

# Dry Arthroscopy and its Applications

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## KEYWORDS

- Dry arthroscopy • Wrist arthroscopy
- Arthroscopic technique • Clinical applications

Arthroscopy traditionally has been performed using fluid to create a working cavity (“wet” arthroscopy). Distending the joint with fluid, however, is not nuisance free. Fluid infiltrates tissues, escapes through the portals, and might cause serious problems such as compartment syndrome. Fluid enormously hampers any concomitant surgery after the arthroscopic exploration, due to loss of definition of anatomic planes. Finally, the use of fluid makes it impossible to combine arthroscopy with semi-open procedures such as intra-articular osteotomies and triangular fibrocartilage (TFC) reinsertions, as massive seepage of fluid will cause constant loss of vision.

Extrapolating that in other “scopies” in the human body, such as laparoscopy or thoracoscopy, fluid was not used to maintain the optic cavity, the author realized that traction through the fingers was sufficient to keep the wrist cavity open, making the use of fluid unnecessary. In fact, all the aforementioned inconveniences could be circumvented, without modifying the visual properties, if fluid were not infused inside the joint (“dry” arthroscopy).<sup>1</sup> Large portals/mini incisions can be created for the passage of large instruments or the extraction of large bony fragments, without fear of losing fluid tightness. Open and semi-open arthroscopic assisted procedures can hence be easily combined. Finally, traditional open surgery can be performed immediately after the arthroscopy exploration, leaving tissue in pristine condition, as there has been no extravasation of fluid outside the capsule (**Fig. 1**).

Not using fluid, on the other hand, engenders a new set of problems secondary to loss of vision caused by splashes on the tip of the scope or blood and debris in the joint. This situation may

induce the novice to give up at the first difficulty met, but the advantages of the dry technique far outweigh the difficulties encountered on the learning curve. In this work the technical tips to carry out an uneventful operation are presented in detail.

## SURGICAL TECHNIQUE

The “dry” arthroscopy technique is similar to a standard wrist arthroscopy (“wet”), except for that fluid is not used to maintain the optic cavity. As stated, the main shortcoming comes from the fact that if one is not able to get rid of the blood and splashes that obscure vision in an expeditious manner, surgery will become a torment and one will give up on the dry technique.

Intuitively, one would think that removing the scope and wiping off the lens with a wet sponge is a good way of clearing the visual field. Although effective, this maneuver is time consuming and, in a fracture or other complex procedures described in this article, there may be so much blood or debris that the maneuver may need to be repeated an exasperating number of times. Based on his experience with more than 700 dry wrist arthroscopies, and—more importantly—seeing how others in the laboratory and surgery struggle with the same difficulties over and over again, the author can recommend the following tips that are critical for a smooth procedure, some of which are improvements on the previous publication.<sup>1</sup>

- The valve of the sheath of the scope should be kept open at all times to allow the air to circulate freely inside the joint. Otherwise, either the suction of the shaver will not

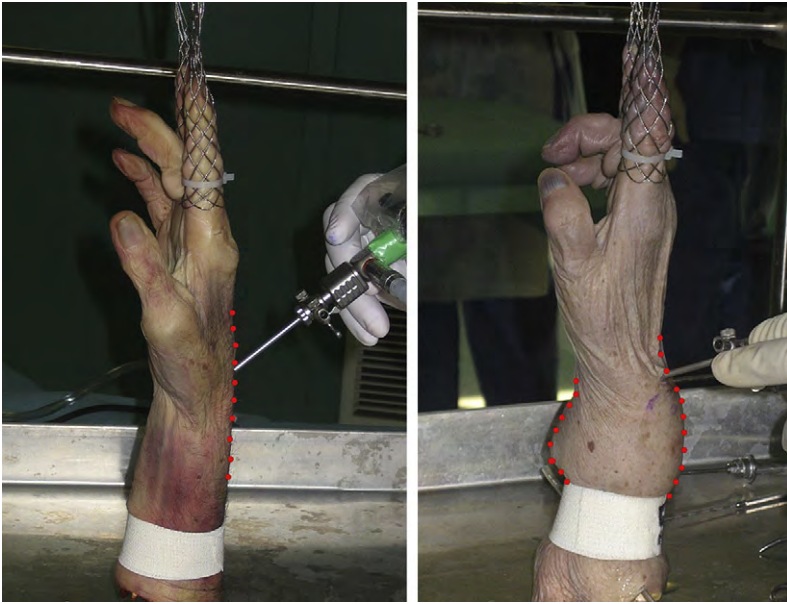
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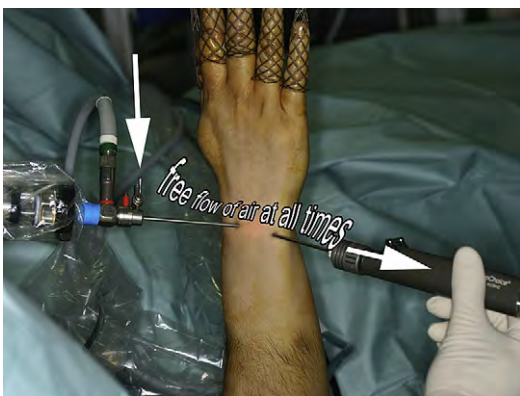
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**Fig. 1.** The deformity of the wrist due to fluid extravasation after 1 hour of wet arthroscopy (*right*) as compared with the left, which was operated on for the same amount of time but under the dry technique. Pictures were taken during a teaching course with cadavers in Strasbourg. Both were operated by students simultaneously in different working posts. (Copyright Francisco del Piñal, MD, 2010.)

function properly or the capsule will collapse inwards because of the power of the suction, resulting in blocked vision. This aspect is critical and cannot be overemphasized (**Fig. 2**).

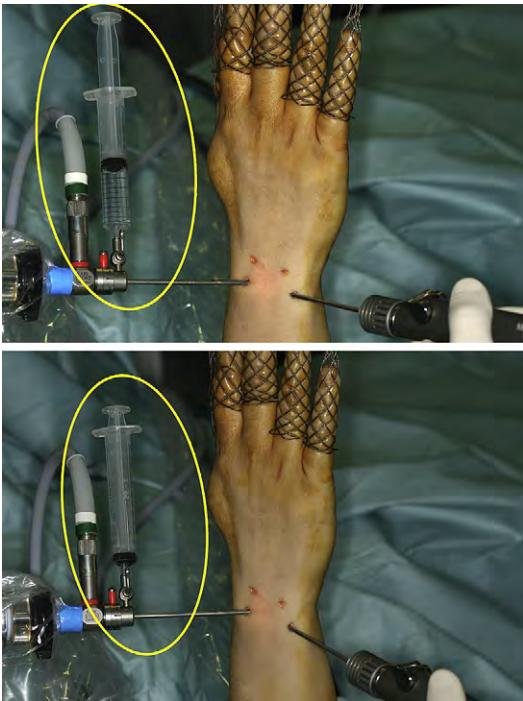
- Suction is necessary to clear the field but, paradoxically, suction might also blur the vision by stirring up the contents of the joint (debris, blood or remaining saline) that may stick to the tip of the scope. It is critical,



**Fig. 2.** The valve of the scope should be open at all times so as to allow air to circulate freely. (From del Piñal F. Treatment of explosion-type distal radius fractures. In: del Piñal F, Mathoulin C, Luchetti C, editors. Arthroscopic management of distal radius fractures. Berlin: Springer Verlag; 2010. p. 41–65; with permission.)

therefore, to open the suction of the shaver or burr only when there is the need to aspirate something. Suction power should be locked when not needed. To sum up, the valve of the sheath of the scope should be open at all times, but suction should only be used as needed.

- Avoid getting too close with the tip of the scope when working with burrs or osteotomes, to avert splashes that might block your vision. Minor splashes can be removed by gently rubbing the tip of scope on the local soft tissue (capsule, fat, and so forth).
- When a clear field is needed, so as to see a gap or a step-off, the author used to recommend drying out the joint with neurosurgical patties.<sup>1</sup> However, the author rarely resorts to this technique now, and prefers to connect a syringe with 5 to 10 mL of saline to the side valve of the scope and then aspirate it with an arthroscopic shaver, to get rid of blood and debris. Pressure on the plunger of the syringe is unnecessary, as the negative pressure exerted by the shaver will suck the saline into the joint, thus preventing any extravasation (**Fig. 3**). Once all the fluid has been aspirated the syringe is removed, and again the suction power of the shaver is enough to dry out the joint sufficiently, thus allowing the surgeon to work. This maneuver should be



**Fig. 3.** Method used to wash out the joint and clear it of blood. Notice that the negative pressure exerted by the shaver is sufficient to aspirate the saline without extravasation of fluid. (From del Piñal F. Treatment of explosion-type distal radius fractures. In: del Piñal F, Mathoulin C, Luchetti C, editors. Arthroscopic management of distal radius fractures. Berlin: Springer Verlag; 2010. p. 41–65; with permission.)

repeated as necessary throughout the procedure, as it is much quicker than struggling with blood in the joint, or trying to dry it out with the patties.

- An important waste of time occurs when the full-radius resector, burr, or any other instruments connected to a suction machine clog because the aspirated debris dries out. When this happens the operation has to be temporarily halted to dismount and irrigate the full-radius resector for dislodging the debris. This situation is to be avoided at all costs by clearing the tubing with periodic saline aspiration from an external basin by the operating-room nurse, or by the surgeon through joint irrigation. Joint flushing should also be done in a systematic fashion in some procedures, such as intercarpal arthrodesis or arthroscopic proximal carpectomy, in which prolonged use of the full-radius resectors and burrs may cause heating of the instrument itself, causing local burns (see later discussion).

- Finally, one must understand that at most times vision will never be completely clear but still sufficient to safely accomplish the goals of the procedure. Having a completely dried field except for at specific times during the procedure is unnecessary and wastes valuable time, and the author relies more on the irrigation-suction explained above.

The technique can be summarized in these 3 fundamental tips:

- The valve of the scope should be open at all times
- The suction should be closed except when needed
- The joint should be irrigated as needed to remove debris and blood.

### CONTRAINDICATIONS

The dry technique is contraindicated when using thermal probes, lasers, and so forth, as the heat generated will not dissipate, risking widespread cartilage damage. The problem is solved easily, however, by swapping to the “wet” technique during the specific moment that these kinds of instruments are being used. Once the thermal shrinkage or debridement is finished, the saline is disconnected and air allowed to flow in the joint. The remaining fluid is sucked out with the full-radius resector and the procedure continues “dry.” In very special scenarios where running fluid is paramount, such as in septic arthritis, the use of the dry technique will offer no advantage and is not advised.

Risk of compartment syndrome has been considered a contraindication for arthroscopy, particularly after severe fractures, but this is not a problem when using the dry technique. Furthermore, open wounds are not considered a contraindication of the dry arthroscopy either, provided debridement of the portal is carried out and thorough irrigation of the joint is performed at the end of the procedure.

One concern of surgeons regarding dry arthroscopy is the possibility of thermal damage inside the joint by the tip of the scope. In the author’s experience this has never occurred, as the tip of the scope never warms up to that point. The reader should be warned, however, that the author has experienced minor contact burns at the portals and the dorsal skin, by the full-radius resector and burr. The rotating mechanism of these instruments heats up, as a result of friction, when used for very long periods of time. This overheating is easily overcome by flushing the joint with saline that will cool down the full-radius resector, and also will improve vision.

## CLINICAL APPLICATIONS

The author uses the dry technique in nearly all his arthroscopic explorations, as he personally has not found it necessary to use vaporizers. There are, however, 4 common scenarios for which not using fluid makes an enormous difference, namely, TFC-complex reattachments, distal radius fractures and malunions, and arthroscopic arthrodeses. Because the first one is covered in another article by Yao and colleagues elsewhere in this issue, the focus here is on the technical aspects of the latter 3 scenarios.

### *Distal Radius Fractures and Malunions*

Despite the existence in the literature of well-performed Level I studies<sup>2-4</sup> supporting the use of the arthroscope when dealing with articular distal radius fractures, there is general resistance in the Hand Surgeon community to admit so. This standpoint is sometimes justified as being due to the very small risk of compartment syndrome, and more so to the massive swelling that accompanies the wet arthroscopy that makes the open part of the procedure more awkward. Although the latter reason is true, the unvoiced reason lies in the technical difficulties of the arthroscopic part itself. This is more so the more comminuted the fracture is, which paradoxically is the one type that benefits most from having an arthroscopic assisted reduction.<sup>5</sup> Yet there is no other single field in wrist arthroscopy where the dry technique can make such a huge difference and ease the procedure, as when dealing with articular fractures of the wrist. The dry arthroscopy allows an unimpeded combination between the open-fixation part and the ability to watch the cartilaginous reduction as well as assess ligamentous and TFC injuries.

The author's current technique<sup>6,7</sup> includes the use of volar locking plates in combination with arthroscopy, except in some specific fractures, such as radial styloid, where cannulated screws through a transverse incision in the styloid is the preferred fixation method. For the typical 3-part or 4-part fracture, the radius is approached between the flexor carpi ulnaris (FCR) and the radial artery. After a preliminary reduction, a volar locking plate is applied and stabilized by inserting only the screw into the elliptical hole on the stem of the plate. The articular fragments are reduced to the plate, which acts as a mold, and once the "best" reduction is obtained as judged by fluoroscopic views, the articular fragments are secured to the plate by inserting Kirschner wires (K-wire) through the distal K-wire holes in the plate. It should be underscored that definitive fixation

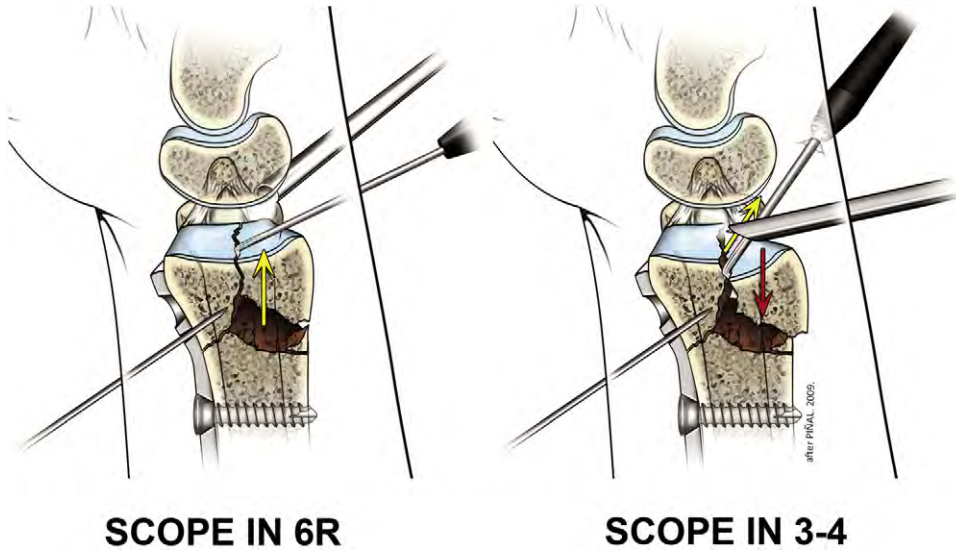
(screws or pegs) should not yet be used, as any change will not be possible later.

The hand is suspended from a bow, the fingers pointing to the ceiling, with a customized system that allows easy connection and disconnection from the bow without losing sterility, as fluoroscopic checkups are needed.<sup>8</sup> Traction is applied to all of the fingers with countertraction of 7 to 10 kg. A small transverse incision is made just distal to Lister's tubercle and, after dilating the portal with a straight mosquito, the scope (2.7 mm; 30° angle) is introduced and directed ulnarly. In the swollen wrist, it may be very difficult to establish a 6R portal, more so because the TFC may be detached from the fovea, acting as a lid blocking the entrance into the radiocarpal joint. This eventuality is overcome through establishing this portal by going blindly with a hemostat in a radial direction immediately radial to the extensor carpi ulnaris, just brushing past the proximal triquetrum.

The blood and debris are aspirated by a 2.9-mm shaver inserted in the 6R. Flushing and debridement is performed until the joint is completely clean. Once the elements that need to be mobilized are identified, the scope is swapped to the 6R, where it will stay until the entire fixation is done. In this position, on top of the ulnar head, the scope will have a steady point to rest on, and will not impede reduction or displace reduced fragments (Fig. 4).

In simpler cases where only a single fragment remains unreduced, the fragment is freed by backing out the specific K-wire that kept it secured to the plate. Depressed fragments are lifted by hooking them with the tip of a shoulder or knee arthroscopy probe introduced from portal 3-4 (Fig. 5).

Elevated fragments nearly always correspond to rim fragments that, due to the effect of traction, are overdistracted. These fragments are easily repositioned by the assistant decreasing traction while the surgeon levels them with the probe or a Freer elevator. Once the fragment is reduced, it is held in position with a bone tenaculum, and stabilized by pushing the corresponding K-wire through the K-wire holes in the plate again. Free osteochondral fragments are extremely unstable, and when repositioned sink into the metaphyseal void. To avoid this the author creates a supporting hammock where they can lie. The distal layer of pegs is inserted in the plate, while keeping these fragments slightly overreduced. Then they are impacted by using a Freer elevator or by releasing the traction and using the corresponding carpal bone as a mold. A grasper can be useful to grab and twist a severely displaced fragment.<sup>7</sup>



**Fig. 4.** If the scope is placed in 6R it will rest on top of the ulnar head providing a stable platform from which to work, thus avoiding conflict with the reduction (*left*). Instability of the scope and conflict of space during the reduction (*yellow and red arrows*) is inevitable when the scope is placed in any other portal (*right*). (Copyright Francisco del Piñal, MD, 2010.)

Still under arthroscopic control, locking pegs/screws are inserted in the plate by the other surgeon in critical spots, so as to make the articular surface stable to probe palpation. This part of the operation is awkward because the flexor tendons are in tension, blocking the vision of the plate. Retracting the tendons ulnarwards with a Farabeuf and reducing the traction to release the flexor tendons may ease the task. As soon as the major articular fragments are stabilized, the hand is placed flat on the operating table, as in this position the remaining pegs and screws can be inserted expeditiously (**Fig. 6**).

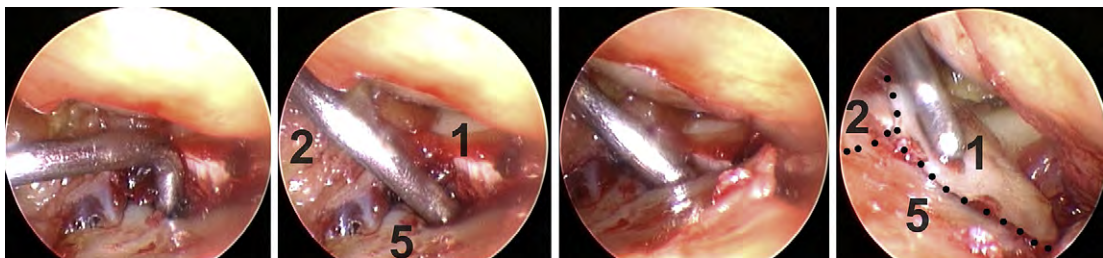
Only in the most comminuted cases will several fragments continue to be displaced after the fluoroscopic part of the operation. Backing out all the K-wires, and attempting to reduce and fix all fragments at the same time, is an impossible

endeavor. The author recommends a step-by-step procedure beginning preferably from the ulnar part of the radius, advancing in a radial direction. The mechanics of the procedure are similar as for a single fragment: the corresponding K-wire is backed out, the fragment reduced, and the K-wire pushed in, building up the rest of the articular surface on this foundation.

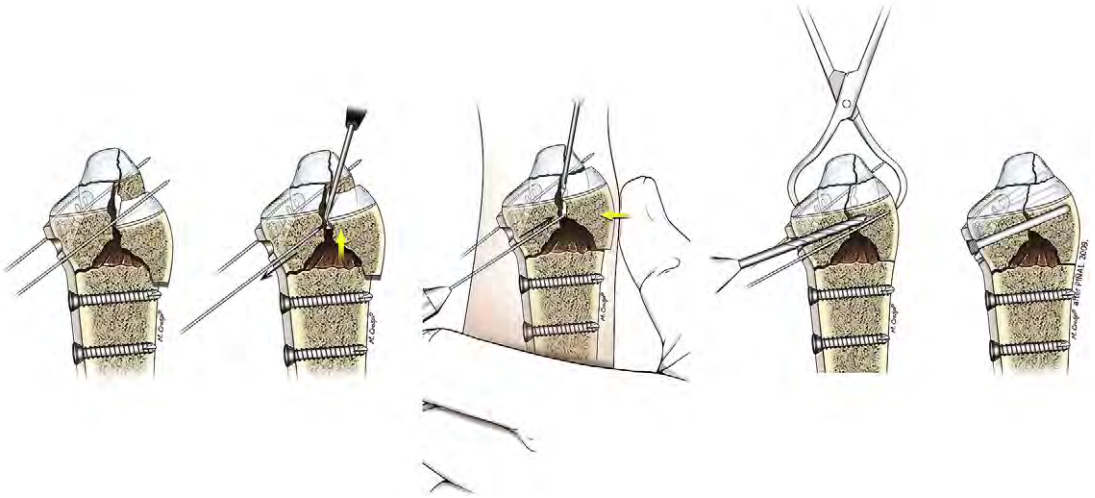
Once the radius fixation is over, the hand is again placed on traction, and the distal radioulnar joint and midcarpal joint are assessed for instability or ligament damage.

**Arthroscopic Guided Osteotomy for Distal Radius Malunion**

Arthroscopy can be invaluable to locate step-offs, to visualize the geometry of the malunited



**Fig. 5.** Reduction of a depressed fragment in the scaphoid fossa. From left to right: the shoulder probe is gauging the step-off (3 mm), hooking the depressed fragment, elevating it, and leveling it to the rest of the joint. Scope in 6R, viewing radially in a right wrist. 1, volar rim of the scaphoid fossa; 2, dorsal rim; 5, scaphoid fossa. (Copyright Francisco del Piñal, MD, 2010.)



**Fig. 6.** Summary of the author's technique to reduce and stabilize the common scenario of a posterior depressed fragment that remains unreduced. Notice that the K-wire is backed out sufficiently enough to release this malpositioned fragment, while the rest of the reduction remains unaffected during the whole maneuver. (Copyright Francisco del Piñal, MD, 2010.)

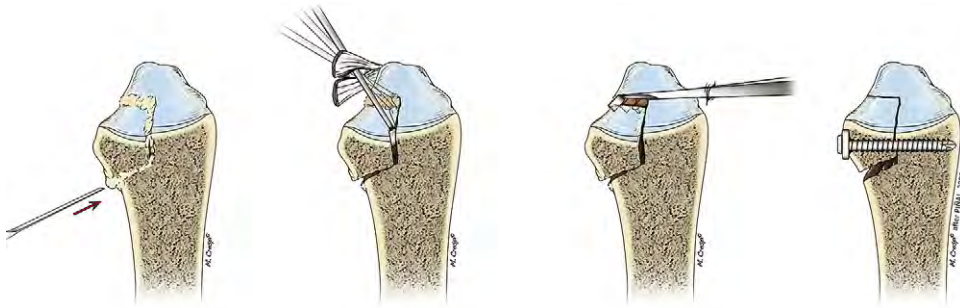
fragment, to osteotomize the bone precisely at the interface between the malunited fragment and the articular surface, and to assess the reduction (**Fig. 7**). In fact this is more so, as fluoroscopy has not proved very reliable even in the setting of acute fractures,<sup>9,10</sup> and because performing the osteotomy blindly can section the joint surface in an undesired spot.<sup>11</sup>

The technique of osteotomy has been described previously,<sup>8,11</sup> and the early results reported.<sup>12</sup> In brief, the procedure is started by preparing the proposed site of plate fixation with the arm lying on the hand table. To facilitate the separation of the fragments when later doing the intra-articular osteotomy, the external callus is removed with a rongeur and the outer callus is weakened with an osteotome. No attempt is made to go all the way to the joint or to do any rough bending or prying

open of the fragment with the osteotome, as this may break the cartilage at the incorrect place. A plate, when needed, is preplaced at this stage, and held in position with a single proximal screw as explained for acute fractures. The hand is then placed in traction. An arthroscopic arthrolisis is first performed to create working space, as the joint is scarred and unyielding. For cutting the bone the author uses a shoulder periosteal elevator (of 15° and 30° angle) (Arthrex AR-1342-30° and AR-1342-15°; Arthrex, Naples, FL, USA), and also straight and curved osteotomes (Arthrex AR-1770 and AR-1771). Instruments with different angles are required to avoid damaging the cartilage, and laceration of the extensor tendons are to be avoided by the appropriate technique.<sup>11</sup> The osteotomes also have to be inserted through different portals to adapt to the different configurations of



**Fig. 7.** (A) Correction of a 4-mm step-off on the lunate fossa (right wrist scope in 6R). (B) The osteotome (entering the joint through a dorsal portal) is separating the malunited fragments. (C) Corresponding view after reduction. (Copyright Francisco del Piñal, MD, 2010.)



**Fig. 8.** Most malunions require multiple accesses and combinations of osteotomy types. Notice that the osteotome is introduced into the cleft between the radioscaphocapitate and long radiolunate ligaments when using the volar-radial portal. (Copyright Francisco del Piñal, MD, 2010.)

the fracture (**Fig. 8**). Stabilization of the fragments is performed with volar locking plates when several fragments are mobilized; screws or buttressing plates are used when only one fragment needs to be addressed.

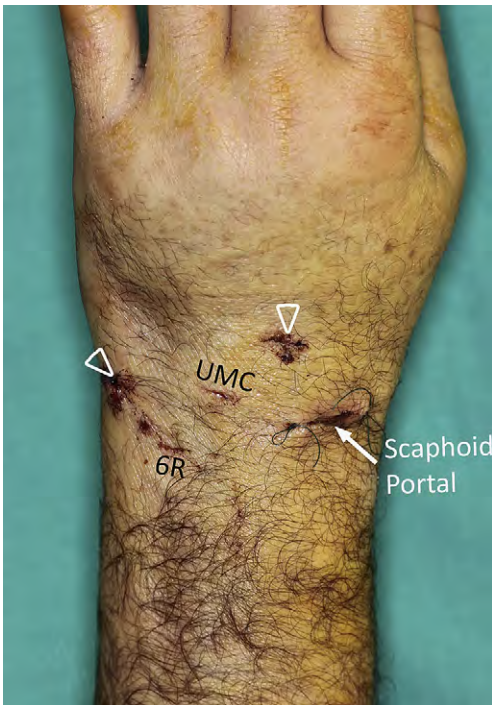
### **Arthroscopic Arthrodesis**

Intercarpal or radiocarpal arthrodesis can be performed arthroscopically.<sup>13</sup> Some may view this with skepticism, but the procedure is sound not only because there will be a cosmetic benefit,

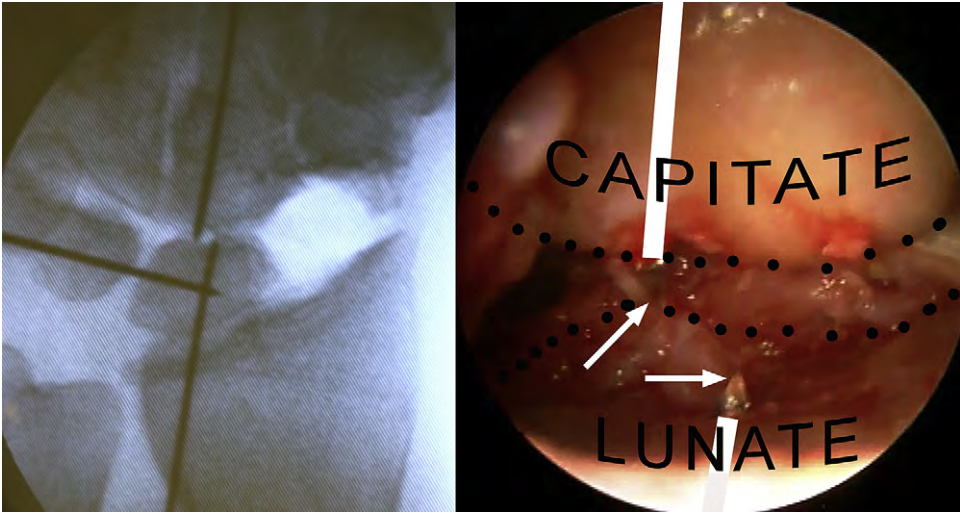
but above all because the degree of insult to the wrist ligaments will be minimized. Ligament preservation will keep the blood supply to the bones intact, with less scarring to the capsule, promoting in turn bony healing and less stiffness, respectively. The operation as described by Ho<sup>133</sup> using a “wet” technique is very cumbersome, due to fluid escaping through the portals and to the difficulty in maintaining the bone graft in the proper position. Furthermore, because the operation takes a long time the amount of tissue infiltration becomes massive, which is detrimental at the time of fixation.

The dry technique can be invaluable in this complicated operation, which ranks among the most difficult procedures in wrist arthroscopy. Several factors contribute to this complexity: the anatomy is distorted; it takes considerable time to burr out and to match the bone surfaces for arthrodesis; there is a need for bone graft insertion; and finally, the surgeon has to “blindly” insert the guidewires for the cannulated screws. All these steps are greatly facilitated if the tissues are not infiltrated. If the dry technique is used, all bony landmarks will be recognizable by palpation throughout the operation.

The aim of this work is not to present in detail any of the techniques; however, a brief description, using the 4-corner fusion (4CF) as a reference, helps to highlight the advantages of the dry technique. The procedure commences by creating the portals, which are easily made ulnarly (6R and ulnar midcarpal portal). With advanced scapholunate advance collapse (SLAC) or scaphoid nonunion advanced collapse (SNAC), the radial portals are more difficult to establish, because of architectural derangement of the carpus and, often, scarring from previous surgery. The author’s preference is to create a large (1.5-cm) transverse “scaphoid portal” (midway between 3–4 and radial midcarpal portal) corresponding to the location of the scapholunate gap or the scaphoid nonunion



**Fig. 9.** The incisions required for a 4CF are shown in this patient. Hollowed arrows point to the entrance of the cannulated screws. Notice the minimal swelling 3 days after the procedure with the dry arthroscopy. (Copyright Francisco del Piñal, MD, 2010.)



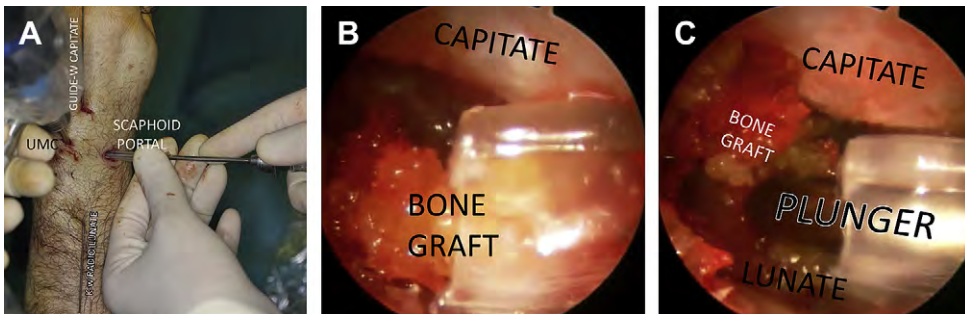
**Fig. 10.** Fluoroscopic and arthroscopic control of the correct position of the lunate on its fossa and good alignment of the capitoulunate guidewire are paramount for a good outcome. Arrows point to the tips of the radiolunate and capitoulunate wires, while white strips mimic the wires' path in the bones. (Copyright Francisco del Piñal, MD, 2010.)

(**Fig. 9**). From there, work can be performed in both the radiocarpal and midcarpal directions.

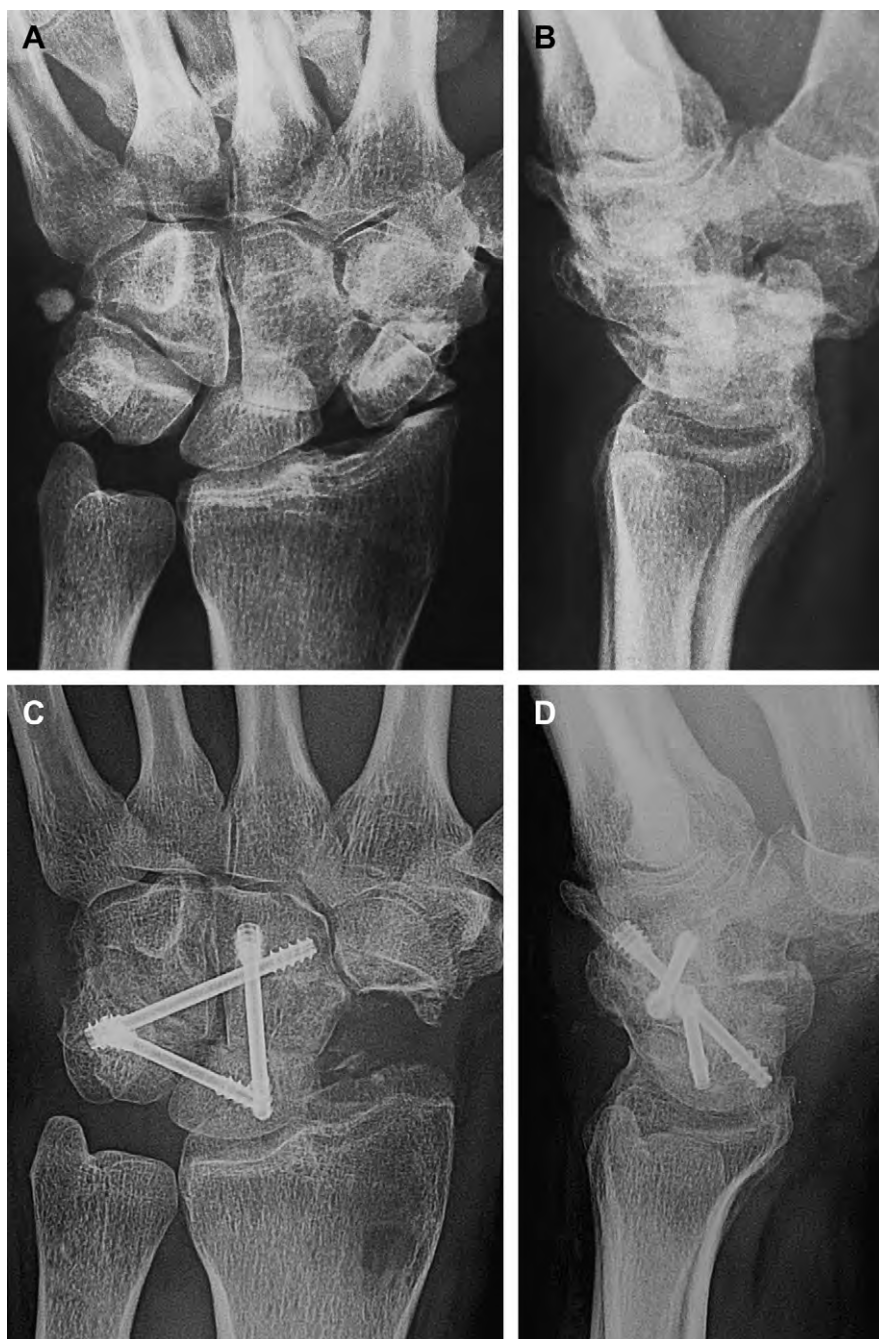
One begins by inserting the scope in 6R and locating the “scaphoid portal” with a needle. An aggressive 2.9-mm full-radius resector is inserted through this portal. Hypertrophic synovium, bone debris, and scarred tissue in the dorsal capsule are radically resected to create a larger working space. As soon as possible one switches to a 4.5-mm full-radius resector, to speed up the process. In both dry and wet techniques, one of the difficulties arises from the need to deal with a large quantity of bone debris secondary to scaphoid and/or subchondral bone excision. As explained in the section on surgical technique, during burring the suction should be switched off to maintain good vision, and irrigation-suction should be intermittently used to remove debris.

In the best of circumstances, burring out the whole scaphoid with a 4.5-mm (or even a 5.5-mm) burr is time consuming. For this reason, whenever possible, the author tries to remove a large part of the scaphoid in one piece after releasing it from the soft tissue connections with a banana blade or a full-radius resector. In 4CF one can be quite rough, for the sake of speediness, in the radial side of the joint, with osteotomes and burrs; denting the cartilage of the radial surface of the capitate, proximal trapezium, and trapezoid is inconsequential, as all this area will be a void at the end of the operation. Similarly, the scaphoid fossa will be nonarticulating, and as a matter of fact a moderate styloidectomy is always needed.

After the scaphoid has been removed (piecemeal, or burred out), the cartilage and hard subchondral bone of the joints to be arthrodesed are resected



**Fig. 11.** Intraoperative view while the bone graft is being delivered in the midcarpal joint through the “scaphoid portal.” (A) The surgeon is holding the cannula with the left hand and the plunger (the scope sheath) with the right hand. (B, C) Corresponding arthroscopic view while the bone graft is being delivered in the midcarpal joint by pushing the bone graft into the joint by the plunger. (Copyright Francisco del Piñal, MD, 2010.)

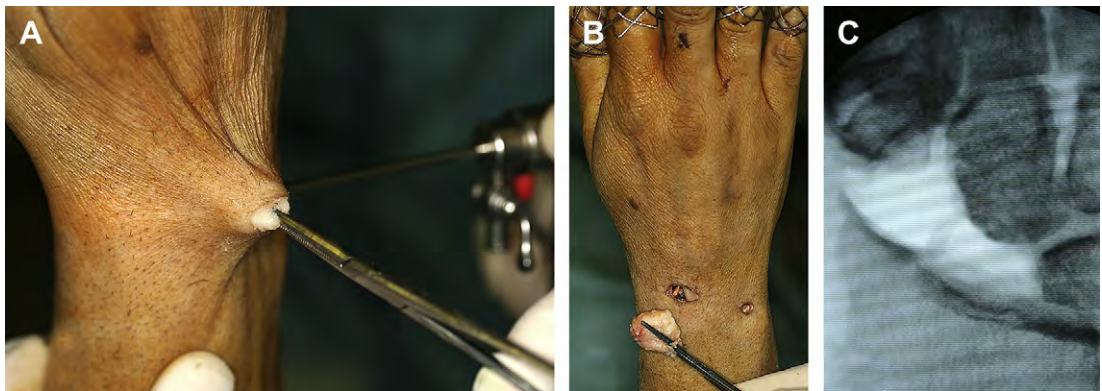


**Fig. 12.** (A, B) Arthroscopic 4-corner fusion. Excision of the scaphoid and loose bodies, burring, and bone grafting were all done arthroscopically. Protected range of motion was started 2 weeks after the operation. (C, D) Solid bony healing at 9 weeks. (Copyright Francisco del Piñal, MD, 2010.)

until healthy cancellous bone is exposed. For this step the author prefers pineapple-shaped, rather than ball-shaped, burrs. The latter tend to produce “holes” instead of an even surface, and easily get “caught” (snagged or stuck). Again for the sake of

speediness, 4.5-mm diameter burrs are preferred if space permits.

Once the bony surfaces are prepared for arthrodeses, the hand is taken off from traction and the position of the lunate assessed. Usually



**Fig. 13.** (A, B) The proximal pole of the scaphoid is being “delivered” in one piece through the “scaphoid portal” during an arthroscopic assisted proximal row carpectomy (B). (C) The distal pole was burred out. (Copyright Francisco del Piñal, MD, 2010.)

the lunate is dorsiflexed and translocated ulnarly, and needs to be reduced in neutral in the lunate fossa; this is achieved by the surgeon maximally flexing the wrist and at the same time translocating the wrist radially. A K-wire inserted about 2 cm proximal to portal 4–5 and directed slightly radially will hit the lunate on its center.

The joints to be fixed are now temporarily stabilized in the reduced position with the guidewires for the cannulated screws. In the author’s view this is the trickiest part of the whole operation, as the screws should sit in an exact position to achieve good purchase and avoid screw collision. Apart from the fluoroscopic aid it is crucial, for orientation purposes, to palpate all the bony landmarks. This task becomes a very difficult in a swollen wrist, just as when the “wet” technique is used. Three cannulated screws are used: one capitoulunate, one triquetrolunate, and the last a triquetrocapitate. The capitate-lunate screw is directed from the dorsal and distal aspect of the capitate to volar-proximal on the lunate. The triquetrum-lunate screw is directed from volarly in the triquetrum to dorsally in the lunate. The triquetrum-capitate screw is lodged in the distal-dorsal triquetrum and directed toward the distal-volar portion of the capitate. In this way each screw skips the other in a given bone. Arthroscopy can be very helpful to ascertain the correct position of the critical capitoulunate guidewire (**Fig. 10**).

The wires are slightly backed out and cancellous bone graft (harvested from the distal radius) is now inserted. An opened needle cap, working as a cannula, and the scope trocar, working as a plunger, is an inexpensive system for delivery of the bone graft inside the joint (**Fig. 11**).

Once the bone-grafting step is completed, the midcarpal joint is again reduced, and the guidewires reinserted in their previous position. A

fluoroscopic assessment is recommended. The appropriate-length screw is now inserted after drilling its canal in the usual fashion. The radiolunate K-wire is removed at this stage. The portals are closed with paper tape except for the scaphoid portal, where an intradermal stitch is used. Protected range of motion is commenced at about 2 weeks (**Fig. 12**).

## SUMMARY

Wrist arthroscopy can be performed without infusing fluid, as simple traction will suffice to maintain the working space. The lack of tissue infiltration by fluid keeps soft tissues in pristine condition if open surgery is needed after the arthroscopic exploration. The fact that the dry technique makes fluid distension irrelevant opens a new set of possibilities by combining arthroscopy with moderate-sized incisions (**Fig. 13**). Although in truth any modification of a technique with which one is familiar can be regarded with major reticence, the advantages of the dry technique merit giving it a try. Any accomplished wrist arthroscopist will have minimal problems in swapping from the wet to the dry, and vice versa.

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