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Name of Scholar (Family Name/First Name): Miró Jiménez José Ignacio

Mail addres: ppnxmj89@gmail.com

Country of Citizenship: Spain

Name and Country of Training Center: Traumaunit Teknon Medical Center

Name of Fellowship Director: Dr Joaquím Casañas Sintes

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ARTHROSCOPIC SCAPHOLUNATE RECONSTRUCTION WITH TENDON GRAFT VS ARTHROSCOPIC RECONSTRUCTION WITH TENDON GRAFT PLUS FIBER TAPE FOR REDUCIBLE STATIC SCAPHOLUNATE INSTABILITY, RETROSPECTIVE STUDY: FUNCTIONAL AND RADIOLOGICAL RESULTS

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José Ignacio Miró Jiménez (Icatme-Quirón Dexeus, Barcelona, Spain).
Gustavo Luis Gómez Rodríguez (CLIMBA, Buenos Aires, Argentina).
Nicolás Irigoitia (CLIMBA , Buenos Aires, Argentina).
Pablo Nicolás Osornio de Vega (Teknon Medical Center, Barcelona, Spain).

ABSTRACT

INTRODUCTION: The scapholunate complex, composed by static and dynamic stabilizers, maintains the alignment and stability of the scapholunate joint. In cases of static reducible injuries of the scapholunate ligament reconstruction procedures using techniques to restore carpal stability and alignment are indicates, also preventing progression to degenerative injuries. The objective of the present study was to compare functional and radiological results in two different arthroscopic SLL reconstruction techniques: Ligamentoplasty with tendon graft and ligamentoplasty with tendon graft plus fiber tape augmentation.

MATERIAL AND METHODS: A retrospective study in 34 patients operated with scapholunate ligament reconstruction was carried out. In 17 patients (group A) flexor carpi radialis graft was used and in other 17 patients (group B) Palmaris Longus graft plus fiber tape augmentation was used. The main variables of the study were wrist range of motion both in flexion and extension, pain on Visual Analog Scale, and wrist function at preoperative, 6 months postoperative, 1 and 2 years postoperative on Quick Dash scale. Additionally, Static scapholunate gap and scapholunate angle on radiography or tomography were also compared in the two groups preoperative, and at 6 months and 2 years postoperative.

RESULTS: The average follow-up time in the two groups of the study was 26 months. Comparative analysis of wrist function at 2 years postoperative showed differences for all the variables, being significant in Flexion, wrist function and pain (all of them $p < 0.05$), with better results in group B. Comparative analysis of radiological parameters also showed differences between groups ($p<0.05$), being better values of group B.

FINAL CONSIDERATIONS: According to the results of the present study, arthroscopic Scapholunate ligament reconstruction technique with tendon graft plus fiber tape augmentation showed better results than arthroscopic reconstruction with tendon graft for treatment of static reducible Scapholunate complex injuries. More relevant conclusions on surgical procedure of treatment of this chronic pathology will be drawn with prospective studies with a larger number of patients and a longer follow-up period, and with comparative studies with suture-only techniques.

KEYWORDS

ARTHROSCOPY
SCAPHOLUNATE INJURIES
LIGAMENTOPLASTY
DISSOCIATIVE INSTABILITIES
MIDCARPAL LIGAMENTS

INTRODUCTION

Carpal instability secondary to SLL rupture occurs when, as consequence of the injury, the wrist is unable to maintain a normal relationship between its structural elements under physiological load (static alteration) and throughout the normal arch of movement (dynamic alteration) (1). The Scapholunate Complex (SLC), composed by static and dynamic stabilizers, maintains the alignment and stability of Scapholunate (SL) joint, on whose integrity the correct biomechanics of the carpus largely depends.

In cases of static reducible lesion of SLC without associated chondral lesions (type IV and V lesions according to M. García Elías classification) (3), reconstruction of Scapholunate Ligament (SLL) is indicated by using various techniques to restore the previous biomechanics and bone alignment, thus avoiding progression to degenerative wrist injuries. Among the techniques used for this purpose are: SL reduction and association with screw (RASL), fixation with bone tendon bone, dorsal capsulodesis, tenodesis, reduction with internal brace, arthroscopic ligamentoplaty, etc. Arthroscopic ligamentoplasty is becoming popular recently due to its apparent good results. However, in our opinion, there is a lack of studies comparing the various techniques used and demonstrating the superiority of some over others. The great heterogeneity between these techniques contributes to the appearance of biases: Palmaris Longus (PL) plasty, Flexor Carpi Radialis (FCR) plasty (4), complete plasty or hemiplasty, different diameter of interference screws (5), association or high resistance sutures like Suture or Fiber Tape ® (Arthrex, Maples, USA) (6), etc.

The objective of the present study was to compare the functional and radiological results of two different SLL arthroscopic reconstruction techniques, ligamentoplasty with tendon graft and ligamentoplasty with tendon graft plus fiber tape augmentation, in a two-year follow-up, with the hypothesis that ligamentoplasty with tendon graft plus fiber tape augmentation is equal or superior to ligamentoplasty with tendon graft.

MATERIAL AND METHODS

A retrospective study was carried out in patients operated with SLL reconstruction from January 2017 to December 2020 in Clínica de la Mano de Buenos Aires-CLIMBA (Buenos Aires, Argentina) and Teknon Medical Center (Barcelona, Spain). Various functional and radiological parameters were collected preoperatively, and at 6 months, at 1 year and at 2 years postoperatively. Informed consents were obtained from patients. Inclusion criteria were:

- Age between 8 and 55 years.

- Non-smokers

- Patients with static reducible SLC instability (types IV and V of García Elías classification) diagnosed by x-ray or TC, of less than 12 months of evolution

- Absence of comorbidities that could interfere with postoperative status such as diabetes, hypertension, peripheral vascular disease, rheumatoid arthritis, and others.

- Absence of previous injuries in the affected wrist that could interfere with pre and postoperative function such as scaphoid or distal radius fractures, triangular fibrocartilage complex injuries, and others.

- Absence of advanced degenerative changes in the affected wrist and Scapholunate advance collapse (SLAC) <2.

Exclusion criteria were:

- Age under 18 and over 55 years.

- Smokers.

- Patients with static non reducible SLC instability (types VI and VII of García Elías classification) of less than12 months of evolution.

- Presence of previous injuries in the affected wrist that could interfere with pre and postoperative function such as scaphoid or distal radius fractures, triangular fibrocartilage complex injuries, and others.

- Presence of comorbidities that could interfere with postoperative status such as diabetes, hypertension, peripheral vascular disease, rheumatoid arthritis, and others.

- Presence of advanced degenerative changes in the affected wrist (SLAC > or = 2).

Patients were divided into two groups of treatment: Group A, Arthroscopic SL reconstruction by ligamentoplasty with FCR hemitendon graft; Group B, Arthroscopic SL reconstruction by ligamentoplasty with PL tendon graft plus Fiber Tape augmentation. Patients of group A were operated by Gustavo Luis Gómez Rodríguez (CLIMBA, Buenos Aires, Argentina), and Patients of group B were operated by Pablo Nicolás Osornio de Vega (Teknon Medical Center, Barcelona, Spain).

Range of motion (ROM) in flexion and extension (percentage compared to the healthy wrist), pain on Visual Analogue Scale (VAS), and functional score on the modified Disabilities of Arm, Shoulder and Hand Scale (Quick-DASH) at preoperative, at 6 months postoperative, at 1 year and at 2 years postoperative were analyzed. Besides, postoperative complications (plasty failure, infection, bone tunnels fracture, complex regional pain syndrome, carpal tunnel syndrome, etc), as well as pre- and postoperative scapholunate gap and scapholunate angle by using dynamic radiographs and computed axial tomography in 2 planes (sagittal and coronal), were also analyzed.

Comparative analysis of the results was performed by using IBM SPSS Statistics 29.0 - 2022 program. A descriptive analysis was carried out using position measures for quantitative variables (median and interquartile range), and frequency distribution for qualitative variables. Differences in clinical characteristics in each group and between both groups were contrasted by bivariate analysis, using Student's t-test for quantitative variables, and Fisher exact test or Chi-Square test for qualitative variables. A level of statistical significance $p<0,05$ was established.

SURGICAL TECHNIQUE

The patient is placed in supine position with the affected upper limb on an orthopedic table, and an auxiliary hand table where the wrist arthroscopy tower is prepared. Antibiotic prophylaxis with cefazolin 2 grams is administered and regional anaesthesia of affected limb is performed. The ischemia cuff is inflated at 250 mmHg. An inspection is performed through radiocarpal portals 3-4 and 6R, and through midcarpal portals radial MC and ulnar MC, to evaluate the type of SLL lesion according to Geissler or European Wrist Arthroscopy Society-EWAS classification, verify that SL joint

is reducible, and perform a complete radiocarpal synovectomy. Then, two 1.5 cm length dorsal incisions are performed, one to extend the 3-4 portal, and the other, 1 cm distal and ulnar to the previous one, to access to lunate. After that, two additional 1 cm volar incisions are performed. One proximal and distal over FCR to recover the plasty, and the other to access lunate (central volar portal) (7). The following steps vary depending on the performed technique:

A Arthroscopic SL reconstruction by ligamentoplasty with FCR hemitendon graft.

From the dorsal radial incision a tunnel in the scaphoid is performed with an abbocath number 14, a 1 mm guide wire, and two drills of 2.5 mm and 3 mm diameter. This tunnel goes from the origin of dorsal SLL at proximal pole, to the volar tubercle of the scaphoid. Subsequently, a tunnel in the lunate is made from the dorsoulnar incision, placing the guide wire parallel to the distal articular surface of the lunate. A 3 mm x 8 cm FCR hemitendon plasty is obtained by cutting the tendon proximally and rescuing it distally. A Suture Lasso® (Arthrex, Maples, USA) is introduced from the dorsoulnar incision and rescued for 3-4. Next, the Suture Lasso is introduced from the dorsoradial incision into the scaphoid tunnel to recuperate the plasty from volar to dorsal. A 3 x 8 mm volar biotenodesis screw is placed maintaining traction on the plasty to extend the scaphoid. The plasty is then recuperated through the dorsoulnar incision with the other Lasso Suture, and the first Lasso Suture is inserted from the central volar incision into the lunate tunnel to recuperate the plasty from dorsal to volar, placing a second biotenodesis screw in the dorsal lunate and maintaining traction to close the SL gap. Finally, the plasty is recuperated from the ulnar-volar to the radial-volar incision below the flexor tendons, and it is sutured to an anchor placed in the volar footprint of SLL (Microcork screw ®, Arthrex, Maples, USA) (9).

B Arthroscopic SL reconstruction by ligamentoplasty with PL tendon graft and fiber tape augmentation.

This technique allows to increase resistance and strength of the plasty by using a 1.3 mm Fiber Tape suture. The 8 cm volar PL graft obtained is passed with the Fiber Tape suture through the bone tunnels, and both graft and suture are fixed with two Biotenodesis screws (Arthrex, Maples, USA) in dorsal scaphoid and volar lunate. Once the plasty is fixed to the scaphoid anchor from the radial-volar incision, the reconstruction is reinforced by knotting the two threads of Fiber Tape in the tunnels (8,9).

After surgery, to control pain and soft tissue edema, a metacarpo-antebrachial plaster of Paris splint is applied in all cases for 4 weeks. After that, active and passive motion exercises start at the physiotherapy room and a removable night splint are used for another 4 weeks.

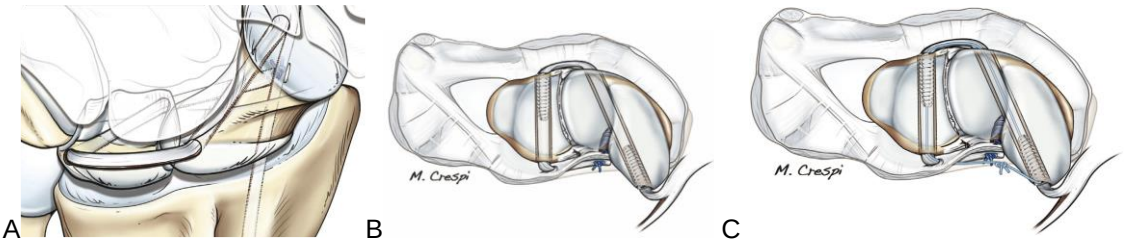


Figure 1. A, SL reconstruction with FCR graft, coronal view. B, SL reconstruction with FCR graft, axial view. C, SL reconstruction with graft and fiber tape augmentation, axial view (Image courtesy of Dr. Fernando Corella).

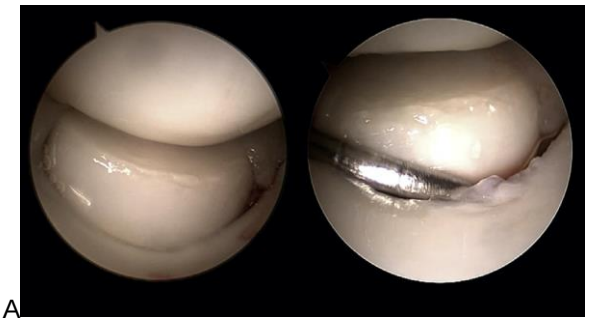
A  B 

Figure 2. A, arthroscopy image from ulnar MC portal showing a Geissler type IV SLL lesion. B, Postoperative arthroscopy image from ulnar MC portal where correct reduction and alignment of SLC is observed (image courtesy of Fernando Corella).

RESULTS

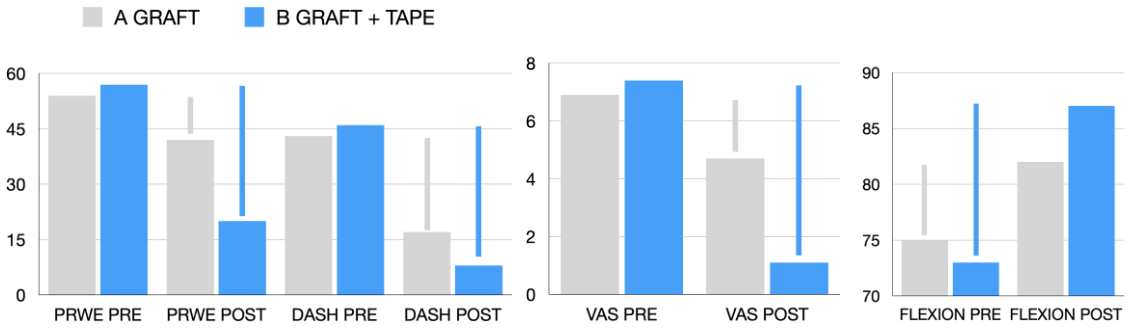
A total of 35 patients were analyzed, 17 in group A (Reconstruction with graft) and 18 in group B (Reconstruction with graft plus fiber tape). Mean time from trauma to surgery was 12 weeks (8-15 weeks). Average follow-up time in the two groups of study was 26 months (18-28 months). Results of functional and radiological variables analyzed are shown in tables 1 and 2.

Regarding the functional variables, in group A significant differences were obtained between preoperative values and values at two years postoperative control for Quick Dash score ($p<0.03$) and for grip strength values ($p<0.05$). In group B significant differences were obtained between preoperative values and values at two years postoperative control for all the parameters analyzed: ROM in Flexion, pain in VAS score ($p<0.03$); ROM in extension, grip strength and function in Quick-Dash Score ($p<0.01$). Comparative analysis between groups of values at two years postoperative control showed greater values in group B, being significant in ROM of Flexion, function in Quick-Dash score, and pain in VAS score ($p<0.05$).

Regarding the radiological variables, in group A significant differences were obtained between preoperative values and values at two years postoperative control for SL gap values ($p<0.05$). In group B significant differences were obtained between preoperative values and values at two years postoperative control for SL gap and SL angle values ($p<0.05$). Comparative analysis between groups of values at two years postoperative control showed significant differences for SL Gap and SL angle, with greater values in group B ($p<0.05$).

	A GRAFT			B GRAFT+TAPE			
	PRE	POST	P PRE-POST	PRE	POST	P PRE-POST	P GROUPS
FLEXION	75 (11)	82 (9)	>0.05	73 (12)	87 (13)	**<0.03**	**<0.03**
EXTENSION	74 (12)	81 (8)	>0.05	71 (14)	91 (7)	**<0.01**	>0.05
RD	54 (17)	68 (13)	**<0.03**	57 (20)	76 (17)	**<0.01**	>0.05
UD	71 (15)	78 (9)	**<0.03**	76 (15)	92 (7)	**<0.03**	>0.05
GRIP	53 (26)	68 (18)	**<0.05**	59 (23)	87 (10)	**<0.01**	>0.05
QDASH	43 (25)	17 (12)	**<0.03**	46 (23)	8 (9)	**<0.01**	**<0.03**
PRWE	54 (23)	42 (17)	>0.05	57 (26)	20 (16)	**<0.01**	**<0.03**
VAS	6,9 (4)	4,7 (2)	>0.05	7,4 (5)	1,1 (1)	**<0.03**	**<0.03**

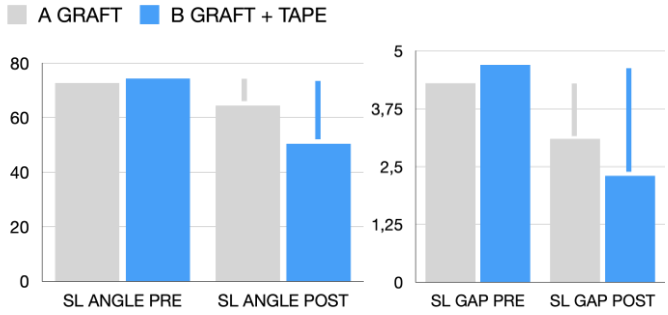
Table 1. Results (mean and standard deviations in parentheses) of functional variables analyzed in the present study. RD, values of radial Deviation. UD, values of ulnar deviation. PRWE, Patient Reported Wrist Evaluation. VAS, Visual Analogue pain Scale. PRE, preoperative. POST, control at two years postoperative. P PRE-POST, difference between preoperative values and values at two years postoperative control in each group. P GROUPS, difference between groups of values at two years postoperative control.



Graph 1. Graphic representation of values of PRWE, Quick DASH, ROM in flexion and VAS score at preoperative and at two years postoperative controls. PRWE, Quick DASH and VAS score values decreased more from preoperative to postoperative in group B, while ROM in flexion values increased more in group B than in group A.

	A GRAFT			B GRAFT + TAPE			
	PRE	POST	P PRE-POST	PRE	POST	P PRE-POST	P GROUPS
SL ANGLE	72,7 (38-83)	64,4 (36-68)	>0.05	74,3 (42-86)	50,4 (31-62)	**<0.05**	**<0.05**
SL GAP	4,3 (3-6)	3,1 (2-4)	**<0.05**	4,7 (3-7)	2,3 (1-3)	**<0.05**	**<0.05**

Table 2: Results (mean and standard deviations in parentheses) of radiological variables analyzed in the present study. SL ANGLE, scapholunate angle. SL GAP, scapholunate gap. PRE, preoperative values. POST, values at two years postoperative control. P PRE-POST, difference between values at two years postoperative control in each group. P GROUPS, difference between groups of values at two years postoperative control.



Graph 2. Graphic representation of values of SL angle and SL gap at preoperative and at two years postoperative controls. Values of SL angle and SL gap decreased more from preoperative to postoperative in group B than group A.

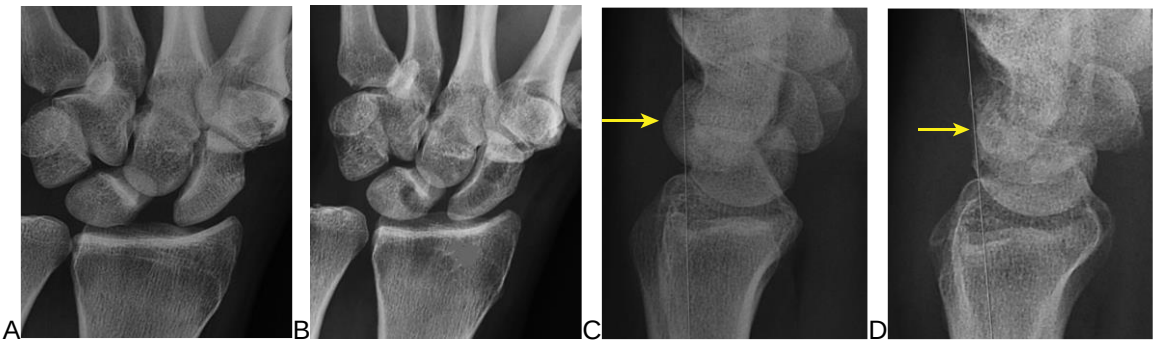


Figure 2. A, coronal plane radiograph showing static reducible SL lesion with SL gap >3 mm. B, postoperative radiograph in coronal plane showing SL gap reduction. C, sagittal plane radiograph showing SL lesion with Dorsal Intercalated segment Instability (DISI) and dorsal subluxation of scaphoid. D, postoperative radiograph in sagittal plane showing correction of DISI and subluxation of scaphoid.

COMPLICATIONS:

1. One neuropraxia of dorsal sensory branch of the radial nerve recovered after 4 months, in group B.

2. One central volar portal superficial infection, treated with Ciprofloxacin during 7 days due to penicillin allergy, in group B.

3. One intolerance to vicryl stitch in central volar portal, extracted with local anesthesia 6 weeks after surgery, in group A.

4. One flexor tenosynovitis related to Volar Central portal, resolved with oral Zamene® (Deflazacort) during 13 days and specific rehabilitation treatment during 3 months after surgery, in group B.

DISCUSSION

The SLC, through its static and dynamic stabilizers, plays an important role in maintaining normal mechanical carpal vectors (2). The SLL, mostly in its dorsal portion, is the main intrinsic ligament and the main primary static stabilizer of SLC. The volar Radioscaphocapitate ligament, the Scaphotrapeziotrapezoid ligament (STT) and the Long Radiolunate ligament, together with the Dorsal Intercarpal ligament (DICL), and the dorsal Radiotriquetral or Radiocarpal ligament, constitute the secondary static stabilizers of SLC. These ligaments, also with the main static stabilizer of lunotriquetral complex, the volar lunotriquetral ligament, constitute the antipronation spiral of the wrist, which keeps the first carpal row stable in supination. The supinator tendons of wrist: Abductor pollicis longus, Extensor carpi radialis longus and Flexor carpi ulnaris, constitute the dynamic stabilizers of SLC (3,10).

In the early phases of SLC injury (included in dissociative midcarpal instabilities), even with primary stabilizers injuries, correct carpal alignment is maintained by contraction of the secondary and dynamic stabilizers. Failure or dysfunction of these structures creates a cascade of progressive changes in the biomechanical carpal vectors: scapholunate dissociation in coronal plane, progressive collapse of the scaphoid in flexion and pronation, dorsal subluxation of proximal pole of the scaphoid on scaphoid facet of the radius, collapse of the lunate and pisiform in extension and supination (producing dorsal intercalated segment instability-DISI), and progressive ulnar translation of the first carpal row. These biomechanical changes maintained over time cause radial and midcarpal degenerative lesions, associated with pain and progressive loss of wrist function (11).

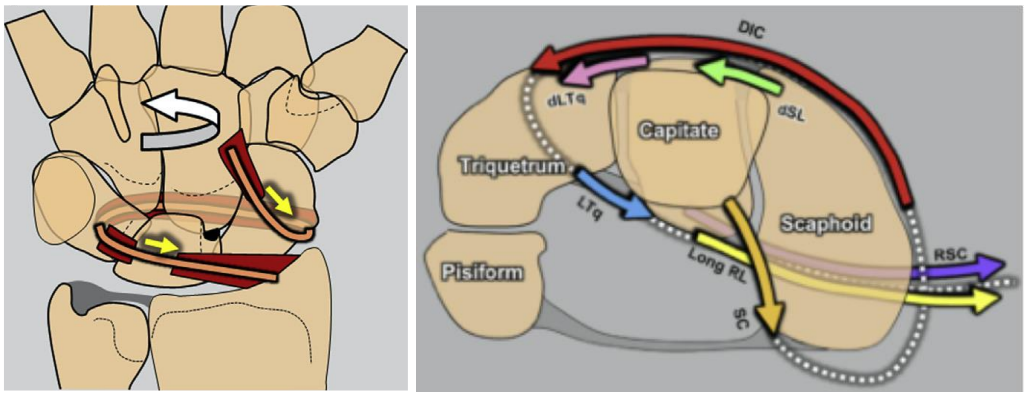


Figure 3. Schematic representations of the ligaments that constitute the antipronation spiral of wrist and favor carpal alignment and carpal stability in supination: dorsal Scapholunate (dSL), volar Scaphocapitate (SC) and Radioscaphocapitate (RSC), Long Radiolunate (Long RL), Dorsal Intercarpal ligament (DIC), volar Lunotriquetral (LTq) (Image courtesy of Dra. Inmaculada Puig).

Scapholunate instability injuries were classified by M.García Elías (12,13) into: stage I, partial SLL injury; stage II, complete repairable SLL injury; stage III, complete nonrepairable SLL injury, with correct scaphoid and lunate alignment; stage IV, complete nonrepairable SLL injury, with reducible deformity in flexion, pronation and dorsal subluxation of the scaphoid; stage V, chronic reducible SLL injury with associated carpal collapse, DISI instability and/or ulnar translation of the lunate; stage VI, chronic irreducible SLL injury with carpal collapse and normal articular cartilage; stage VII, complete SLL injury with irreducible misalignment and degenerative joint lesions. In cases of static reducible injuries, types IV and V according to M. García Elías (12) and European Wrist Arthroscopy Society-EWAS (14) classifications, reconstruction is indicated with different techniques to restore carpal biomechanics and previous alignment of SLC.

The objective of SL reconstruction is to achieve a dorsal and volar midcarpal capsular fibrosis that stabilizes and aligns the SLC to restore the normal mechanical vector of primary and secondary stabilizers. This prevents progression to degenerative lesions of the carpus, with their negative consequences such as stiffness, loss of motion, and wrist pain. Most of the techniques described for IV and V injuries try to reconstruct only the dorsal and membranous portion of SLL. However, it is also important to reconstruct the volar portion as well, since reconstructing only the dorsal portion maintains some residual instability and it does not restore normal biomechanics. When dorsal subluxation of the scaphoid appears it is also of great importance to reconstruct the mechanical vector of secondary stabilizers (mainly the DICL), by centering the scaphoid in the scaphoid fossa of the radius.

Brunelli and Brunelli (15) described a technique to stabilize the scaphoid in the sagittal plane in type IV injuries by using a FCR hemitendon tenodesis. This technique was later modified by Van den Abbele and Marc García Elías (16) who used a Triligamentary tenodesis, which allowed reconstruction of STT, dorsal SLL and ICDL, reporting variable radiological and functional results. In order to reconstruct the dorsal and volar portions of SLL, Corella et al. (7) developed an arthroscopic ligamentoplasty technique with FCR hemitendon graft tunneled through the scaphoid and lunate, obtaining a more anatomical reconstruction and avoiding large approaches. Authors reported satisfactory results of this technique at 6 months postoperatively. Likewise, Ho et al. (8) described a similar box type ligamentoplasty technique using a PL graft, with good results after 4 years of follow-up. Kakar and Greene (17) described an open modification of the box type reconstruction using a Fiber Tape augmentation of the graft, called 360º SLL Tenodesis. They argued that Tape augmentation avoids the use of temporary K-wires, allows for earlier rehabilitation to begin, and provides a strength of reconstruction similar to original SLL. Authors reported good results of the technique at 2 years of follow-up.

In the present study clinical and radiological differences between SL reconstruction with tendon graft and SL reconstruction with tendon graft plus tape augmentation were found at two years of follow-up of 35 patients with type IV and V SLC injuries. Comparative analysis between groups of values at two years postoperative control showed greater, in the authors opinion noticeably better, results in group B (tendon graft and tape augmentation). Due to the low incidence of this type of injuries in the general population and the difficulty of recruiting and following up these patients, the sample size of the present study was not what the authors would have wished for. This may have been the main limitation of the study. Further studies with a greater number of patients would be advisable for a better interpretation of the results. Currently there are some surgeons who use only Fiber Tape reconstruction techniques, with good short-term results. However, in the authors opinion, augmenting the reconstruction with Fiber Tape, despite increasing surgical time and total cost of the procedure, improves functional parameters, provides greater mechanical resistance, reduces the possibility of loosening of the plasty, and accelerates functional recovery compared to the graft reconstruction technique. According to the results of the study, we firmly believe that using graft and tape is favorable, and justifies its use in manual working patients with static reducible SL injuries.

CONCLUSION

Considering functional and radiological results of the present study, it can be concluded that arthroscopic scapholunate reconstruction with tendon graft and Fiber Tape augmentation could be considered superior to arthroscopic reconstruction with tendon graft for treatment of type IV and V injuries of scapholunate complex. Prospective studies with larger number of patients and follow-up are necessary, as well as comparative studies of these techniques with suture-only techniques, to obtain more relevant conclusions about the best surgical alternative in this pathology.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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