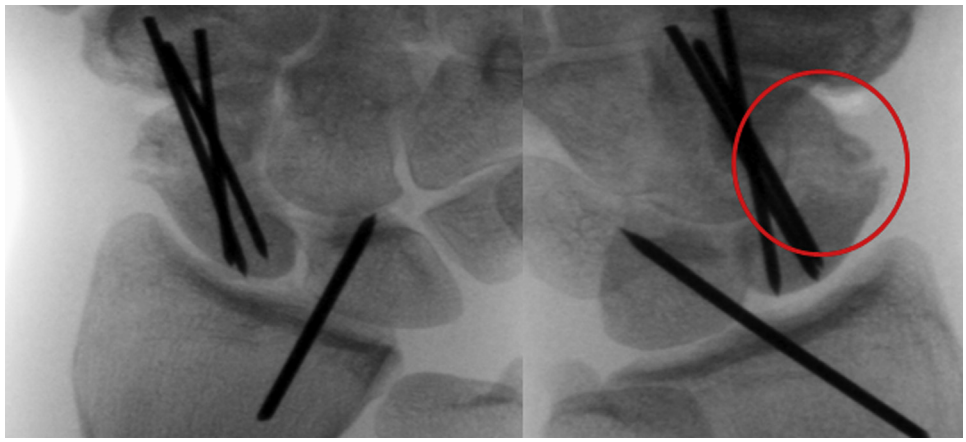

FIGURE 12: Immediate postoperative radiographs of arthroscopy-assisted scaphoid nonunion treatment with autogenous bone graft. Note the radiolunate K-wire maintaining the lunate in neutral position and the quantity of bone graft needed to fill the nonunion site (circle).

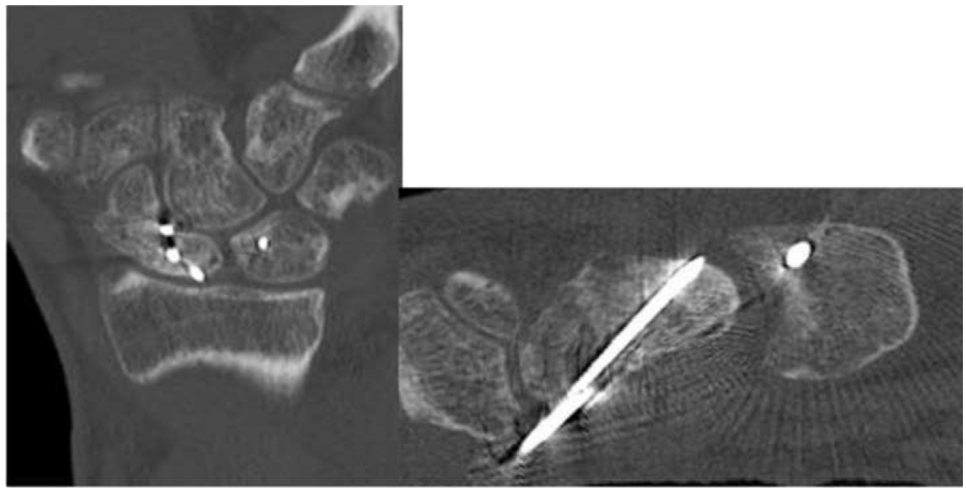

FIGURE 13: Coronal (left) and sagittal (right) computed tomography scans show evidence of scaphoid union with correction of the humpback deformity.

Using a DWA technique, Herzberg et al[13] reported on a series of 27 patients with PLIs. There were 11 transscaphoid PLIs, 12 pure ligamentous PLIs, and 4 PLIs nondislocated. In 7 cases, fixation of the PLI lesions was performed all-arthroscopically. In 20 patients, a combination of arthroscopy and minidorsal approach was used through an enlargement of the initial 3-4 portal. The miniopen dorsal approach allows an easy fixation of either the SL ligamentous remnants or the scaphoid fracture (Figs. 15–18).

Herzberg et al[51] expanded the concept of all-arthroscopic management of PLIs with DWA technique for the treatment of a translunate transradial styloid PLI. The midcarpal ulnar and midcarpal radial portals were first used to assess the extent of intercarpal ligament injuries. Then the 3-4, 6R, and 6U portals were used to visualize, reduce, and fix the lunate fracture and the radial styloid fracture with K-wires. Intraoperative fluoroscopy confirmed the reduction. At 44 months follow-up, the Patient-Rated Wrist Evaluation was 13 points, the arc of wrist flexion-extension was 110°, and the grip strength was 75% of the normal side. The Lyon wrist score was 78% (good).[51]

Follow-up radiographs showed anatomical union of both the lunate and the RS fractures.

THUMB TRAPEZIOMETACARPAL JOINT ARTHRITIS

The trapeziometacarpal joint is a common site of osteoarthritis, with a prevalence of 25% in men and

FIGURE 14: Posteroanterior radiograph shows scaphoid union.

FIGURE 16: Lateral radiograph of a dorsal perilunate fracture-dislocation.

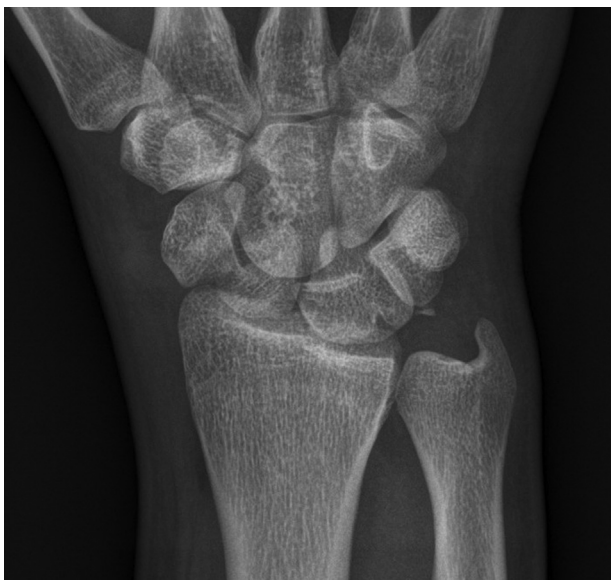

FIGURE 15: Posteroanterior radiograph of a dorsal perilunate fracture-dislocation.

40% in women older than 75 years.[52] Arthroscopic treatment includes debridement, synovectomy, removal of loose bodies, thermal shrinkage, partial trapeziectomy, complete trapeziectomy, K-wire stabilization, and suture suspension arthroplasty. Dry arthroscopy is particularly appealing for this joint given the lack of fluid extravasation within the soft tissues, preserving the small bony landmarks and reducing the risk of neurovascular damage that may be consequent to the distortion of soft tissue planes.

The most common portals used are 1R (or volar radial portal) and 1U (or dorsal ulnar portal) as described respectively by Berger[53] and Menon.[54] The 1R portal is on the radial side of the abductor pollicis longus and the 1U portal is between the extensor pollicis longus and the extensor pollicis brevis. The radial portal is mainly used for assessment of joint cartilage as well as the dorsoradial, posterior oblique, and ulnar collateral ligaments. The ulnar portal is helpful to visualize the volar ligaments including the anterior oblique ligament and the ulnar collateral ligament. To improve the working distance between the portals, Walsh et al[55] described the transthenar portal. Badia[56] recognized that substantial carpometacarpal joint degeneration often occurs before there is radiographic evidence and can be diagnosed only by performing arthroscopy on the joint. Thus, he described a 3-stage arthroscopic classification to help guide treatment depending upon the findings.[56] Once

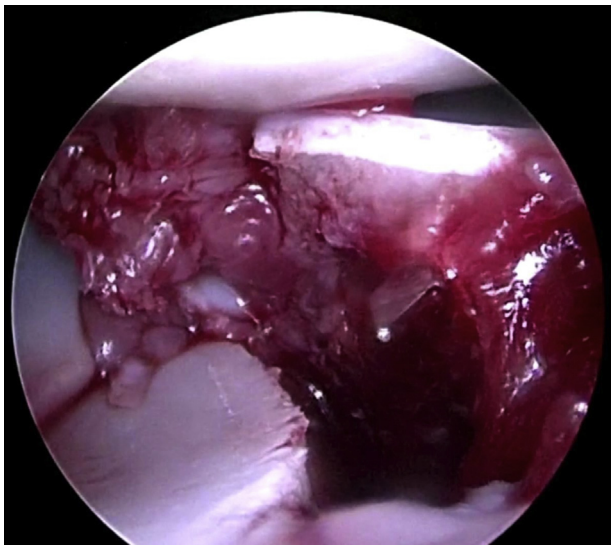

FIGURE 17: All-arthroscopic treatment of the case shown in Figures 15 and 16. Dry arthroscopy at the midcarpal joint shows the displaced scaphoid fracture site.

FIGURE 18: Posteroanterior postoperative radiograph showing fixation of the scaphoid and stabilization of the carpus.

inside the joint, a 2.5-mm aggressive shaver is first used to perform a synovectomy and capsular reflection. Thorough joint examination and removal of loose bodies in the capsular folds, especially in the intermetacarpal pouch, is mandatory because loose

FIGURE 19: Radiograph shows trapeziometacarpal arthritis with a palmar osteophyte.

bodies are the most common cause of painful locking joints with apparently well-preserved (or minimally degenerated) cartilage. If arthrosis is noted (Fig. 19), it is particularly important to expose the palmar osteophyte, which is located just proximal to the joint line and which can be debrided arthroscopically, resulting in reduction of the carpometacarpal joint (Figs. 20, 21).

Furia[57] compared 23 patients with stage I or II disease treated by arthroscopic debridement and synovectomy with a control group of 21 patients treated nonsurgically. At 1 year after surgery, the surgical group had significant improvements in pain and pinch strength with 83% of the surgical patients reporting good to excellent outcomes. Wilkens and colleagues[58] conducted a systematic review and meta-analysis on arthroscopic techniques in the management of basilar thumb arthritis and concluded that visual analog score pain improved by 4 points, DASH by 22 points, and grip strength by 2.8 kg with a complication rate of 4%. Encouraging results can be achieved either after arthroscopic partial or complete trapeziectomy, when stability of the first metacarpal is restored using a suture button suspensionplasty.[59,60] Landes et al[60] reviewed 97 cases of

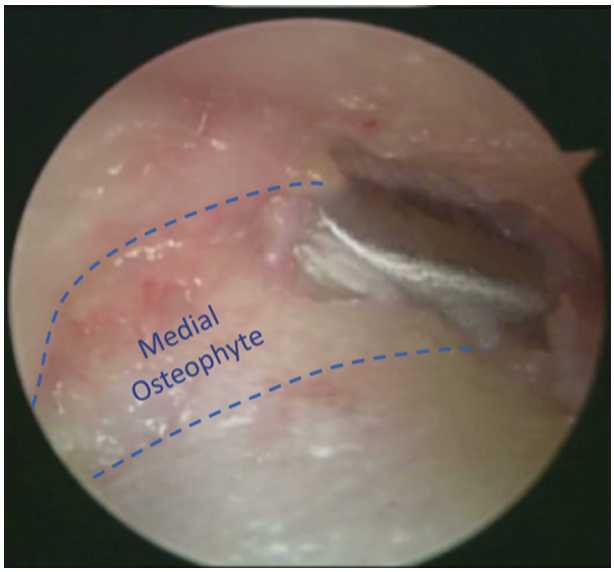

FIGURE 20: Dry arthroscopic view of the trapezium with debridement of the palmar osteophyte. The palmar osteophyte is being resected by the bur. Bony debris is removed using the automated washout technique and to prevent potential overheating of the shavers/burs. Special care should be taken with the arthroscopic resection of the medial osteophyte, which develops in the intermetacarpal pouch and prevents anatomical reduction of the first carpometacarpal joint. Fluoroscopy is mandatory to ensure proper resection

FIGURE 21: Postoperative radiograph shows reduction of the trapeziometacarpal joint with suture suspension. Note the debridement of the palmar osteophyte. If a tendon interposition is being performed, the tendon graft (eg, palmaris longus) is rolled up and sutured into a ball approximately 1 cm in diameter. The graft is pushed into the expanded carpometacarpal joint via the radial portal. Under arthroscopic control, the graft is contoured to cover the joint and sutured to the capsule to prevent extrusion.

arthroscopic partial trapeziectomy and 56 cases of arthroscopic complete trapeziectomy followed by suture button suspensionplasty and found a significant improvement in pain and function, with a very low revision rate (9 patients out of 153; $< 6\%$). No significant difference was found between after partial and complete trapeziectomy.[60]

SUMMARY

The development of wrist arthroscopy has been useful in diagnosis, prognosis, and treatment of both ligament and osseous injuries. As the treatment indications and techniques become more refined, dry arthroscopy adds a further resource to the surgeon's toolbox to tackle these conditions in a minimally invasive manner.

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JOURNAL CME QUESTIONS

Dry Wrist Arthroscopy for Radial-Sided Wrist Disorders

1. When performing an arthroscopic radial styloidectomy, which portal is helpful to view the dorsal aspect of the radial styloid?
   a. STT portal
   b. Volar radial portal
   c. Volar ulnar portal
   d. Volar midcarpal portal
   e. 6U portal

2. Which portal best delineates the extent of a scaphoid waist fracture?
   a. 3-4 portal
   b. 1-2 portal
   c. 4-5 portal
   d. 6R portal
   e. Radial midcarpal portal

3. Where is the 1-R portal located?
   a. On the radial side of the abductor pollicis longus
   b. Between extensor pollicis longus and extensor pollicis brevis
   c. Between the flexor carpi radialis and the radial artery
   d. Between the extensor carpi radialis longus and the extensor carpi radialis brevis
   e. On the ulnar side of the abductor pollicis longus

4. Which viewing portal is best indicated to view a very proximal pole scaphoid fracture:
   a. 3-4 radiocarpal portal
   b. 6R radiocarpal portal
   c. Radial midcarpal portal
   d. Ulnar midcarpal portal
   e. Triquetrohamate portal

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