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New Directions in Wrist Arthroscopy

Introduction

Despite the fact that wrist arthroscopy is still in its infancy progress in the last few years has been enormous. Some surgeons can now perform operative procedures unthinkable just a couple of years ago.

This report seeks not to go against current tides of thought, but intends to spark the minds of the Hand Surgery community to show where the restless arthroscopic minds are heading.

For this report I have asked some of the world leading arthroscopists to present their experience in some pathologies where the use of magnification, good lighting and minimal devascularization-scarring may change the outcome and prognosis. Needless to say, some of these efforts will be fruitless, whereas others will succeed and become the "standard way"….only time will tell. However, while waiting for this future to unfold, lest you miss the opportunity to be involved in this "future"….my advice is to not let the bandwagon get too far away. Jump on it now!

1. Arthroscopic Dorsal Capsuloligamentous Repair in Chronic Scapholunate Ligament Tears (Prof. Christophe Mathoulin, MD)

The rupture of the scapholunate ligament occurs most often after a fall on an outstretched hand. Arthroscopy is the most valuable tool for the diagnosis and treatment of acute scapholunate dissociation. In chronic lesions treatment options are more controversial. Most forms of treatment recommended in the literature consist of an open repair or alternative reconstruction techniques which can improve pain and grip strength, but very often lead to stiffness in the wrist joint. We have developed an arthroscopic dorsal capsuloplasty technique to avoid open dissection of the wrist capsule. In cases where the ligament is partially or completely ruptured and where the scaphoid is well-aligned or can be reduced, we propose the new technique of arthroscopic dorsal capsuloplasty which may be combined with K-wire fixation of the scapholunate and the scaphocapitate joints where the scaphoid appears to be mal-aligned. (1)

The procedures were performed on an outpatient basis. We used the standard arthroscopic 3-4 and 6R portals for the radiocarpal joint and midcarpal radial [MCR] and midcarpal ulnar [MCU] for the midcarpal joint.

Usually, the scapholunate ligament is detached from the scaphoid and remains attached to the lunate, but on the dorsal aspect, close to the normal insertion of the scapholunate ligament to the capsule, there are remaining parts of scapholunate ligament on both, the dorsal horn of lunate and the scaphoid.

A needle is inserted under visual control through the 3-4 portal but rather than penetrating the radiocarpal joint it is inserted through the dorsal capsule and used to spear the radial and ulnar remnants of the SL ligament with the needle tips coming out in the midcarpal joint. The scope is then changed to the MCU portal and a 3.0 PDS suture thread is passed through the needles and pulled out through the MCR portal with a forceps under visual control from the MCU portal (Fig. 1). A knot is tied between the two sutures. Following this, proximal traction is applied to both proximal ends of the sutures in order to place the first knot into the mid-carpal joint between the scaphoid and the lunate, volar to the dorsal part of the SL ligament (Fig. 2). A second knot is tied between the two proximal ends and introduced in the 3-4 portal incision, dorsal to the capsule. This knot lies outside the radiocarpal joint on the dorsal capsule. The net effect of this is to achieve a capsule ligamentous repair between the scapholunate ligament and the dorsal capsule overlying the ligament (Fig. 3).

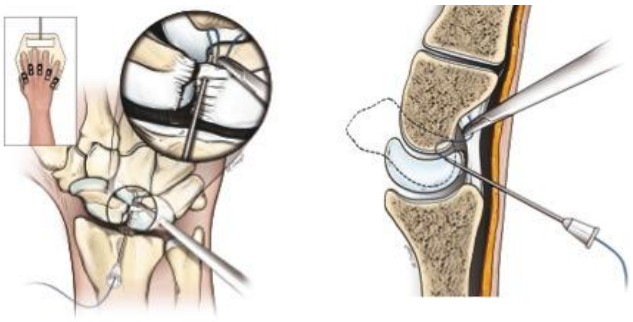


Figure 1: Schema representing an AP and lateral view of the passage of the first suture through the dorsal capsule with a remaining dorsal fragment of the scapholunate ligament attached to the dorsal horn of lunate. The passage made from the radiocarpal to midcarpal joint.

Figure 2: After a first knot is tied between the two sutures, proximal traction is applied to the both proximal ends of the sutures in order to seat the first knot into the midcarpal joint between the scaphoid and the lunate, volar to the dorsal part of SL ligament.

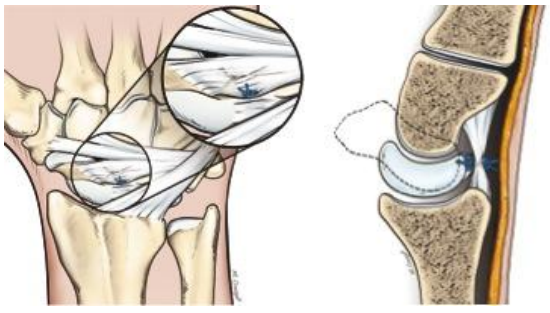


Figure 3: Schema representing an AP and lateral view of the second knot tied between the two proximal ends and introduced in the 3-4 portal incision, dorsal to the capsule. This knot lies outside the wrist joint on the dorsal capsule. The net effect of this produces a capsuloplasty between the scapholunate ligament and the dorsal capsule overlying the ligament.

Our series of 57 patients shows very encouraging preliminary results even with highly demanding patients in a short-term follow-up. Pain relief and recovery of grip strength were observed as with the other techniques. A very low incidence of post-operative wrist stiffness was noted. Post-operative improvement of mean wrist motion was observed in

all planes and all professional athletes returned to their pre-injury level of sports training and competition.

2. Update on Arthroscopic Excision of Wrist Ganglion Cysts (Lee Osterman, MD)

Arthroscopic resection of these common tumors was pioneered by Osterman and Raphael (2) and has grown in popularity in the last 20 years. The present literature supports arthroscopic excision as a first line treatment for operative treatment of all dorsal, radiocarpal volar, and recurrent ganglion cysts. Kang et al. compared arthroscopic and open dorsal ganglion excision in 72 patients and found no differences in recurrence rate or residual pain between the two treatments at 12 month follow-up (3).

Arthroscopic volar wrist ganglion excision was first described in 2003 using standard radiocarpal portals including a 1-2 portal (4). Rocchi and colleagues prospectively compared treatment of volar wrist ganglion cysts in 50 patients randomized to either open or arthroscopic excision and found comparable complication rates between open and arthroscopic excision of radiocarpal volar ganglion cysts but with a shorter functional recovery in the arthroscopic group (5).

Arthroscopic excision of wrist ganglion cysts is not without complications. Recent reports place the risk of recurrence at 0-12% and complications at 0-6%, including multiple extensor tendon lacerations. (4,6-8). A higher complication rate has been associated with arthroscopic excision of midcarpal volar ganglion cysts including recurrence rate but data is limited (5). Despite the risk of recurrence with all techniques, revision excision has shown to be effective arthroscopically. Shih et al. (9) treated 32 patients with arthroscopic dorsal ganglion excision, 5 of which had recurrent cysts after open excision, and found results comparable to open excision. Similarly Edwards and Johansen (10) prospectively followed 55 dorsal wrist ganglion cysts after arthroscopic excision, 10 of which were recurrent cysts, and found significant improvements in clinical outcomes at 6 weeks, 6 months and 2 years with no recurrences in all patients.

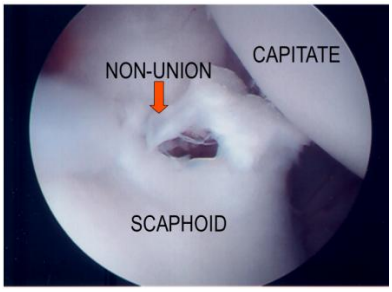
Arthroscopic excision of wrist ganglion cysts is an important treatment option for this common diagnosis. Future directions for scientific investigation include the safety and effectiveness of arthroscopy in the treatment of midcarpal volar ganglion cysts.

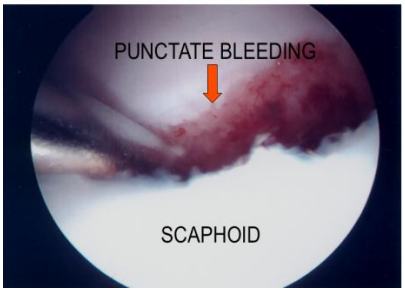
3. Arthroscopic Bone Grafting in Scaphoid Nonunion (Pc Ho, MD)

The entire intra-articular location of scaphoid nonunion allows an arthroscopic approach for both evaluation and therapeutic intervention with maximal preservation of blood supply and ligamentous architecture and hence favours union and functional restoration. We present the technique developed in our center since April 1997 and discuss the long-term outcomes and indications (11).

Fifty-six established symptomatic nonunion and 12 delayed union cases were operated between April 1997 and November 2009. There were 64 male and 4 female, with an average age of 27.5 (ranged 14-53). The median duration of symptoms was 8 months (ranged 1- 276 months). Radiologically, there were 10 distal third, 30 mid-third and 28 proximal third fractures. Twenty cases had DISI deformity.

Evaluation started at the radiocarpal joint arthroscopy to check for any SNAC wrist changes and concomitant ligament lesions. Stage 1 SNAC wrist could be managed by arthroscopic radial styloidectomy. The standard repair procedure included a take-down of the nonunion site at the midcarpal joint with motorized burr till healthy cancellous bone was encountered (Fig. 4). Tourniquet was not inflated so that vascularity of both fragments could be appreciated critically (Fig. 5). DISI deformity could be corrected by closed Linscheid manoeuvre under fluoroscopic guidance. The fracture was then transfixed with a single K wire inserted percutaneously at the scaphoid tubercle. Cancellous chip graft harvested from the iliac crest was delivered and densely packed into the fracture site through 4mm arthroscopic cannula. We considered bone graft from distal radius as inadequate. Fibrin glue was injected at the end to stabilize the bone graft and to protect the articular surface (Fig. 6). Fixation was completed either by inserting 2 additional K wires (42 cases) or with cannulated screw (26 cases). Wounds were apposed with steri-strips. Early active mobilization was initiated two weeks after the procedure. Buried K wires were removed under local anaesthesia when union was evidenced.





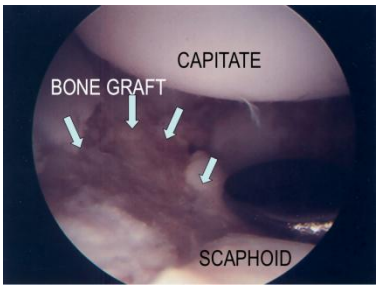


Fig 4 (left): Nonunion site located by the disruption of articular cartilage and fibrous tissue interposition.

Fig. 5 (centre): Both ends of nonunion site burred till healthy looking cancellous bone with punctate bleeding is seen.

Fig. 6 (right): The bone graft has been delivered to the nonunion site through an arthroscopic cannula and impacted. A small depressor is employed to mold the graft into contour of the articular surface of the scaphoid.

At final follow up, all patients were evaluated radiologically on union status, carpal alignment, arthritic changes and clinically with regard to pain, motion, grip power and complications.

The average follow up was 39.5 months (range 5-125 months). Overall union rate was 92.7% (63/68). The average radiological union time was 12 weeks (6-39 weeks). While

good bleeding from the proximal scaphoid fragment predicted union in 40 out of 42 cases (95.2%), unsatisfactory bleeding still permitted union in 16 out of 19 cases (84.2%) Complications were few. There was no pain in 53 patients while the average pain score according to a visual analog scale in the remaining was 1.8. There was significant improvement in ADL performance score, ADL pain score, exertion pain and grip power ($p<0.05$). The average scapholunate angle was 62.3° and AP intra-scaphoid angle was 34.5°.

With minimal surgical insult to the blood supply of the carpal bones and their ligamentous connections, arthroscopic bone graft provides a more favourable biological environment for the nonunion to repair with a shorter time of rehabilitation. A high union rate is uniform at 92.7% and the clinical outcome is satisfactory. Avascular necrosis is not a contraindication as a union rate of 84.2% can be expected and compares favorably to other techniques. DISI and humpback deformity can be corrected and tackled. Therefore arthroscopic bone grafting represents a significant breakthrough in arthroscopic surgery of the wrist.

4. Arthroscopic Assisted Fixation of Distal Radius Fractures and Malunions (David J. Slutsky, MD)

Doi and coworkers (12) performed a prospective study comparing 34 intra-articular distal radius fractures treated with arthroscopic reduction, pinning (ARIF) and external fixation vs. 48 fractures treated with open plate fixation (ORIF) or with pinning ± external fixation. At an average follow-up of 31 months, the ARIF group had significantly better ranges of flexion-extension, radial-ulnar deviation and grip strength ($p<0.05$). Radiographically, the ARIF group had better reduction of volar tilt, ulnar variance, and articular gap reduction. Ruch et al (13) compared the functional and radiologic outcomes of arthroscopically assisted (AA) percutaneous pinning and external fixation versus fluoroscopically assisted (FA) pinning and external fixation of 30 patients with comminuted intra-articular distal radius fractures. Patients who underwent AA surgery had significantly improved supination compared with those who underwent FA surgery (88° vs 73°) AA reduction also resulted in improved wrist extension (77° vs 69°) and wrist flexion (78° s. 59°). Varitidimis et al performed a randomized prospective study comparing 20 patients with intra-articular fractures of the distal radius who underwent AA and FA reduction and external fixation plus percutaneous pinning vs 20 patients with the same fracture characteristics who underwent FA reduction alone and external fixation plus percutaneous pinning (14). At 24 months the patients who underwent AA and FA treatment had significantly better supination, extension and flexion though the mean DASH scores were similar for both groups.

The AAOS clinical guidelines on Distal Radius Fractures considers the use of the arthroscope in distal radius fractures, as yet, has only weak evidence to support its use.

Malunion of the radius articular surface can be also approached under arthroscopic guidance. The main benefit is the feasibility of performing the cut through the original fracture line with minimal devascularization and scarring (Fig. 7). Good results have been reported in a small cohort of patients (15). Under certain circumstances some patients may benefit from minimal intervention by smoothing out irregularities under arthroscopic guidance with promising results (16)

Fig. 7: Left - Correction of a 4 mm step-off on the lunate fossa (right wrist scope in 6R).
Centre - The osteotome (entering the joint through a dorsal portal) is separating the malunited fragments.
Right - Corresponding view after reduction. (© Dr Piñal, 2010).

5. TFCC Reconstruction and Reinsertion (Andrea Atzei, MD)

Since the early 90's, wrist arthroscopy has been considered the gold standard for the diagnosis of TFCC peripheral tears and it has been proven to be beneficial to repair edges of the tear to the dorsoulnar wrist capsule or ECU tendon sheath. However, it was generally agreed that arthroscopic treatment was not appropriate when a TFCC peripheral tear was associated with DRUJ instability and/or when the TFCC was not repairable. Thus, these conditions were usually treated by open surgery. Refinements in arthroscopic diagnosis and surgical technique have permitted us to overcome these limitations and perform an "all-arthroscopic" treatment of the TFCC peripheral tear even when associated with DRUJ instability.

Diagnostic accuracy of TFCC tears has improved dramatically with the introduction of the Hook Test (or TFCC pulling test). The test consists of using the probe to pull the ulnar-most border of the TFCC towards the center of the radiocarpal joint, in order to confirm foveal disruption of the TFCC. The high reliability of the hook test has reduced the need for DRUJ arthroscopy for direct visualization of the proximal TFCC rupture or avulsion. The combination of arthroscopic and clinical findings allows a more detailed classification of TFCC peripheral tears that serves also as a treatment-oriented algorithm [17]. Isolated distal TFCC tear (Class 1) is repaired by simple ligament-to-capsule suture, since the foveal origins of the TFCC are intact. Complete, repairable TFCC tears (Class 2) and isolated foveal, repairable tears (Class 3) are associated with

DRUJ instability and require reinsertion of the TFCC onto the ulnar head. Irreparable foveal disruption (Class 4) requires TFCC reconstruction by tendon graft. Presence of DRUJ arthritis defines Class 5 TFFC tears, which should be treated by DRUJ arthroplasty, and presence of the different types of styloid fractures allows further sub-classification [18]. Arthroscopic repair of foveal avulsions has become possible with technical refinements of DRUJ arthroscopy and the use of the DF (Direct Foveal) portal. Through the DF portal, eventually enlarged to a limited open approach, it is possible to debride the proximal TFCC, refresh and drill the fovea ulnaris in order to introduce a four-strand bone anchor/screw (Fig. 8). Arthroscopic view allows precise positioning of one suture (two strands) through the palmar DRUJ ligament and the other suture for the dorsal DRUJ ligament. In a series of 18 patients with a minimum follow-up of 1 year, the Modified Mayo Wrist score was excellent in 14 patients, good in 3 and fair in 1. The DASH score showed 94.4% excellent and good results [19].

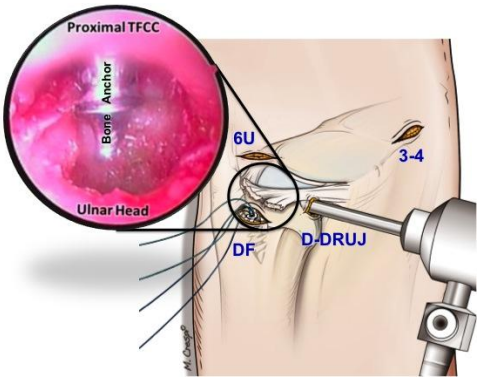


Fig. 8. Foveal refixation of proximal TFCC avulsion. With the scope in D-DRUJ portal, the suture screw is inserted into the fovea through the DF portal.

Arthroscopic Reconstruction of DRUJ Ligaments using a tendon graft has also achieved a widespread acceptance and use. The arthroscopic technique [20] is a modification of the open procedure originally described by Michel Mansat and popularized by Bryan D Adams. The advantages of the new technique are not only related to the limited skin incisions (with consequent reduced pain and scar and faster postoperative rehabilitation), but also to the possibility of performing a more anatomic reconstruction of the TFCC, including retensioning of the ulnocarpal ligaments. Under arthroscopic guidance it is possible to introduce the graft through a small opening between the ulnocarpal ligaments, just distal to the palmar DRUJ ligament, to improve stability of the palmar side of the TFCC (Fig. 9). This technique was used in 11 patients and showed excellent to good results according to the Modified Mayo Wrist Score and DASH score in all patients [20].

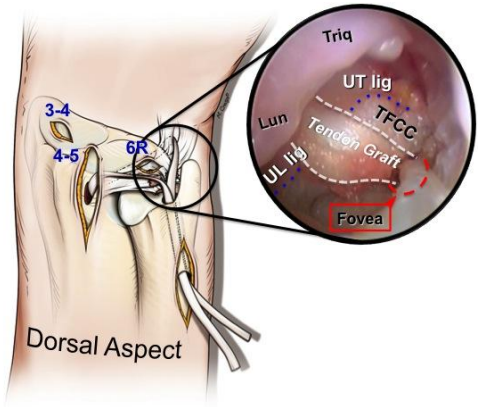


Fig. 9. Arthroscopic reconstruction of irreparable TFCC tear. The palmar limb of the tendon graft is to introduced between the ulnolunate and ulnotriquetral ligaments, just distal to the TFCC, then enters the foveal tunnel.

6. Arthroscopic Arthrodesis (F Del Piñal)

The feasibility of performing intercarpal or radiocarpal arthrodesis arthroscopically was presented by Ho in a pioneering work (21). It may be considered by the sceptical as just another arthroscopic filigree. However, the procedure is sound, not only because there will be a cosmetic benefit, but above all, in my view, because the degree of insult to the ligaments will be minimized. Ligament preservation will keep the blood supply to the bones intact and with less scarring to the capsule. This, in turn, promotes bony healing and less stiffness respectively. Furthermore, the proprioception of the wrist will be undisturbed providing (in theory) some extra protection to the joint.

However, performing this procedure with classic "wet" arthroscopy has the disadvantages of a long operating time (more than 3 hours), massive swelling, and difficulty with bone graft placement (21). Implementation of the technique was difficult, yet the advantages were undisputed. We have endorsed the dry arthroscopy technique (arthroscopy without infusing saline) (22). It is particularly useful in complex operations such as distal radius fixations and in any semi-open operation such as four corner arthrodesis. With this technique, most of the difficulties mentioned for the wet A-4CA as described by Ho (21) are circumvented, and the operation can be carried out in a competitive time: less than one tourniquet time (23). The critical steps of the operation can be summarized as follows: 1) A larger SL portal (Fig. 10) allows for introduction of pituitary rongeurs to remove in an expeditious way the scaphoid (Fig. 11). Moreover, with the rongeur technique, the cancellous bone is preserved for bone graft. 2) When inserting cancellous bone graft, it is placed at the arthrodesis site and does not migrate with the infusion fluid throughout the rest of the wrist. Furthermore, the use of a large bore drill guide allows quick and easy placement of the bone graft in the midcarpal space. 3) Fixation is by using a triangular construct with cannulated screws (Fig. 12). Without the infusion of fluid, distortion of bony landmarks does not occur and the surgeon can feel the bony landmarks, making this critical step of placement of the guidewires and cannulated screws, much easier. After the operation immobilization for 3-4 weeks is recommended.

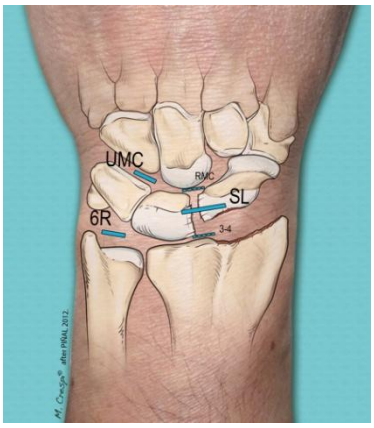


Figure 10 (left): The SL portal is located midway between the 3-4 and radial midcarpal portals. (Key: SL: scapholunate portal, RMC: radial midcarpal; UMC: ulnar midcarpal) (ref 23).

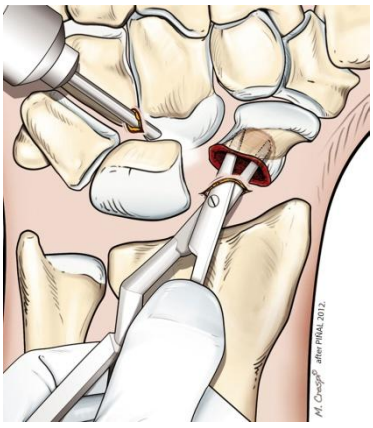


Fig. 11 (right): The process of scaphoid resection with a rongeur. With the scope in UMC the surgeon scoops out the middle third of the scaphoid with the rongeur. (ref 23).

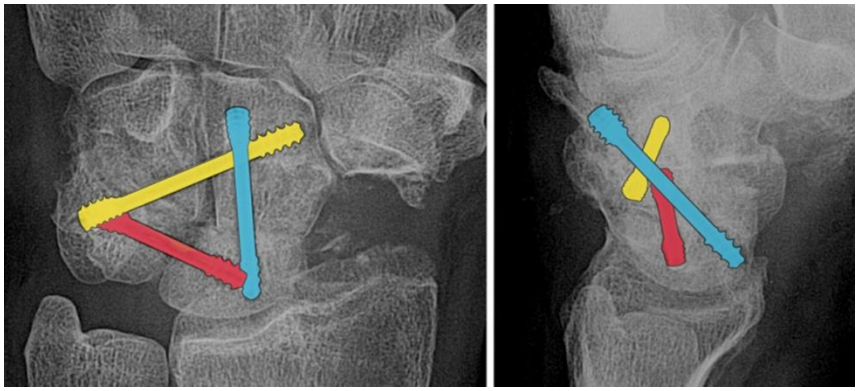


Fig. 12: Ideal position of the screws to avoid collision and provide maximal purchase. (ref 23).

Our experience is limited to 16 cases of four corner arthrodesis and several others of different fusions (mainly radioscapholunate arthrodesis). We have been very satisfied with the early results, and only have had problems with union in one case where immediate range of motion was permitted.

Remarks and Conclusions

The aim of this report is not to claim that results are any better than with the open approach but that arthroscopy assisted procedures are conceptually appealing and feasible in a competitive time. Most of the procedures discussed in this report rank among the most difficult operations one can perform arthroscopically, and some of them have a steep learning curve even for skilled arthroscopists. Nevertheless, the possibility of performing complex procedures through minimally invasive surgery represents the future of wrist surgery and the direction in which we should head.

It is of justice to stress that there are many more surgeons doing stunning work that have been left out of this report due to space limitations, but whose quality would have deserved their presence here. I have to highlight some of the investigation lines that without a doubt will have an impact on the future: Park et al. (24, 25) are presenting outstanding results in the management of complex carpal injuries. Also a word is needed to emphasize the work of Badia (26, 27) in the development of techniques for the trapeziometacarpal joint, and Cobb and others (28) in the expansion to small joint arthroscopy. Finally, some groups are working now under local anaesthesia, minimizing expenses and morbidity (29).

Although the future is already here in many respects, beyond doubt there will be much more to come. I foresee an enormous expansion by the combination of arthroscopy and mini-open approaches (30) benefiting from both the accuracy of direct vision with magnification and the minimal scarring. To make this combination smooth and easy, in my view we should master the dry technique, as this avoids the problem of swelling and constant loss of vision due to water escaping through the large portals (22). But no doubt each surgeon can master different ways of doing things and achieve similar results.

In conclusion, arthroscopy is allowing us to perform complicated surgery without the need to create scarring by our surgical approaches. The forefront techniques that have been discussed here are based on the work of others. We stand in the shoulders of giants: Whipple, Poehling, Geissler, Luchetti, Nakamura, all the contributors of this report and so many others surgeons that I have not mentioned. Without their dedication and hard work, wrist arthroscopy would not be where it is today. This report is dedicated to all of them.

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