Arthroscopic Ligamentoplasty of the Dorsal and Volar Portions of the Scapholunate Ligament

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Classical arthroscopic techniques for scapholunate instability consist of debridement, thermal shrinkage, and percutaneous pinning. Good results are obtained in acute lesions or in chronic partial tears, but they are less predictable when the lesion is complete, because of the poor healing capacity of the scapholunate ligament and because it is not possible to perform an anatomic ligamentous reconstruction with these techniques. Open techniques are thus required for reconstruction, but they damage the soft tissues. We recently published a description and cadaver study of an arthroscopic ligamentoplasty, trying to combine the advantages of arthroscopic techniques (minimally invasive surgery) and open techniques (reconstruction of the ligament). With this approach, it is possible to reconstruct the dorsal scapholunate ligament and the secondary stabilizers while causing minimal damage to the soft tissues and avoiding injury to the posterior interosseous nerve and detachment of the dorsal intercarpal ligament. The current report describes an additional step to this technique with which it is possible to reconstruct the volar portion of the scapholunate ligament. We also describe an early mobilization postoperative protocol that we believe is equally important. *(J Hand Surg Am. 2013;38(12):2466–2477. Copyright © 2013 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Scapholunate instability, arthroscopic ligamentoplasty, scapholunate ligament, wrist arthroscopy.

To date, there are 2 possible ways to treat scapholunate instability: arthroscopic surgery and open surgery.

Classical arthroscopic surgery consists of debridement, thermal shrinkage, and temporary Kirschner wire pinning of the scaphoid and lunate.[1] The results are satisfactory for acute lesions[2] or partially chronic lesions,[3–5] but they are less effective when the ligamentous lesion is complete and chronic.[6]

A wide variety of open techniques such as capsulodesis, tenodesis, and bone–ligament–bone reconstructions have been described to perform ligamentous reconstruction.[1,7,8] All of these techniques require a wide dorsal approach, which results in considerable damage to the soft tissues and often a reduction in articular mobility with stiffness.

To perform a ligamentous reconstruction that minimizes damage to the soft tissues, we recently published a technique and a cadaver study of an arthroscopic ligamentoplasty to reconstruct the dorsal scapholunate ligament.[9]

In the following report, we present a modified version of this technique with which it is also possible to reconstruct the volar portion of the scapholunate ligament and an early mobilization postoperative protocol.

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INDICATIONS

The absolute indication is a complete tear of the scapholunate ligament without misalignment of the carpus: in other words, dynamic scapholunate instability. Arthroscopic evaluation of the patient should reveal a grade 3 lesion.

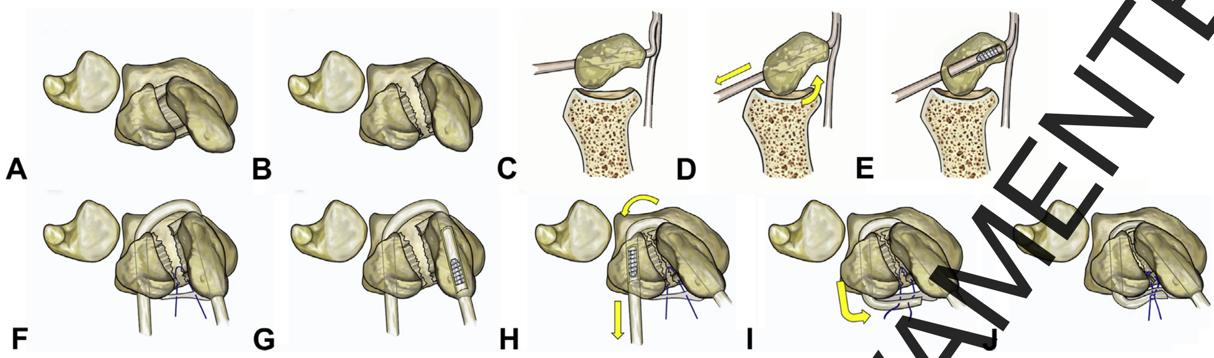

FIGURE 1: **A**, **B** With a scapholunate ligament tear, the scaphoid flexes and pronates. **C**–**E** When the graft is passed through the scaphoid tunnel and tensioned, the scaphoid extends. **F**–**H** When the graft is passed through the lunate tunnel, the scaphoid supinates, avoiding the impaction at the dorsal margin of the radius. **I**, **J** Volar fixation prevents volar opening and movement in a sagittal plane.

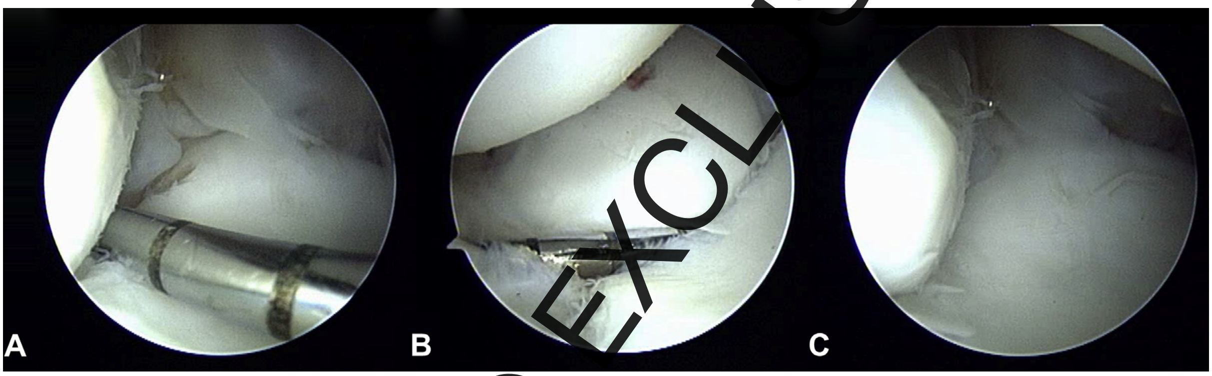

FIGURE 2: Arthroscopic evaluation of patient. **A** View from the radial midcarpal portal: the probe enters easily and twists between the scaphoid and the lunate. **B** View from the ulnar midcarpal portal: the probe enters through the 3-4 portal and twists easily between the bones. **C** View from the radial midcarpal portal: marked gap between scaphoid and lunate.

Another indication would be static but very easily reducible instability.[10]

Not easily reducible instability, lunotriquetral instability, and ulnar translocation of the lunate are contraindications for the technique.

JUSTIFICATION AND SURGICAL ANATOMY

We described an arthroscopic ligamentous reconstruction that attempted to combine the advantages of arthroscopic techniques (minimally invasive surgery) and open techniques (reconstruction of the ligament).[9] We conducted a cadaver study and demonstrated that it is a minimally invasive technique with much less damage to the soft tissues. Damage to the posterior interosseous nerve is avoided, so the proprioception of the carpus is preserved and the dorsal dynamic ligament stabilizers are also preserved.[11] The dorsal intercarpal ligament is not detached, so the ligament that may result in a dynamic instability evolving into a static one is preserved.[12,13]

Modification of the technique previously presented makes it possible to reconstruct the volar portion of the scapholunate ligament simply by adding a few steps to the original technique, which are performed through the same incisions.

As Short et al[14,15] demonstrated, in cases of scapholunate instability, the scaphoid bone flexes and pronates, producing a conflict at the dorsal margin of the radius. By passing the graft through the scaphoid tunnel and tensioning it from dorsal, this makes the scaphoid extend, correcting its flexion, and passing the graft through the lunate tunnel and tensioning it from volar makes it supinate, correcting its pronation and avoiding the conflict at the dorsal margin of the radius (Fig. 1).

Few publications have paid attention to the volar reconstruction.[16–19] Like the one previously described by the authors,[9] most modern reconstructive techniques only reconstruct the dorsal area, because it is the most robust and has the most mechanical resilience.[20] However, an exclusively dorsal reconstruction results in only 1 junction point

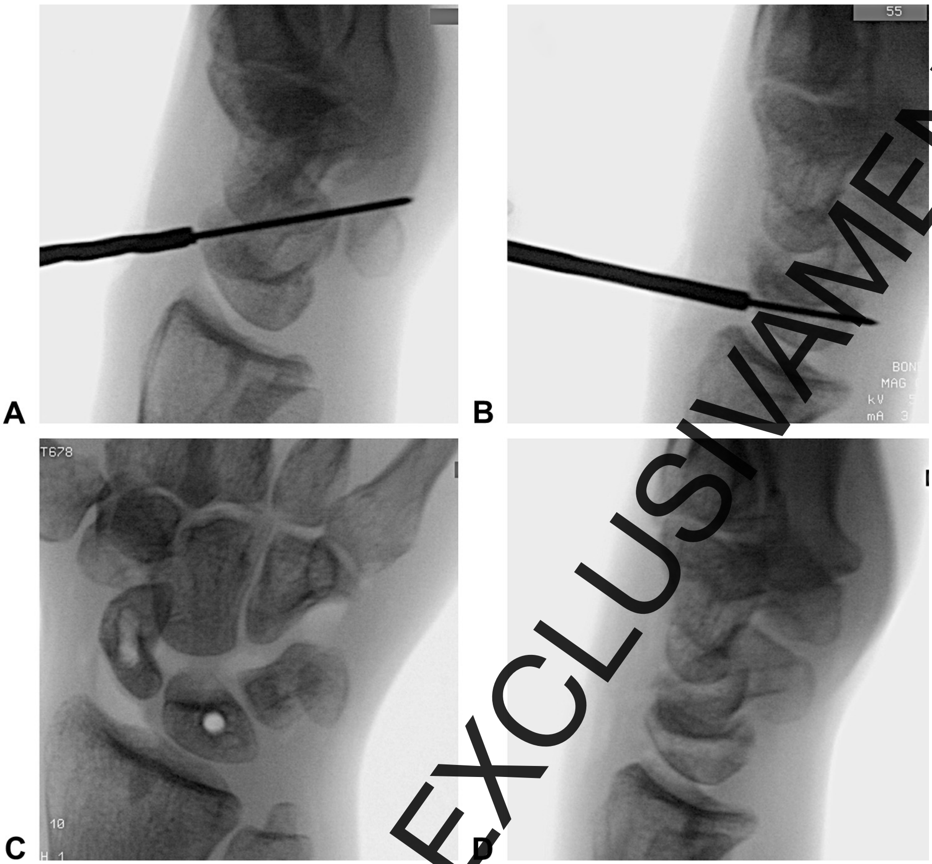

FIGURE 3: **A** Tunnel in scaphoid bone using a Kirschner wire and a 3-mm cannulated drill. **B** Tunnel in lunate using a Kirschner wire and a 3-mm cannulated drill. **C** Appearance of bone tunnels on the posteroanterior radiograph. **D** Appearance of bone tunnels on lateral radiograph.

between the 2 bones, and consequently, it is not possible to avoid volar opening and rotation in the sagittal plane.

The open volar technique is technically complicated and requires a dual approach, which results in more damage to the soft tissues. However, under arthroscopic control there is minimal damage to the soft tissues and it adds little complexity to that of arthroscopic dorsal ligamentoplasty alone (Fig. 1).

SURGICAL TECHNIQUE

Standard arthroscopy

A standard arthroscopy via the dorsal radiocarpal portals (3-4 and 6-R) and the radial midcarpal and ulnar midcarpal portals is performed. The state of the articular surfaces, the associated lesions that might also be present, and the degree of scapholunate instability[21] are evaluated (Fig. 2).

Bone tunnels in the scaphoid and lunate

A 1-mm Kirschner wire is introduced through the 3-4 portal. The entry point in the scaphoid is the insertion of the dorsal portion of the scapholunate ligament, and the exit point, the scaphoid tubercle. The tunnel is created with a 3-mm cannulated drill bit (Fig. 3).

The lunate tunnel is also created with a 3-mm cannulated drill bit. It is performed in the dorsal and medial region of the lunate, parallel to its articular surface (Fig. 3). The insertion point usually corresponds to the most ulnar portion of the fourth compartment; therefore, a 1.5- to 2-cm longitudinal cutaneous incision is performed, the extensor retinaculum is opened longitudinally, and the tendons of the fourth compartment are retracted toward the radial side, exposing the articular capsule (Fig. 4).

Preparation of dorsal area for recovering graft

The arthroscope is introduced through the 6-R portal and a portal is created uniting the entrance of the lunate tunnel with the radiocarpal joint. A Curved SutureLasso (Arthrex, Naples, FL) is then introduced through this portal, and the loop is retrieved from the 3–4 portal (Fig. 5).

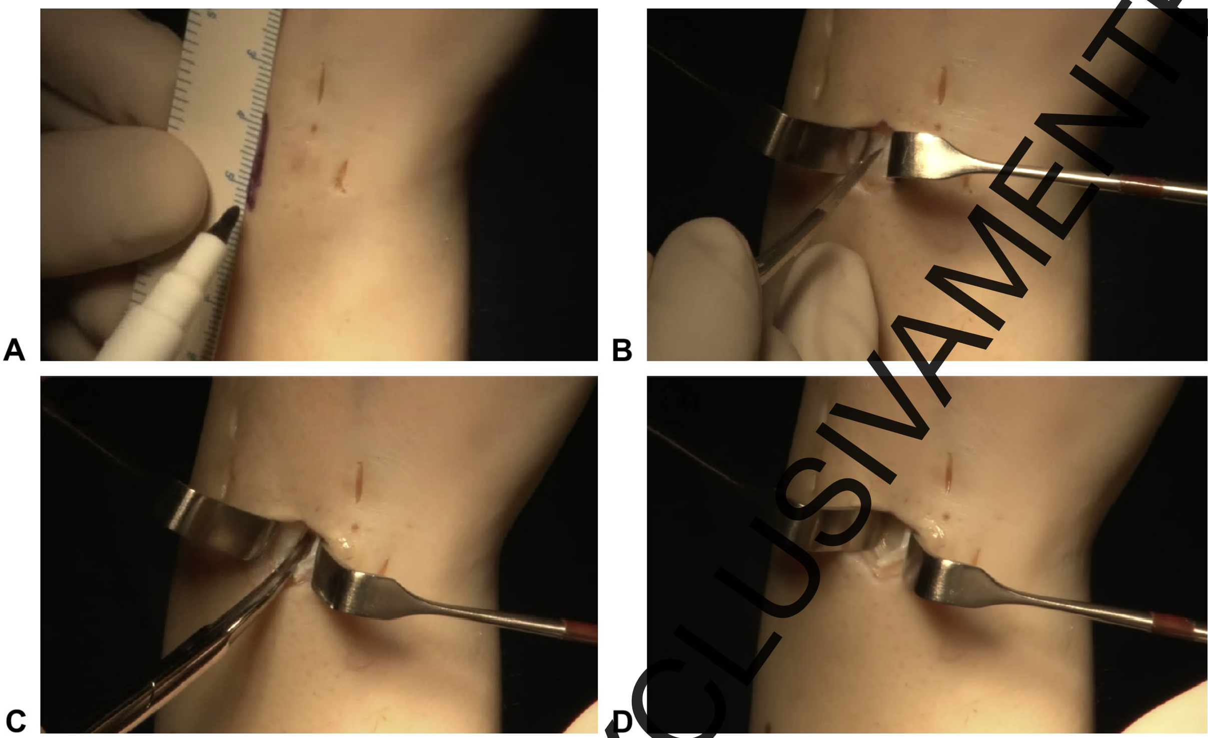

FIGURE 4: **A** The 1.5-cm incision is centered over the lunate. **B** The extensor retinaculum is opened longitudinally. **C** The tendons of the fourth compartment are retracted toward the radial side. **D** Exposure of the articular capsule.

Harvesting flexor carpi radialis graft

The graft is a hemi-tendon 3 mm in width and 8 to 10 cm in length from the radial half of the flexor carpi radialis. It is harvested via 2 incisions. The first extends from the scaphoid tunnel exit and the second is a transverse incision 8 to 10 cm proximally. It is important to dissect the graft distal to the scaphoid tunnel because otherwise, when it is tensioned, the graft will flex the scaphoid instead of extending.

Graft passage along tunnels and fixation

A Straight SutureLasso is passed through the scaphoid tunnel and the graft is captured and retrieved through the 3-4 portal. When the graft is tensioned, the scaphoid extends, and then the first 3 × 8-mm biotenodesis screw (Arthrex) is placed at the volar exit of the scaphoid tunnel (Fig. 6).

The graft is captured with the loop previously introduced and is then taken to the incision over the lunate (Fig. 7).

To pass the graft through the lunate tunnel, it is necessary to create a portal, which we have called the "volar central portal." This portal is similar to the ulnar volar radiocarpal portal,[22] but with 2 differences: The incision is more radial (centered at the radial side of the fourth metacarpal) and instead of separating all the deep flexor tendons to the radial side, the tendons to ring and little fingers are retracted toward the ulnar side. In this way, the portal is centered on the lunate (Fig. 8).

A second Straight SutureLasso is introduced through the lunate tunnel and the graft is retrieved and taken out through the central volar portal (Fig. 7).

With the arthroscope in the midcarpal joint, we verify how the scapholunate gap closes when the graft is tensioned. It is important to release the traction from the arthroscopy tower so that it is easier to reduce the diastasis. The second screw is then introduced at the dorsal entrance of the lunate tunnel with the graft tensioned from volar (Fig. 9).

Capsuloligamentous suture of volar portion of scapholunate ligament, passage of graft, and suturing

A volar capsuloligamentous suture, described by del Piñal et al,[23] is performed with the arthroscope in the ulnar midcarpal portal; but unlike with the original technique, we make the suture from outside to inside with a 2-0 FiberStick Suture (Arthrex). The threads are introduced medial to the flexor carpi radialis through the proximal incision used for harvesting the graft (Fig. 10).

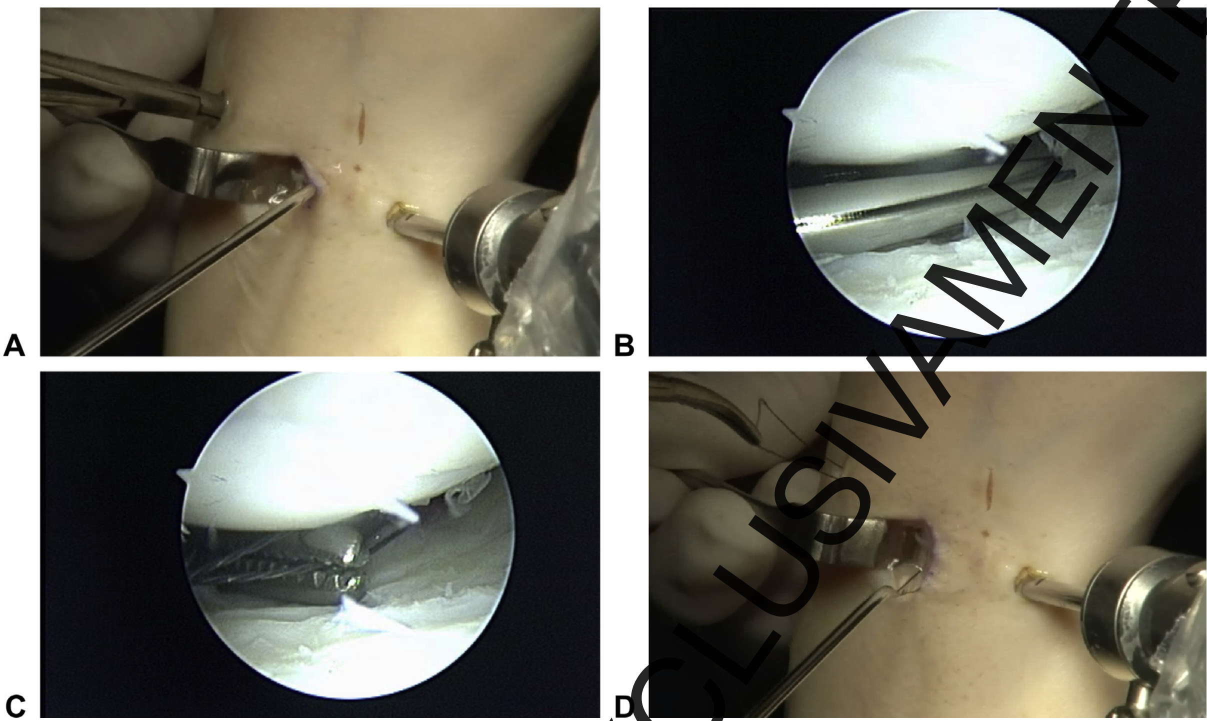

FIGURE 5: **A** A portal is created, uniting the entrance of the lunate tunnel with the radiocarpal joint. A Curved SutureLasso (Arthrex, Naples, FL) is introduced through this portal, while the arthroscope is located in the 6R portal. **B** Arthroscopic view of the Curved SutureLasso from the 6R portal. **C** The loop is captured with a grasper introduced through the 3/4 portal. **D** The loop is taken to the 3/4 portal.

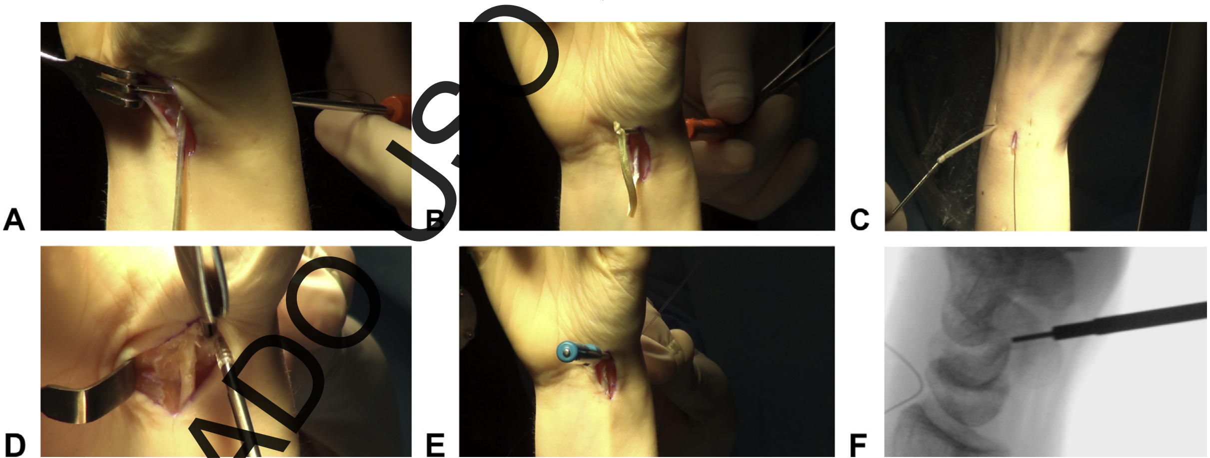

FIGURE 6: **A** The straight SutureLasso enters through the 3-4 portal into the scaphoid tunnel. **B** The graft is retrieved. **C** It is taken out through the 3-4 portal. **D** The first biotenodesis screw is placed at the volar exit of the scaphoid tunnel. **E** The screw is introduced while maintaining the tension on the graft from the dorsum. **F** Radiographic assessment.

The volar passage of the graft is similar to that performed dorsally. A curved SutureLasso is introduced through a volar radiocarpal portal just proximal to the capsuloligamentous suture. An incision of the volar capsule is performed through the volar central portal and should connect the radiocarpal joint with the lunate tunnel to pass the graft. The loop is retrieved from this incision (Fig. 11).

These steps can also be done before the second screw fixes the graft, because it can be difficult to perform these steps without traction.

The graft is introduced into the loop and taken to the portal proximal to the capsuloligamentous suture.

Next, the graft is tensioned to the radial side, which closes the volar scapholunate gap, and is tied with capsuloligamentous sutures (Fig. 12).

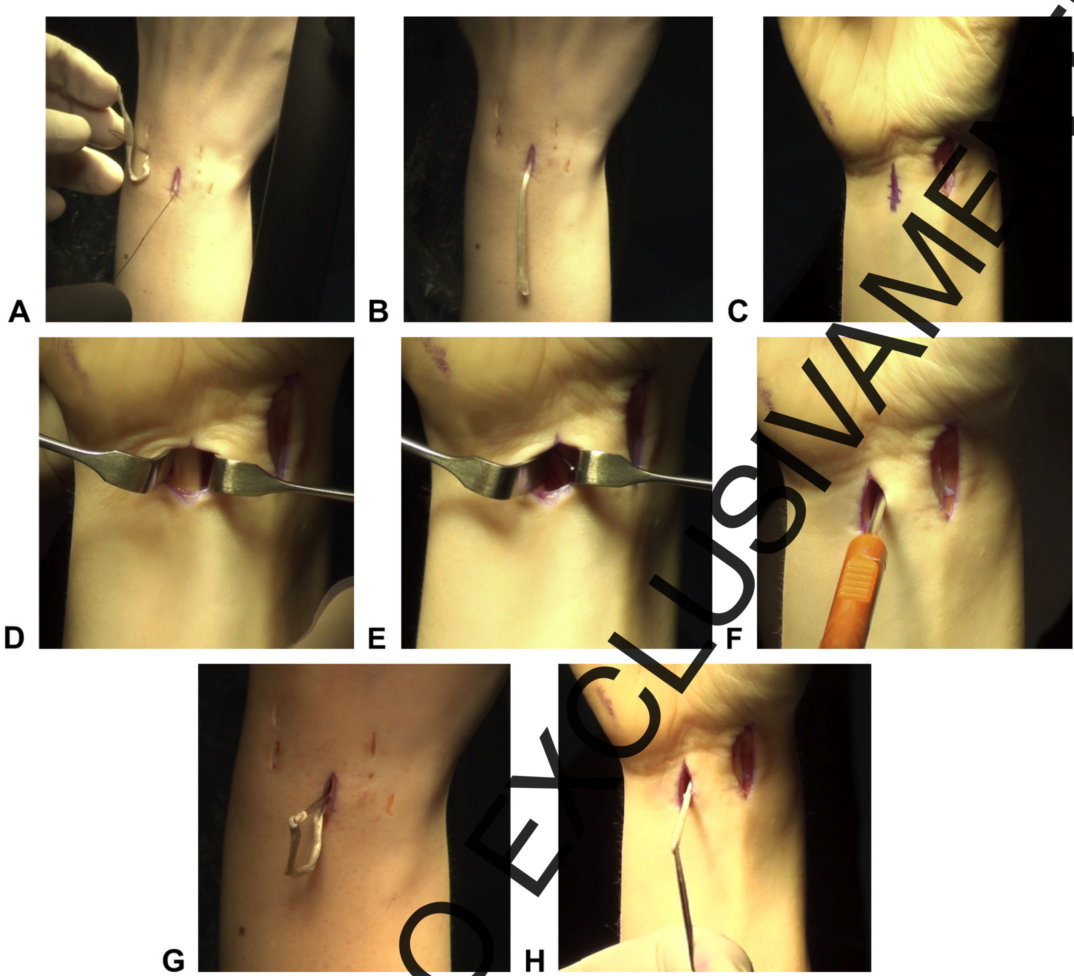

FIGURE 7: **A**, **B** The graft is captured with the loop previously introduced and is then taken to the incision over the lunate. **C**, **D** The volar central portal is created. **E** The wire is introduced from dorsal to volar. **F** Following the wire, a straight SutureLasso is introduced. **G**, **H** The graft is captured and taken to the volar central portal.

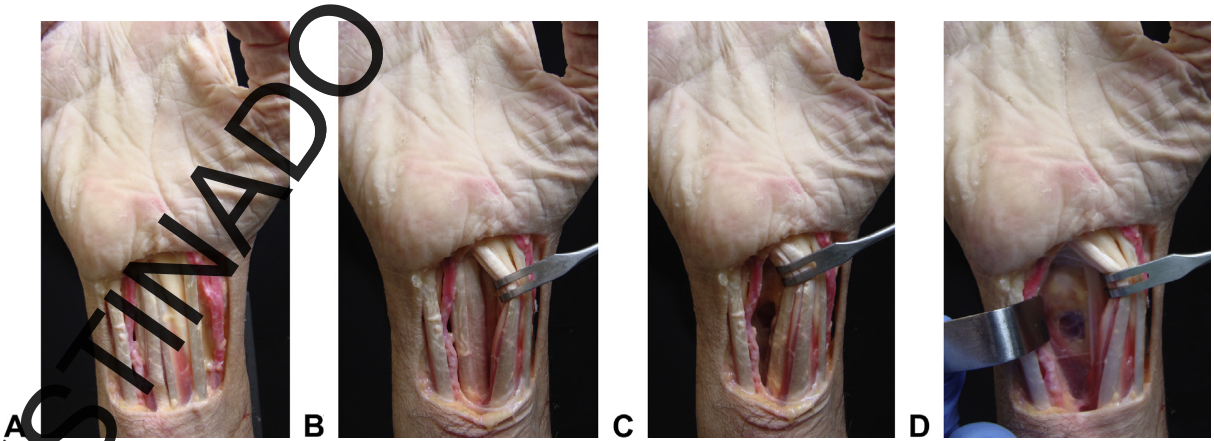

FIGURE 8: **A** Volar anatomic dissection. **B** While performing both the ulnar volar portal and the central volar portal, the superficial flexor tendons are retracted toward the radial side. **C** Volar ulnar portal: the deep flexor tendons are retracted to the radial side together with the superficial ones. **D** Volar central portal: the deep flexors of the ring and little fingers are retracted to ulnar side, and the rest radially. The portal is centered on the lunate, protecting the median nerve and the ulnar neurovascular bundle.

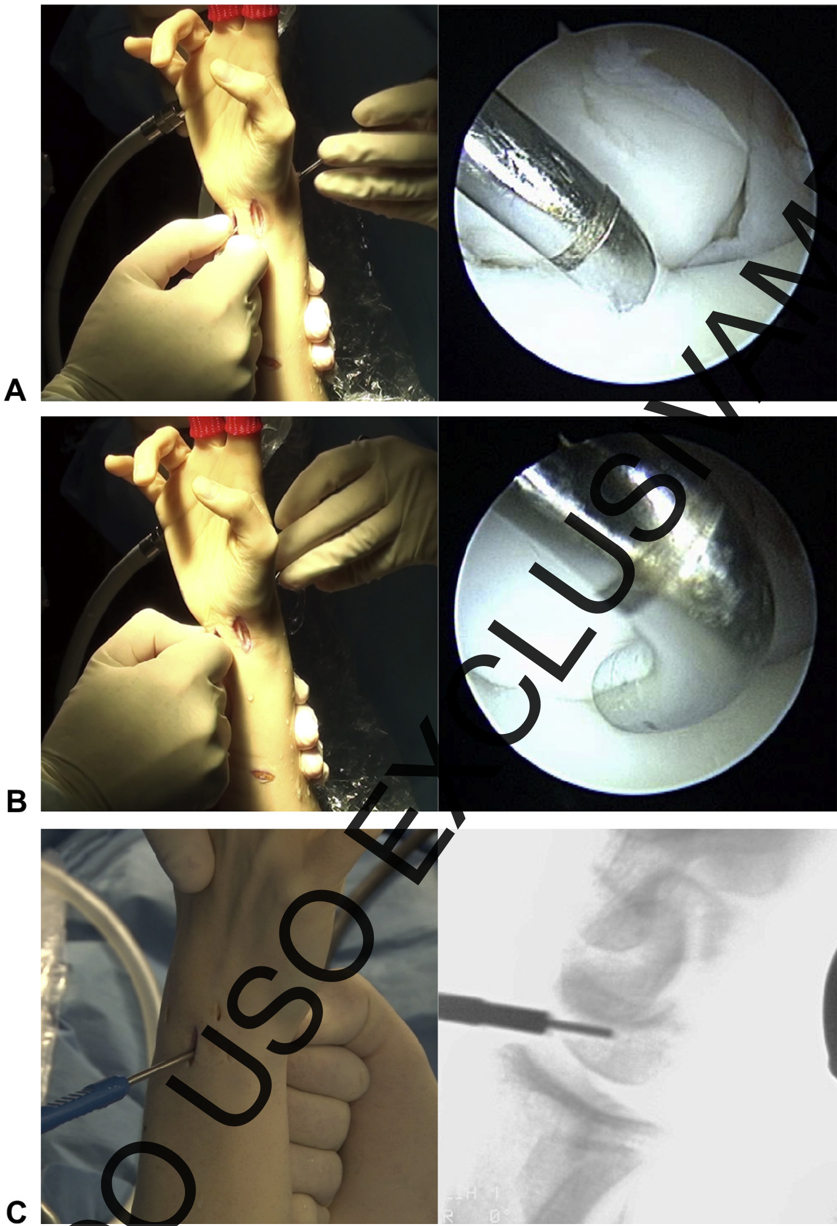

FIGURE 9: **A** With traction removed, the probe can pass and twist between the bones. **B** When the graft is tensioned, the gap closes and the probe can no longer enter the gap. **C** While maintaining tension on the graft, the second screw is positioned in the lunate tunnel.

POSTOPERATIVE MANAGEMENT

We feel believe it is important to initiate an early mobilization protocol to achieve full wrist motion. The fact that the graft is fixed with interference screws enables early mobilization without the use of Kirschner wires. In addition, beginning with a dart-thrower's motion avoids overloading the graft. This motion principally involves the midcarpal joint with practically no movement in the proximal carpal row[24,25] and induces minimal elongation and tension on the scapholunate ligament.[26]

The postoperative mobilization protocol is as follows (Fig. 13):

Immediately postoperatively, the wrist is immobilized with a dorsal splint and the patient begins with immediate finger motion.

At 2 weeks, the splint is removed and the patient practices the dart-thrower's motion for 30 minutes, 4 times a day. For the rest of the time and at night, the patient wears a thermoplastic splint.

At 4 weeks, the patient starts a complete range of wrist movements (flexion, extension, ulnar, and radial

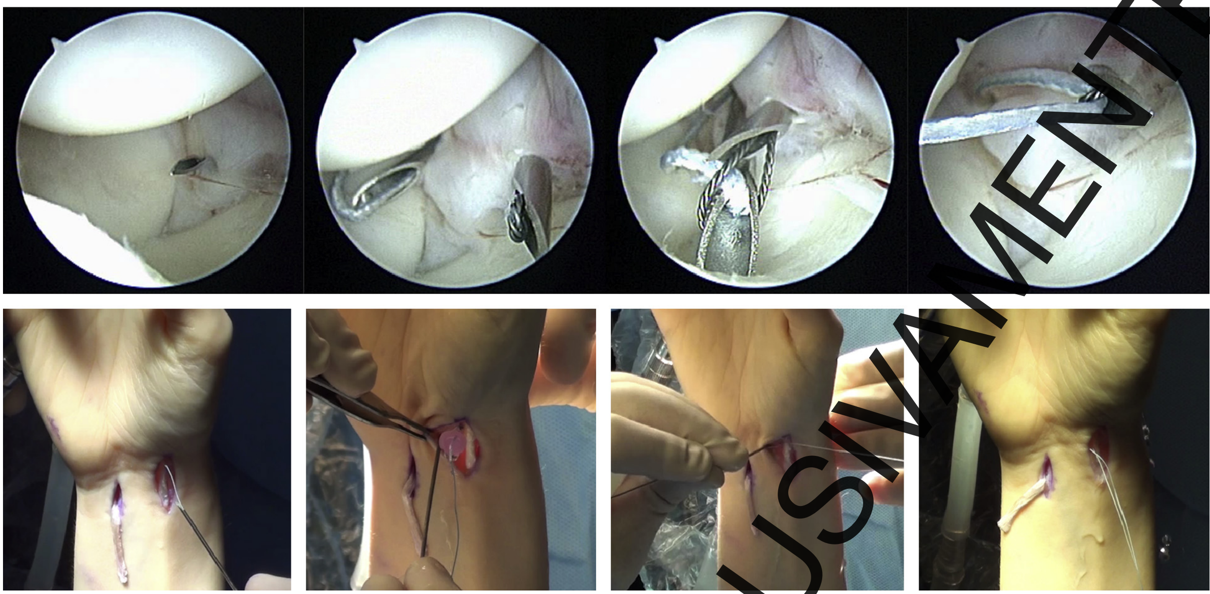

FIGURE 10: Volar capsuloligamentous suture performed through the incision used for harvesting the graft, medial to the flexor carpi radialis tendon.

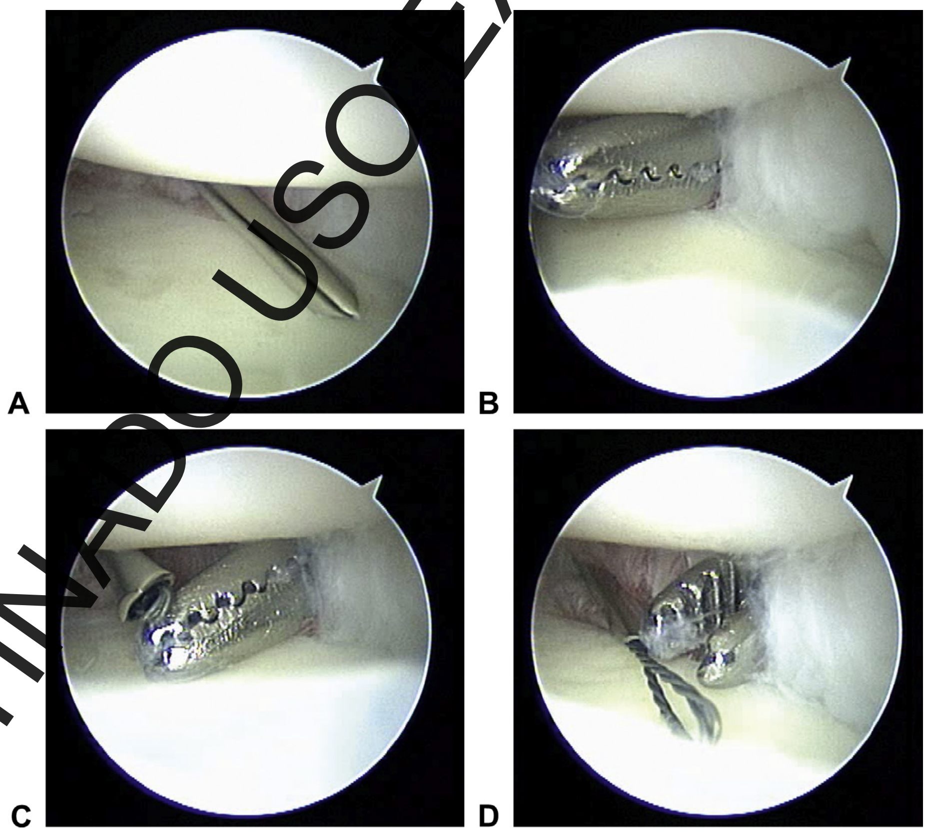

FIGURE 11: **A** SutureLasso entering the radiocarpal joint through a portal just proximal to the capsuloligamentous suture. **B** Grasping forceps entering through the volar central portal. **C**, **D** The loop is captured and taken to the volar central portal.

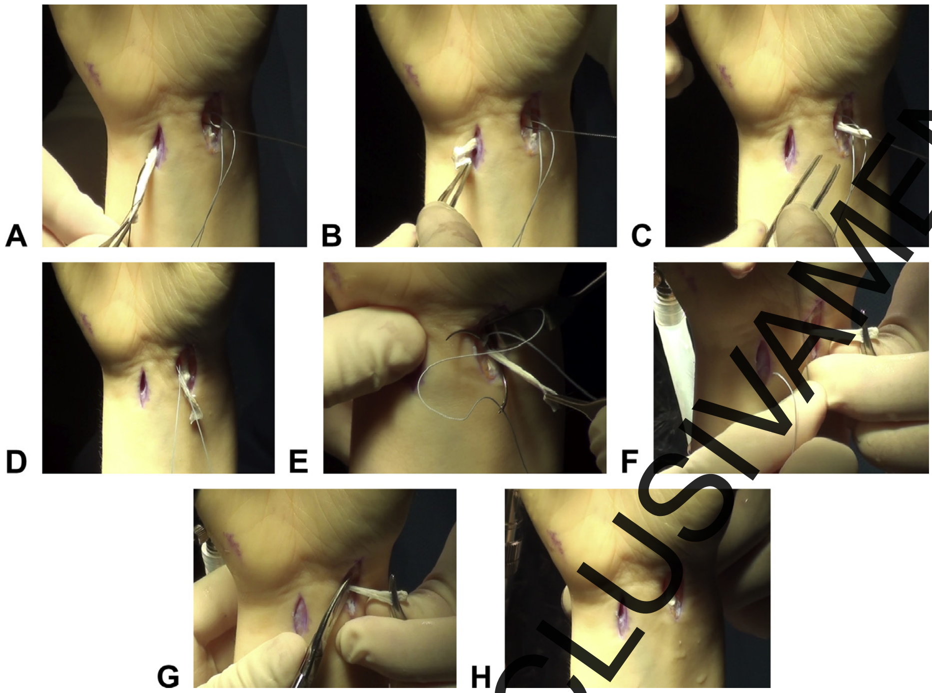

FIGURE 12: A–D The graft is captured in the volar central portal with the loop and taken to the portal proximal to the volar capsuloligamentous suture. **E–H** While tensioned, it is tied with the capsuloligamentous suture using a free-eyed needle.

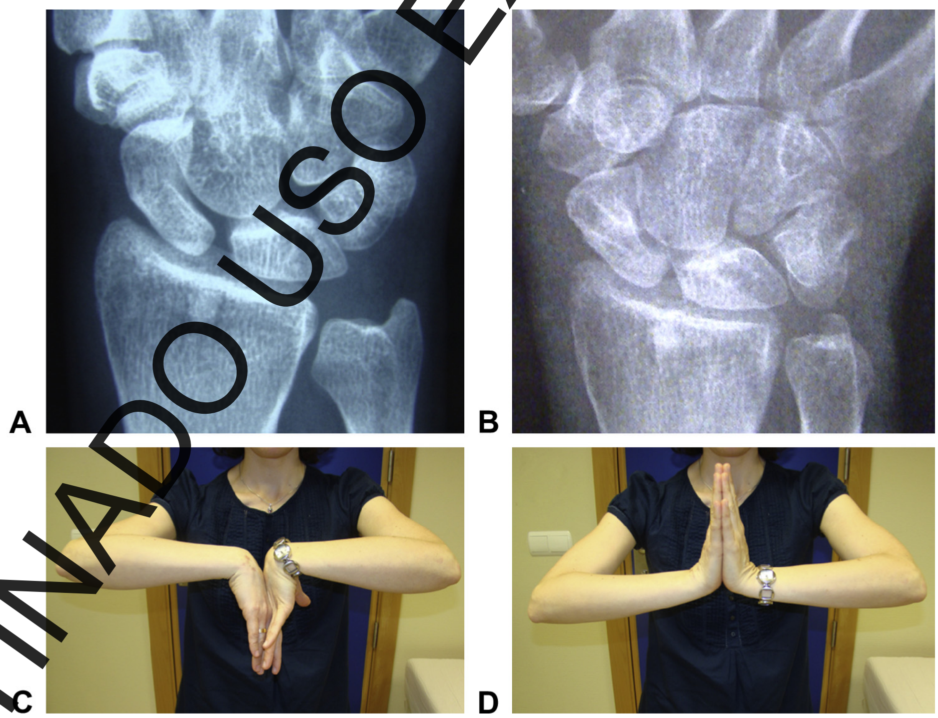

FIGURE 13: Preoperative and postoperative radiograph with fist clenched. The patient's range of motion 6 months after surgery.

deviation) for 30 minutes, 4 times a day. The patient continues to wear the splint at night.

By 6 weeks, the thermoplastic splint is removed and the patient starts strengthening exercises with a 1-kg weight and proprioception exercises with a power ball.[27]

At 10 weeks, the patient starts resistance exercises with weights building up to 3 kg.

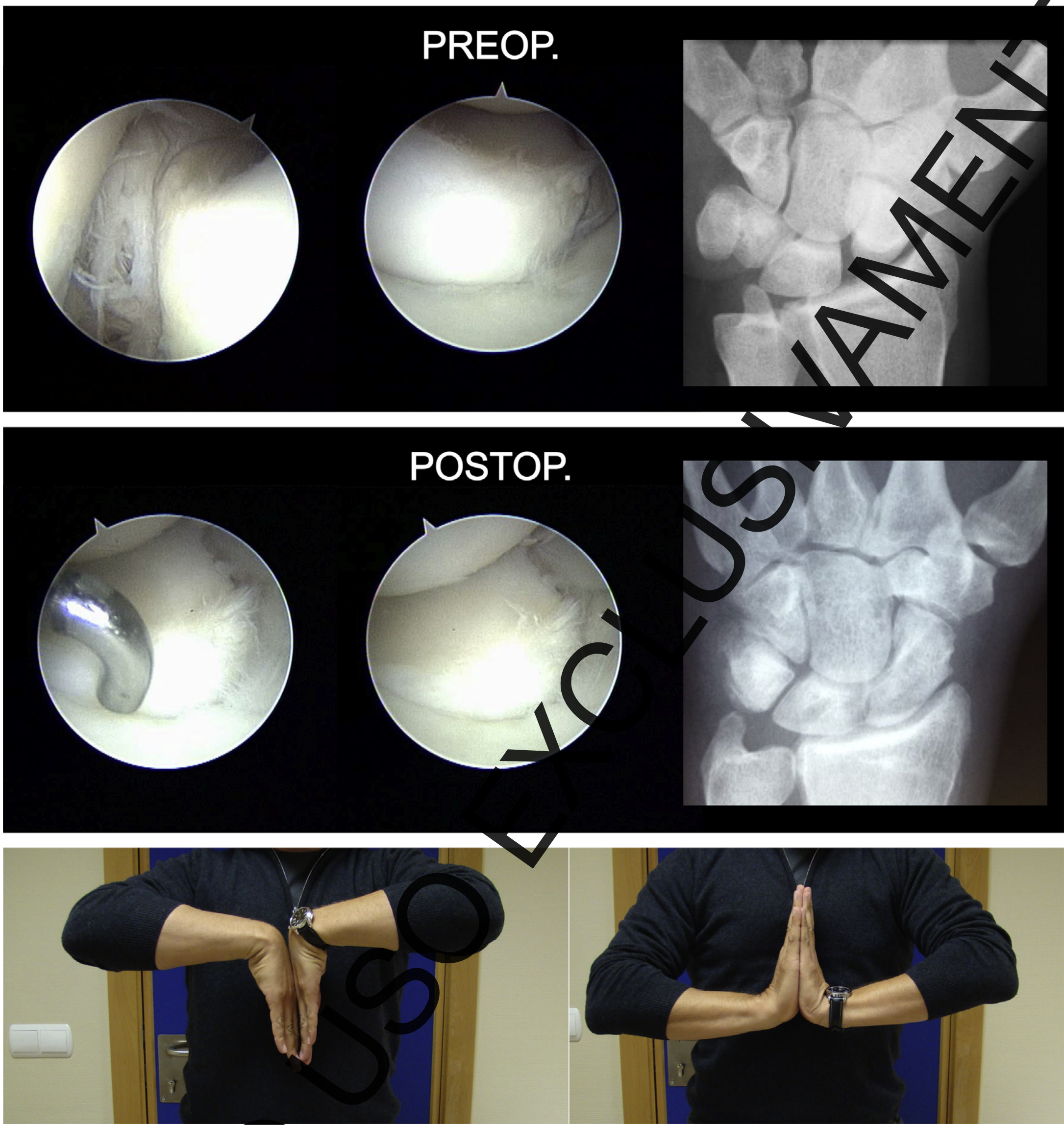

FIGURE 14: Case with dynamic instability (dynamic x-ray with fist clenched) and grade 4 instability according to the classification of Geissler. Preoperatively, the arthroscope can enter between the scaphoid, and lunate and there is a large stepoff between bones. Postoperatively, the probe cannot enter, and there is no stepoff. Range of motion at 6 months after surgery.

Finally, at 12 weeks, the patient can resume normal activity without restrictions, apart from contact sports, which should not be undertaken until the 4th or 5th month.

COMPLICATIONS AND RISKS

There are 3 major risks. The first is that tunneling in the bones can result in a perioperative fracture. For this reason, it is essential to check as often as necessary that the guide wire is positioned correctly before drilling.

The second is damage to the delicate structures surrounding the access portals or tunnels. In our preliminary cadaver article, we demonstrated the safety of the technique by measuring the distances to these structures at risk.[9] Because the volar reconstruction is executed via the same previously described access portals, the surgical risk for these structures does not increase with the current modification.

Finally, the most concerning risk is avascular necrosis of the tunnelled bones. On the scaphoid bone, the tunnel entry point (at the insertion of the dorsal portion of the scapholunate) is far from the vessel insertion point (at the waist of the scaphoid bone). In addition, there is a wide range of open techniques in which the scaphoid bone is also tunneled, and there are few reported cases of necrosis. Therefore, it can be expected that when performing the tunneling without opening the capsule, avascular necrosis will be even more improbable.

Avascular necrosis of the lunate may be more worrisome, but the insertion of the supplying vessels to the lunate is located in the peripheral area across various ligamentous insertions.[28] Because the tunnel is centered in the middle of the lunate and the articular capsule is not detached, vascular damage is unlikely. In addition, in the patients on whom we have operated so far, we have had no reported cases of avascular necrosis of the lunate.

As with any other ligament reconstruction, tendon has compliance different from the ligaments replaced, and despite trying to make the reconstruction as strong as possible with screws and with reconstruction of both the dorsal and volar structures, it is possible that the graft will stretch out over time. Intermediate and long-term follow-up are needed to evaluate this potential complication.

CLINICAL CASES

The case used to illustrate the technique is that of a 37-year-old, right hand–dominant woman, who had wrist pain after a fall with the wrist in hyperextension 1 year previously. Clinical examination showed pain at the dorsum of the wrist, in the scapholunate joint, which increased with forced extension of the wrist. Both Watson test and finger extension test were positive. The range of motion was 80° extension (90° contralateral) and 70° flexion (90° contralateral) with complete pronosupination. Grip strength was 17 kg (21 kg contralateral), with a visual analog score of 8 and a Disabilities of the Arm, Shoulder, and Hand score of 51.8. Radiographic evaluation study showed an increased gap between the scaphoid and lunate.

Nonoperative measures failed, so a diagnostic arthroscopy was performed and showed grade 3 scapholunate instability according to the classification of Geissler, with a big stepoff between bones (Fig. 2). An arthroscopic ligamentoplasty was performed, and the early mobilization protocol was applied after surgery.

The preoperative range of motion had recovered in the 3rd month, and by the 6th month, the patient had 85° extension, 80° flexion, grip strength of 21 kg, a visual analog score of 1.2, and a Disabilities of the Arm, Shoulder, and Hand score of 10 (Fig. 13).

This technique can also be used for grade 4 scapholunate instability according to the classification of Geissler, but only for dynamic or easily reducible static instability, as shown in Figure 14.

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