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# Extensor Carpi Radialis Longus Ligamentoplasty as a Reconstruction Technique for Scapholunate Injuries

## *Tratamiento de lesiones escafolunares mediante reconstrucción con plastia del extensor radial largo del carpo*

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**Abstract**

**Objective** To describe the arthroscopic surgical technique for the reconstruction of the scapholunate ligament using the extensor carpi radialis longus (ECRL) as a donor. This muscle can be very useful in this kind of procedure due to its biomechanical properties.

**Surgical Technique** After an initial diagnostic arthroscopy of the wrist, ligamentous reconstruction was carried out using an ECRL hemitendon though a minimally-invasive technique. The fixation devices used were the SwiveLock for the scaphoid and a $3 \times 8$-mm biotenodesis screw (Arthrex, Naples, FL, US) for the lunate.

**Complications** Difficult extraction of the ECRL tendon is the most frequent complication, due to an anatomical intersection between the first and second extensor compartments. It can be easily solved by performing an intermediate incision at this level to ensure the adequate release of the plasty.

**Conclusion** It is possible to perform a reconstruction of the scapholunate ligament using the ECRL hemitendon. Due to its biomechanical properties, it may be more advantageous to restore the carpal biomechanics. Further studies are required to confirm the suitability and superiority of this donor compared to others in reconstruction techniques.

**Keywords**
- scapholunate
- ligament
- injury
- reconstruction
- ligamentoplasty

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**Resumen**

**Objetivo** Describir la técnica quirúrgica de reconstrucción del ligamento escafolunar asistida por artroscopia empleando como donante el *extensor carpi radialis longus* (ECRL), un músculo que, gracias a sus propiedades biomecánicas, puede ser muy ventajoso en este tipo de cirugía.

**Técnica Quirúrgica** Tras artroscopia diagnóstica inicial según la técnica habitual, se llevó a cabo la reconstrucción ligamentosa empleando un hemitendón del ECRL mediante técnica mínimamente invasiva. Los dispositivos de fijación empleados fueron el SwiveLock para el escafoides y el tornillo de biotenodesis de $3 \times 8$ mm (Arthrex, Naples, FL, EE.UU.) para el semilunar.

**Complicaciones** La complicación que puede surgir durante la realización de esta técnica es la extracción dificultosa de la plastia, por la intersección entre el primer y el segundo compartimentos extensores. Es fácilmente solventable realizando una incisión intermedia a nivel de la intersección para garantizar la adecuada liberación de la plastia a esta altura.

**Conclusión** Es posible reconstruir el intervalo escafolunar empleando un hemitendón del ECRL, que, por propiedades biomecánicas, puede ser más ventajoso a la hora de restaurar la biomecánica del carpo. Se precisan estudios posteriores para confirmar la idoneidad y la superioridad de este donante frente a otros empleados en las técnicas de reconstrucción.

**Palabras Clave**
- escafolunar
- ligamento
- lesión
- reconstrucción
- ligamentoplastia

## Introduction

The scapholunate (SL) ligament and its pathology have been the subject of interest in multiple lines of research over the last decades. The better understanding of the anatomy and biomechanics of the carpus, as well as advances in minimally-invasive surgery of the wrist and hand, resulted in a wide range of possibilities that are now available for the treatment of SL lesions.[1] In contrast to traditional open surgery techniques, the current surgical treatment is increasingly geared towards minimally-invasive techniques with the aim of preserving proprioception and joint mobility as much as possible.[2]

Recent biomechanical studies[3–7] have highlighted the importance of the secondary wrist stabilizers and their role in intracarpal mobility. For practical purposes, the extrinsic muscles can be divided into two large groups:

- Carpal pronator muscles: flexor carpi radialis (FCR) and extensor carpi ulnaris (ECU). The FCR also presents a paradoxical effect of supination of the scaphoid.[8]
- Carpal supinator muscles: abductor pollicis longus (APL), extensor carpi radialis longus (ECRL), and flexor carpi ulnaris (FCU).

When the SL ligament is incompetent or injured, the scaphoid tends to assume a flexed, pronated, and ulnar-deviated position, while the lunate assumes an extended position. This characteristic alteration is known as dorsal intercalated segment instability (DISI), and is mainly observed in complete injuries of the SL ligament.[9–11] The objective of SL reconstruction is to restore the correct intracarpal anatomical relationships, to also recover adequate joint biomechanics.

Based on the described effect of the extrinsic musculature on intracarpal mobility, and following the growing trend towards minimally-invasive surgery, we have developed a new surgical technique for the reconstruction of the SL ligament. The objective is to get the most out of the biomechanical properties of the donor tendon, in this case, the ECRL, which acts as a supinator of the first row and is a stabilizer of the SL interval.[3–7] Radial extensors have been previously used as donors for this type of ligamentoplasty. Linscheid and Dobyns,[12] and later Kakar et al.,[13] have described plasties through open surgery using the ECRL as donor. Likewise, Almquist et al.[14] have based their own technique on the use of the extensor carpi radialis brevis (ECRB). The present study seeks to describe the surgical technique step by step, as well as the indications and potential complications that may arise during its course.

## Indications and Contraindications

The surgical indication for this technique coincides with that previously described for other ligamentoplasties or techniques for SL interval reconstruction: Geissler grades III to IV SL ligament injuries, reducible, and not associated with degenerative changes in the joint surface.[2]

Acute injuries, grades I to II injuries that can be treated with other types of techniques, and the presence of injuries with fixed deformity or degenerative changes in the joint are contraindications to perform this type of technique.

## Surgical Anatomy

The ECRL tendon inserts at the base of the second metacarpal, a place that is easy to locate by palpation, especially when the upper limb is suspended from the traction tower. Its muscle belly presents a volar-radial location in the

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proximal forearm, being superficial to the ECRB, deep to the brachioradialis (BR), which we must dissect and retract. The length of the tendinous path is extensive, easily exceeding 15 cm; this anatomical characteristic makes it an ideal donor if the extraction of long plasties is required. Between 5 cm and 7 cm proximal to its insertion, it passes through the intersection with the tendons of the first slider, following its path distally through the second extensor slider to the base of the second metacarpal (►**Figure 1**). Both points are critical places of stenosis that can make it difficult to remove the plasty if an adequate dissection is not performed.

The superficial radial nerve travels deep to the BR muscle until it divides into terminal sensory branches to the dorsum of the hand. It is a structure at risk during the plasty extraction process if careful dissection and extraction are not performed (►**Figure 1**).

The proximal pole of the scaphoid is almost constantly located at the intersection between the extensor pollicis longus (EPL) and the tendons of the second extensor compartment. At the distal level, these three tendons form a triangular space through which we can directly access the joint capsule of the wrist and, through arthrotomy, the proximal pole of the scaphoid and even the SL interval (►**Figure 2A-B**).

The surgical anatomy applied to perform the dorsal approach to the lunate and the volar portal has been described in previous articles.[2,15]

## Surgical technique

1. Standard wrist arthroscopy:

With the upper limb suspended in a traction tower (Acumed, Hillsboro, OR, US), a standard diagnostic arthroscopic procedure is first performed using the usual radiocarpal portals 3-4, 6R, and dorsal midcarpal portals (►**Figure 3A**). This first surgical gesture is essential to typify the SL ligament injury, as well as to determine if the patient meets the criteria to be submitted to this reconstruction technique.

1. *ECRL plasty extraction*

We make a longitudinal incision joining the 3-4 and the radial midcarpal portals. Next, we dissect the subcutaneous cellular tissue, preserving as much as possible the small veins of the back and the dorsal sensory branches. At the radial edge of the incision, we can identify and dissect the ECRL tendon (►**Figure 3B**). Next, we open and dissect the tendon sheath up to the entrance of the tendon in the second extensor groove, releasing all the adhesions that may later hinder donor extraction. Once identified at the distal level, we gently pull to locate it at the proximal level, on the radial-volar border of the forearm. We extract a hemitendon of approximately 12 cm in length (►**Figure 3C**), marking the ulnar 2 mm with a number 0 or number 1 monofilament that we will use to divide the tendon longitudinally. At this level, it is equally important to open and dissect the tendon sheath, as well as tunneling the path with blunt material to facilitate the extraction of the graft. Once the ulnar hemitendon is released, we will use it to perform the ligamentoplasty, while the remnant will remain inserted at the base of the second metacarpal to guarantee the functional continuity of the donor muscle.

**Fig. 1** Dissection of the muscle belly and tendon of the ECRL. The asterisk indicates the second extension slider and the intersection with the first slider. The arrow points to the superficial radial nerve.

1. Scaphoid tunneling and plasty fixation with the DX SwiveLock device (Arthrex, Naples, FL, US).

At the distal level, we perform a deep dissection until we reach the joint capsule. During the dissection, special care must be taken not to injure the EPL tendon, which can be observed at the proximal edge of the incision. We performed a longitudinal arthrotomy, exposing the proximal pole of the scaphoid and its dorsal crest. Using a guide

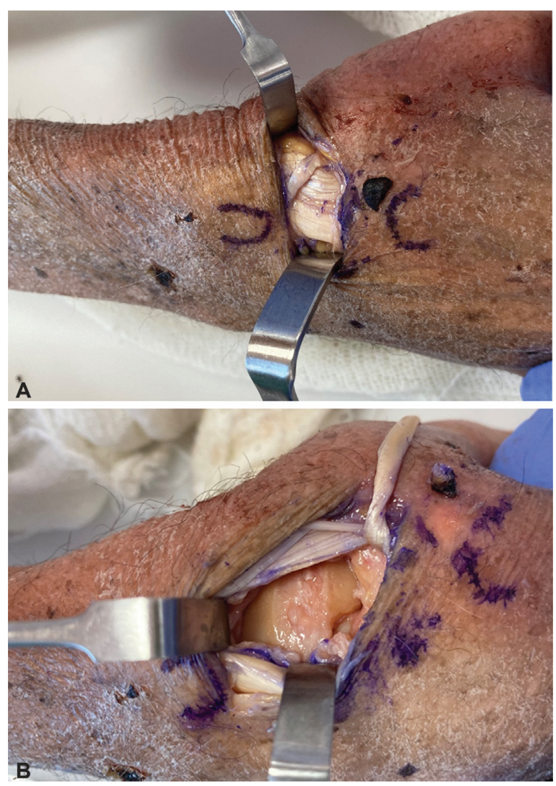

**Fig. 2** (A-B) Anatomical relationships of the extensors of the second extensor groove, EPL, joint capsule, and proximal pole of the scaphoid.

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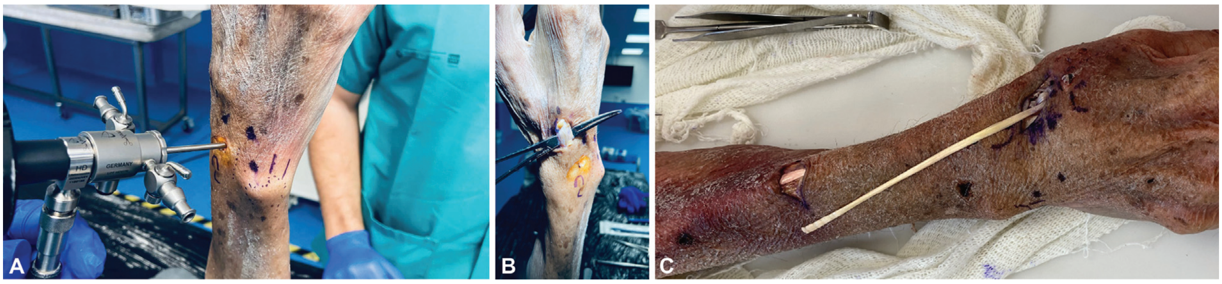

**Fig. 3** (**A**) Placement of anatomical piece in the traction tower. (**B**) Distal location of the donor tendon. (**C**) Extraction of the ECRL hemitendon plasty.

needle, we locate the entry point for the tunnel in the scaphoid through radioscopic control, which is located proximal to the crest following the longitudinal axis of the bone (►**Figures 4A-C**). The slightly more dorsal entry point enables us to further extend and supinate the scaphoid. The tunnel is drilled using a 3.5-mm drill for the DX SwiveLock device, with which we will fix the plasty inside the bone. During the tunneling process, it is important to leave the distal cortex unharmed so that the device can press on the bone. If the thickness of the plasty exceeds the size of the tunnel or fixation device, making it difficult to insert, it can be thinned to fit exactly. Lastly, we check the adequate anchorage to the scaphoid by means of traction.

1. Tunneling of the lunate bone:

We locate the center of the bone by radioscopic control. We make a 2-cm longitudinal skin incision centered at this level. To access the dorsum of the lunate, it is necessary to open the retinaculum, retract the extensor tendons of the fourth compartment in an ulnar direction, and perform a longitudinal arthrotomy as described in previous techniques.[2,15] We make a tunnel parallel to the articular surface of the lunate bone guided by radioscopy, first using a guide needle for its correct location, and later, a 3-mm cannulated drill bit.

1. Recovery from the plasty and passage to the volar region:

Using an arthroscopic grasping forceps or a mosquito, we slide the plasty below the extensor tendons and the joint capsule, intra-articularly, towards the incision made on the lunate. In this step, we must be careful to pass the plasty under the EPL tendon and the ECRB tendon so that they are not pinched under it. Next, we make a central fly portal.[16] Using a straight SutureLasso (Arthrex), we recover the plasty towards the volar region of the wrist. With the arthroscope located in the midcarpal joint, we apply tension to the plasty, testing the adequate closure of the joint space by palpation. We fix the plasty on the back of the lunate with a 3 × 8-mm biotenodesis screw (Arthrex).

## Postoperative period

During the first three postoperative weeks, the joint must be kept immobilized with a dorsal splint in extension and slight ulnar deviation to inhibit the action of the extensor carpi ulnaris (ECU), which is detrimental to the SL. Subsequently, we remove the splint and begin with passive mobility exercises to gain joint range, especially flexion-extension, as well as active mobility in unloading the joint for another 3 to 4 weeks. From this period on, wrist proprioception exercises can be started, limiting weight-bearing activities until the third postoperative month.

## Complications

Prior to performing it on the live patient, we have developed this surgical technique using 28 cadaveric pieces preserved fresh, from the Cadaver Donation Center of Universidad Complutense de Madrid, Spain. The potential complications that we have been able to verify are:

1. During the removal of the plasty:
    - Injury to neurovascular structures if an adequate dissection is not carried out; in this case, the structure with the greatest risk of being injured is the superficial radial nerve.

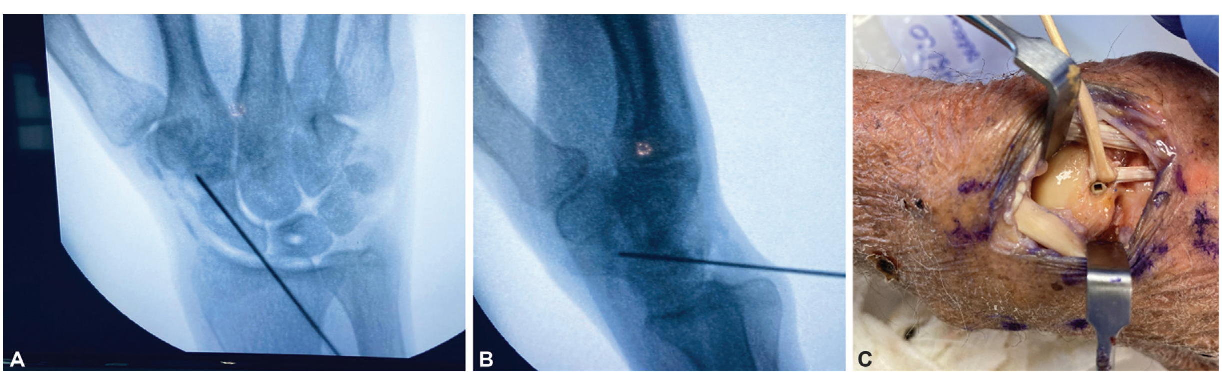

**Fig. 4** (**A-C**) Radioscopic control to locate the entry point in the scaphoid.

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- Error in identifying the donor tendon. At the distal level, the ECRL and ECRB tendons are in proximity, so errors may occur when identifying the donor. It is important to always check that the tendon is correct; when in doubt, the ECRL is always the most radial and is easily identified at the base of the second metacarpal.
- Difficulty in extracting the plasty if an adequate dissection of the tendon sheath is not performed. It is essential to tunnel the path with a blunt instrument to avoid potential points of stenosis that can make extraction difficult (intersection with the first slide, extensor retinaculum, EPL).
- Donor rupture during extraction. The development of this complication makes it practically necessary to choose another donor to continue with the surgical technique, since the tendon remnant is usually of insufficient length to continue.

2. Scaphoid tunneling:
   - During capsular dissection and arthrotomy, the EPL tendon is located proximal to the incision. One must be careful not to produce an injury to it. Likewise, care must be taken not to injure the ECRB tendon that is ulnar and in proximity to the donor.
   - Anomalous location of the tunnel: if an entry point is made that is excessively dorsal (distal to the crest of the scaphoid) or the tunnel does not develop in the axis of the bone, it can lead to complications such as rupture of the wall or perforation of the distal cortex. Therefore, tunneling of the carpal bones must be performed under radioscopic guidance.
3. During the course of the plasty:
   - The plasty should not exceed 2 mm in thickness, as it may compromise the press of the DX SwiveLock device inside the bone. In the case of excessively thick plasties, we recommend thinning them until a correct diameter is obtained that enables the safe implantation of the device.
   - During its passage through the dorsal region of the wrist towards the lunate, it is important that the plasty travels below the wrist extensors and the joint capsule. Its passage under the EPL and the ECRB is especially critical; if it is not carried out properly the tendons can be trapped under the plasty when it is subjected to tension.

## Clinical case

A 42-year-old male with no personal history of interest, who practiced sports on a regular basis, especially climbing. The patient had a history of repetitive trauma related to sports activities, not a history of recent acute trauma.

He was evaluated in Outpatient Consultations by his traumatologist due to nonspecific pain in the right wrist that had lasted for months. The magnetic resonance imaging (MRI) study showed an SL ligament injury (►**Figure 5A-B**), which is why the patient was referred to our center.

Upon physical examination, the patient presented pain in the dorsal region of the wrist with activity, and pain at the tip of the finger over the SL interval. The Watson test was positive. The patient had full passive range of motion (PROM) and active range of motion (AROM) of the wrist, and reported pain in the last degrees of extension or when carrying loads. The grip strength in the right hand (Jamar-type dynamometer) was of 30, markedly decreased compared to the contralateral hand. We requested a dynamic study using functional radiographs that showed opening of the SL space (►**Figures 6**), which is why we suggested

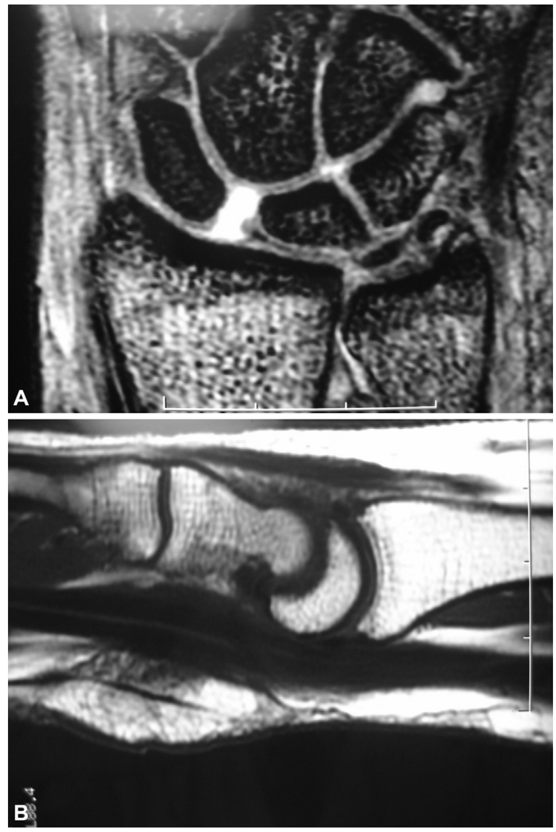


**Fig. 5** (**A-B**) Magnetic resonance imaging scan with scapholunate ligament injury and DISI deformity.


**Fig. 6** Functional study with opening of the SL space in the right wrist.

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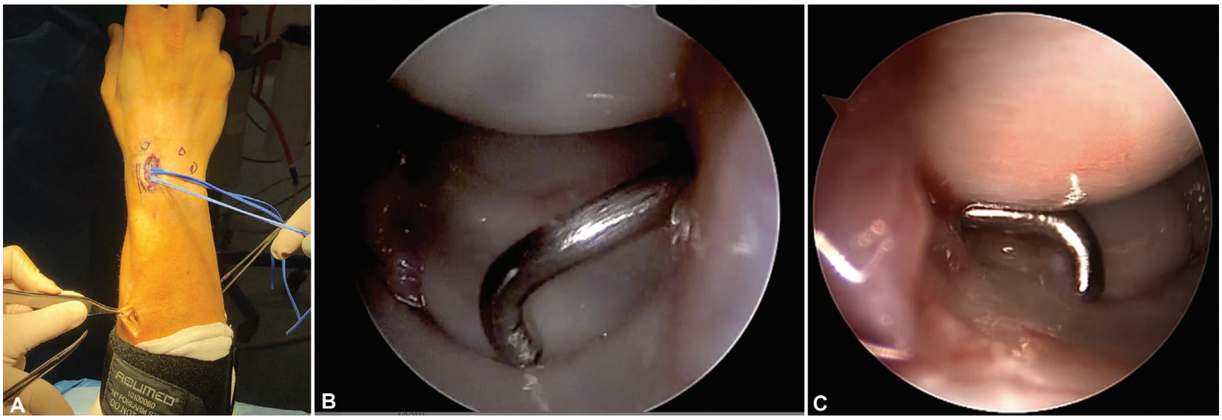


**Fig. 7** (**A**) Placement of the patient in the traction tower. Distal and proximal incisions for extraction of the plasty. (**B**) Arthroscopic image of SL ligament injury with evident step between the scaphoid and lunate. (**C**) Image of ligamentoplasty on the dorsum of the wrist. (**D**) Arthroscopic control after reconstruction of the SL ligament.

diagnostic arthroscopy and treatment by means of reconstruction withSL ligamentoplasty, using the ECRL as a donor (►**Figures 7A-C**).

The patient is currently in his fifth postoperative month, and he presents disappearance of the previous symptoms of joint instability, as well as a negative Watson test. The score on the Visual Analog Scale (VAS) with activity improved from 7 in the preoperative period to 2 at the present time when carrying out activities with load. The grip strength measured by a Jamar-type dynamometer is currently at 41, remaining lower than on the contralateral hand. He performs activities of daily living without limitation, and is working with progressive weight bearing. The PROM and AROM present an extension deficit of −20 degrees. The functional score on the Quick Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire has improved from 33 preoperatively to 16 at the present time.

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