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Results of the Sauvé-Kapandji Arthroscopy-Assisted Technique with Proximal Ulnar Stabilization

Resultados de la técnica de sauvé-kapandji asistida por artroscopia con estabilización ulnar proximal

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Abstract

Introduction Distal radioulnar arthropathy causes significant functional limitation due to pain and loss of strength during forearm pronation. Our paper aimed to describe the surgical technique of the arthroscopic Sauvé-Kapandji (S-K) procedure with proximal tendon stabilization, its outcomes, complications, and advantages.

Methods This study retrospectively evaluated 11 patients. All underwent the S-K arthroscopic technique with proximal tendon stabilization performed by the same surgical team. The study assessed mobility, grip strength, Disability of Arm, Shoulder, and Hand (DASH), visual analog scale (VAS) for pain, and the Mayo Wrist Score (MWS).

Results The patients included ten males and one female, with a mean age of 39.1 years. The minimum follow-up was 12 (range, 12 to 36) months. Significant improvements were observed in flexion (preoperative, 48°/postoperative, 74°), extension (preoperative, 34°/postoperative, 48°), pronation (preoperative, 28°/postoperative, 88°), supination (preoperative, 19°/postoperative, 88°), VAS for pain (preoperative, 7.1/postoperative, 0.4), grip strength (preoperative, 19/postoperative, 45 kg), Quick DASH (preoperative, 54/postoperative, 2) and MWS (preoperative, 46/postoperative 91) scores. All patients were satisfied with the procedure at the end of the follow-up.

Discussion The S-K procedure is the gold standard technique in distal radioulnar osteoarthritis. It may be performed with arthroscopic assistance to restore wrist mobility, stability, and grip strength. Arthroscopy has several advantages, including preserving secondary joint stabilizers, improving joint cruentation and anatomical placement, reducing vascular damage, and allowing earlier rehabilitation, resulting in a lower incidence of pseudarthrosis and a better aesthetic scar.

Keywords
- Sauvé-Kapandji
- arthroscopy
- proximal stabilisation

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Conclusion The S-K arthroscopic technique with proximal tendon stabilization offers better outcomes than open techniques in the short term, with a faster and more comfortable functional recovery and allowing a more precise resection and reduction.

Resumen

Introducción La artropatía radiocubital distal produce gran limitación funcional con dolor y pérdida de fuerza durante la pronosupinación del antebrazo. El objetivo de nuestro trabajo fue describir la técnica quirúrgica del procedimiento de Sauvé-Kapandji artroscópico con estabilización tendinosa proximal, así como sus resultados, complicaciones y ventajas.

Material y método Se estudiaron 11 pacientes de forma retrospectiva intervenidos con la técnica de Sauvé-Kapandji artroscópica con estabilización tendinosa proximal por el mismo equipo de cirujanos. Se evaluaron la movilidad, fuerza de prensa, DASH, EVA y Mayo Wrist Score.

Resultados 10 pacientes eran varones y 1 mujer con una edad media de 39.1 años. El seguimiento mínimo fue de 12 (12-36) meses. Se observaron mejorías significativas en la flexión (preoperatoria 48° / postoperatoria 74°), extensión (pre 34°/post 48°), pronación (pre 28°/post 88°) y supinación (pre 19°/post 88°), el dolor (EVA pre 7.1/ post 0.4), la fuerza de prensión (pre 19/ post 45 kg) y en las escalas *QuickDash* (pre 54/ post 2) y *Mayo Wrist Score* (pre 46/ post 91). Todos los pacientes estuvieron satisfechos con el procedimiento al final del seguimiento.

Discusión El procedimiento de S-K es la técnica de elección en la artrosis radiocubital distal y puede realizarse con asistencia artroscópica, restaurando la movilidad de la muñeca, la estabilidad y la fuerza de prensa. La técnica artroscópica tiene una serie de ventajas como son preservar los estabilizadores secundarios articulares, mejorar la cruentación y la colocación anatómica de la articulación, provocar menos daño vascular y permitir una rehabilitación más precoz lo que favorece la menor incidencia de pseudoartrosis y con un mejor resultado estético.

Conclusión La técnica de Sauvé-Kapandji artroscópica con estabilización tendinosa proximal ofrece unos resultados mejores que las técnicas abiertas a corto plazo, con una recuperación funcional más rápida y confortable, además de permitir una resección y reducción más precisa.

Palabras Clave
- Sauvé-Kapandji
- artroscopia
- estabilización proximal

Introduction

The distal radioulnar joint (DRUJ) consists of the sigmoid notch of the radius and the ulnar head. DRUJ is essential for normal wrist functioning.[1] It presents different curvature radii between its components since the distal radius has a 15-mm curvature and the ulnar head curvature is only 10-mm. In a neutral pronosupination position, the contact between facets is 60%, which becomes only 2 or 3 mm in maximum pronation or supination, i.e., the stability degree is lower.[2] In addition, forearm pronosupination combines rotation and translation movements, allowing the ulnar head displacement over the sigmoid notch. All these factors result in DRUJ instability from a bone and biomechanical point of view.[3] DRUJ stabilization fundamentally relies on main stabilizers, such as the triangular fibrocartilage complex (TFCC), the dorsal and volar radioulnar ligaments, the ulnocarpal ligaments, the floor of the tendon sheath of the extensor carpi ulnaris (ECU), and the joint capsule with its volar thickening. Secondary stabilizers include the interosseous membrane and the deep head of the pronator quadratus muscles.

The diagnosis of DRUJ injuries, whether traumatic or degenerative, is a challenge. This fact, along with the poor bone stability provided by its incongruent articular surfaces, leads to early DRUJ osteoarthritis.[4] Traumatic causes include radial fractures consolidated in a bad position[5] and injuries to the primary or secondary stabilizers, while degenerative causes encompass all chronic arthropathies. All these conditions cause pain in the ulnar region of the wrist, as well as loss of strength and mobility restriction, affecting the quality of life of patients.[6]

Several procedures have been proposed to treat this condition when conservative management fails. These include the Darrach,[7] Bowers,[8] and Sauvé-Kapandji (S-K)[9] procedures, in addition to partial or total joint replacement using a prosthesis.[10] The Darrach procedure is effective for older patients with few functional demands but leaves an unstable proximal stump and weak grip. The Bowers procedure is out of use due to tendon interposition-associated

complications and its poor outcomes. The S-K procedure has the advantage of preserving the load since it increases the load-bearing surface of the radius and carpus and maintains joint stability. Replacement with a prosthesis significantly improved grip strength, weightlifting strength, range of motion, and pain, but its complication rate is close to 30%.[11]

The arthroscopic S-K technique, described by Luchetti et al.,[2] is a less invasive procedure with better aesthetic results. Moreover, it preserves the extensor retinaculum, improving the DRUJ placement in a more anatomical position and allowing earlier rehabilitation. The S-K procedure consists of a DRUJ arthrodesis with an ulnar osteotomy, sparing the relationship between the sigmoid fossa of the radius and the ulnar head. This procedure improves load transmission, mainly in young people with high functional demands.[12] Arthroscopy allows a complete assessment of the joint status before making decisions; moreover, it is a less invasive procedure. Our study aimed to describe the surgical technique of the arthroscopic S-K procedure with proximal tendon stabilization, its outcomes, complications, and advantages.

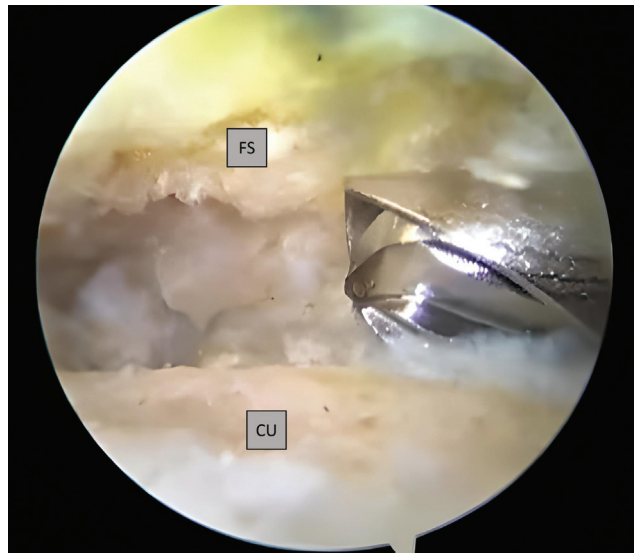

Fig. 1 Arthroscopic image of the cruentation of the distal radioulnar joint (DRUJ) from the dorsal distal radioulnar portal (d-DRU) with a 2.9-mm arthroscopic drill introduced from the volar distal radioulnar portal (v-DRU). CU: ulnar head. FS: sigmoid fossa of the radius.

Surgical Technique

The arthroscopic S-K technique follows the description from Luchetti et al.[2] and adds tendon stabilization of the proximal stump using the method introduced by Minami et al.[13]

Standard wrist arthroscopy occurred using a zenith traction tower (Acumed, Hillsboro, OR, USA), a 2.5-mm arthroscope (Arthrex, Naples, FL, USA), and a 2.9-mm synoviotome (Smith & Nephew, Andover, MA, USA), beginning with the radiocarpal and DRUJ examination to complete the diagnosis. The radiocarpal portals included 3-4 and 6R and those for DRUJ access, such as the dorsal distal radioulnar (d-DRU) and the volar distal radioulnar (v-DRU),[14] recently described and not used in the technique described by Luchetti et al.[2]

The first step was a complete synovectomy, which allowed good visualization of the remaining articular cartilage. Articular cartilage resection used 2.9-mm arthroscopy dissectors and burs (►**Fig. 1**) through the RCD-d and v-DRU portals. The arthroscopy was dry but with frequent washings to remove the cartilage and bone remnants still detached. The cartilage was removed until the exposure of the subchondral bone of the sigmoid fossa of the radius and the ulnar head. Subsequently, articular surface reduction and a temporary fixation with Kirschner wires (►**Fig. 2a**) occurred under fluoroscopic control to ensure the correct joint position (►**Fig. 2b**) Then, DRUJ fixation used a cannulated screw (►**Fig. 3a** and **3b**). his series employed one 4-mm SpeedTip® Cannulated Compression Screw (Medartis®, Basel, Switzerland) or two 3-mm cannulated screws depending on the size of the ulnar head. The screws were volar to the extensor retinaculum with the wrist in neutral pronosupination. In cases with associated ulna plus, arthrodesis compression occurs after osteotomy to

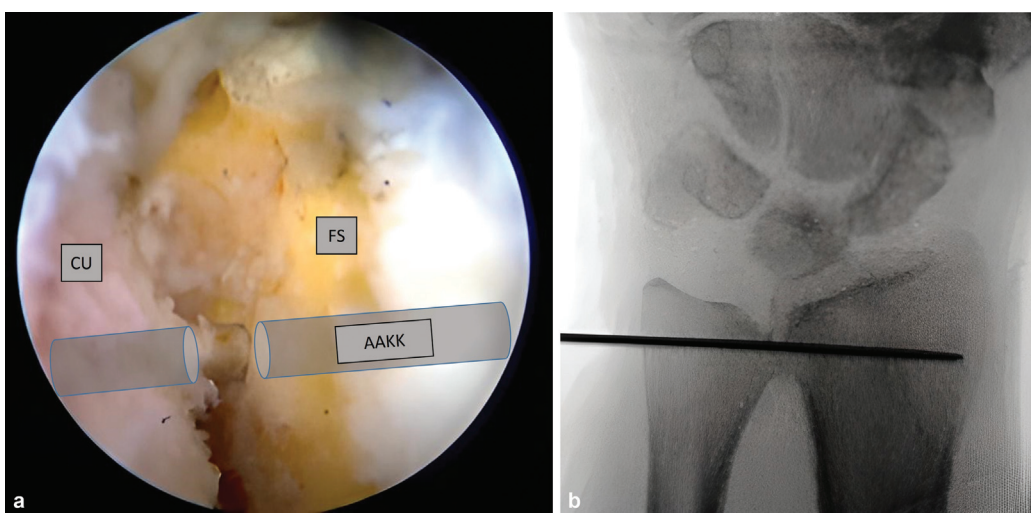

Fig. 2 (**a**) Arthroscopic image of the temporary fixation of the distal radioulnar joint (DRUJ) from the dorsal distal radioulnar portal (d-DRU). CU: ulnar head. FS: sigmoid fossa of the radius. AAKK: Kirschner wire. (**b**) Anteroposterior intraoperative fluoroscopic image of the temporary DRUJ fixation to ensure correct joint position.

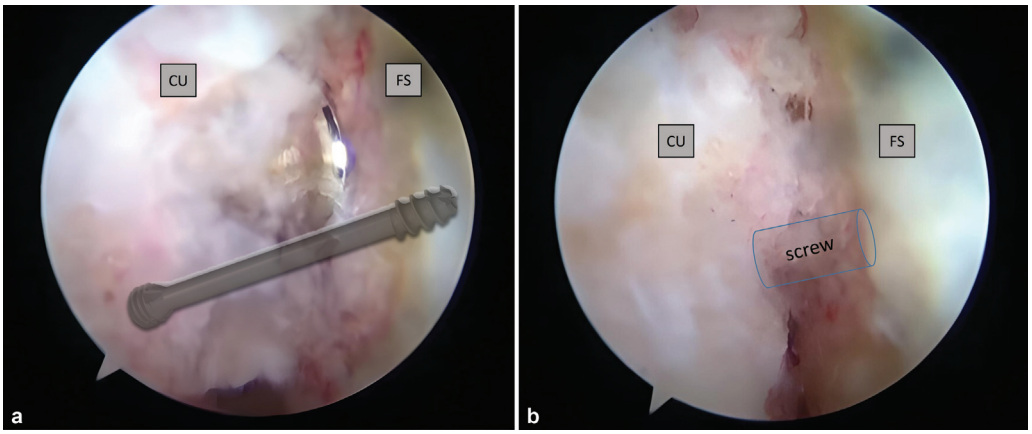

Fig. 3 (**a**) Arthroscopic image of the definitive cannulated screw fixation of the distal radioulnar joint (DRUJ) from the dorsal distal radioulnar portal (d-DRU). CU: ulnar head. FS: sigmoid fossa of the radius. (**b**) Arthroscopic image of the cannulated screw compression at DRUJ from the dorsal distal radioulnar portal (d-DRU). CU: ulnar head. FS: sigmoid fossa of the radius.

ensure more precise placement of the ulnar head in the sigmoid fossa and achieve a neutral ulnar variance. With DRUJ arthrodesis completed (►**Fig. 4**), an incision is made in the skin of the ulnar edge from the head to the neck of the ulna, and a 5 to 6 mm osteotomy is performed just proximal to the ulnar head with chisels or oscillating saw (►**Fig. 5a** and **5b**). Complete pronosupination is checked. The surgeon completed the procedure by stabilizing the proximal stump using an ECU hemiband and preserving its distal insertion, which is introduced through the diaphyseal canal and extracted through a hole in the dorsal cortex of the ulna according to Minami's technique[13] Subsequently, the surgeon proceeded to suture, concluding the stabilization.

After the intervention, the patient received a brachial splint with the wrist in a neutral position for 2 weeks. After splint removal, an antebrachial splint was placed with slight ulnar deviation so as not to stress the ECU for 3 or 4 weeks.

Fig. 4 Anteroposterior intraoperative fluoroscopic image of the definitive fixation of the distal radioulnar joint (DRUJ) with correct arthrodesis using a cannulated screw.

After splint removal, there is a first phase of pain and edema control, recovery of joint movements in flexion-extension and prono-supination, and proprioceptive re-education exercises for conscious articular control. In the second phase, not before the sixth week, we worked on DRUJ's stabilizing muscle strengthening, ECU, and flexor carpi ulnaris (FCU) concomitant contraction for proximal stump stabilization, and exercises for unconscious neuromuscular control. In this last phase, the patient receives education on specific activities.

Material and Methods

This retrospective study consisted of a case series of 11 patients operated on from 2015 to 2022 by the same team of hand surgeons using the S-K technique with arthroscopic assistance and proximal tendon stabilization. The inclusion criteria were patients with DRUJ arthropathy, whether primary or secondary to traumatic wrist injuries, and high sports or work demands. We excluded patients undergoing arthropathy secondary to rheumatic diseases or previously submitted to DRUJ arthropathy surgeries.

We analyzed age, laterality, cause, and associated injuries. We also clinically evaluated flexion-extension and pronosupination mobility using a goniometer, pain with the visual analog scale (VAS), the Disability of Arm, Shoulder, and Hand (DASH) score, the Mayo Wrist Score (MWS), grip strength, and patient satisfaction preoperatively and at 1, 3, 6, and 12 months postoperatively. We compared the grip strength with the healthy contralateral wrist using a Jamar® Hand Dynamometer (Sammons Preston, Bolingbrook, IL, USA).

Radiological follow-ups occurred monthly, with anteroposterior (AP) and lateral radiographs until confirming the consolidation of the arthrodesis between the sigmoid fossa and the ulnar head.

We incorporated the data into a database created with Microsoft Excel 365 program. The IBM SPSS version 28 program performed the statistical analysis. This analysis consisted of a descriptive analysis of the variables, calculating the frequency distribution for qualitative variables and

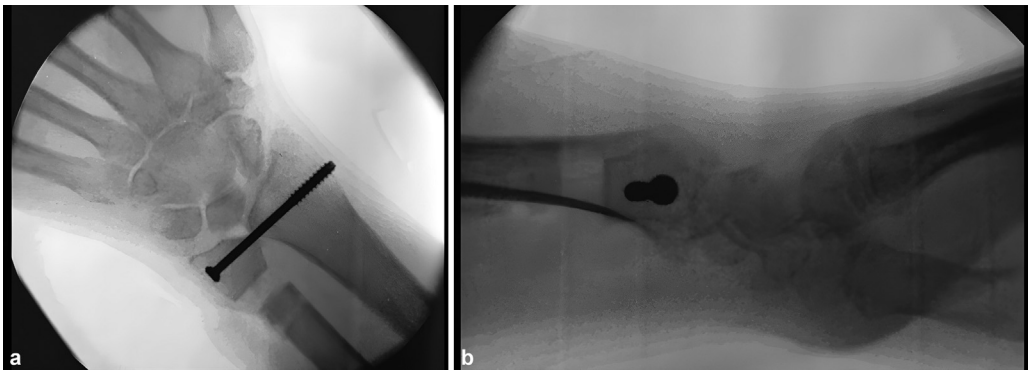

Fig. 5 (**a**) Anteroposterior intraoperative fluoroscopic image after ulnar osteotomy and tendon stabilization. (**b**) Lateral intraoperative fluoroscopic image after ulnar osteotomy and tendon stabilization.

the arithmetic mean and the standard error of the mean (SEM) for quantitative variables. Statistical comparisons used a one-way analysis of variance (ANOVA) for repeated measures with a posthoc Bonferroni multiple comparisons test to determine statistically significant differences in mean values at several evaluation times. Differences were statistically significant when p-values were lower than 0.05.

Results

We analyzed 11 patients with secondary DRUJ osteoarthritis who underwent surgery using the described technique (arthroscopic S-K with proximal tendon stabilization) (►**Table 1**). The minimum follow-up was 12 months (range, 12 to 36 months) with a meantime of 19 months.

Pain per the VAS scale significantly improved from the preoperative period to the four postoperative evaluations. Moreover, there were significant differences between each evaluation and the next up to the sixth month (►**Fig. 6**). Joint balance also improved significantly in extension, flexion, pronation, and supination (►**Fig. 7**).

The grip strength presented a statistically significant difference between the preoperative measurement and the four postoperative evaluations. The strength worsened in the first postoperative month and increased from the third month onward. There were statistically significant differences between each evaluation and the next (►**Fig. 8**).

Table 1 Series of patients operated on with arthroscopic S-K technique with proximal tendon stabilization

Gener	10 males, 1 female
Age	39.1 ± 4.0 years old (range, 16 to 55)
Side	8 right; 3 left. 91% of dominant hand involvement
Cause	5 distal radius fractures consolidated in poor position (45.5%)
	3 DRUJ dislocations (27.3%)
	3 Chronic instabilities due to foveal lesion of the TFCC (27.3%)

DRUJ, Distal radioulnar joint; TFCC, triangular fibrocartilage complex.

The Quick-DASH score (►**Fig. 9**) for functional assessment revealed a significant improvement from the preoperative period and the four postoperative assessments. In addition, there were significant differences between each evaluation and the next up to the sixth month. The MWS score improved significantly between the preoperative period and the assessment performed 12 months after surgery (►**Fig. 10**).

All patients presented arthrodesis consolidation in an average period of 3.25 months after surgery (range, 2.5 to 4 months).

Work and sports recovery with no limitations occurred in 10 patients (91%), while one subject returned to work with restrictions. This last patient had a previous arthroscopic foveal TFCC reattachment surgery that was unsuccessful due to the poor quality of the repaired tissue. No patient presented osteotomy fusion or arthrodesis nonunion. During the postoperative period, one patient had a sensation of instability of the proximal stump one month after surgery, with complete resolution after forearm muscle strengthening.

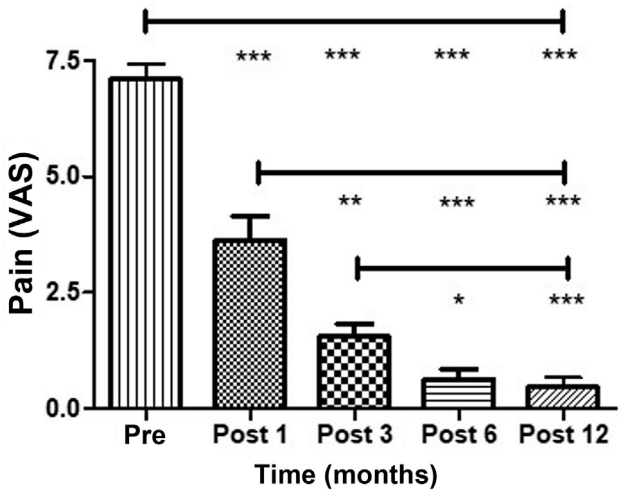

Fig. 6 Pain evaluation using the visual analog scale (VAS) before the intervention (pre) and in the postoperative period (post 1, 3, 6, and 12 months). Data are expressed as mean ± standard error of the mean (SEM). Significantly differences, $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. 1. Pain (VAS), 2. Pre, 3. Post 1, 4. Post 3, 5. Post 6, 6. Post 12, 7. Time (months).

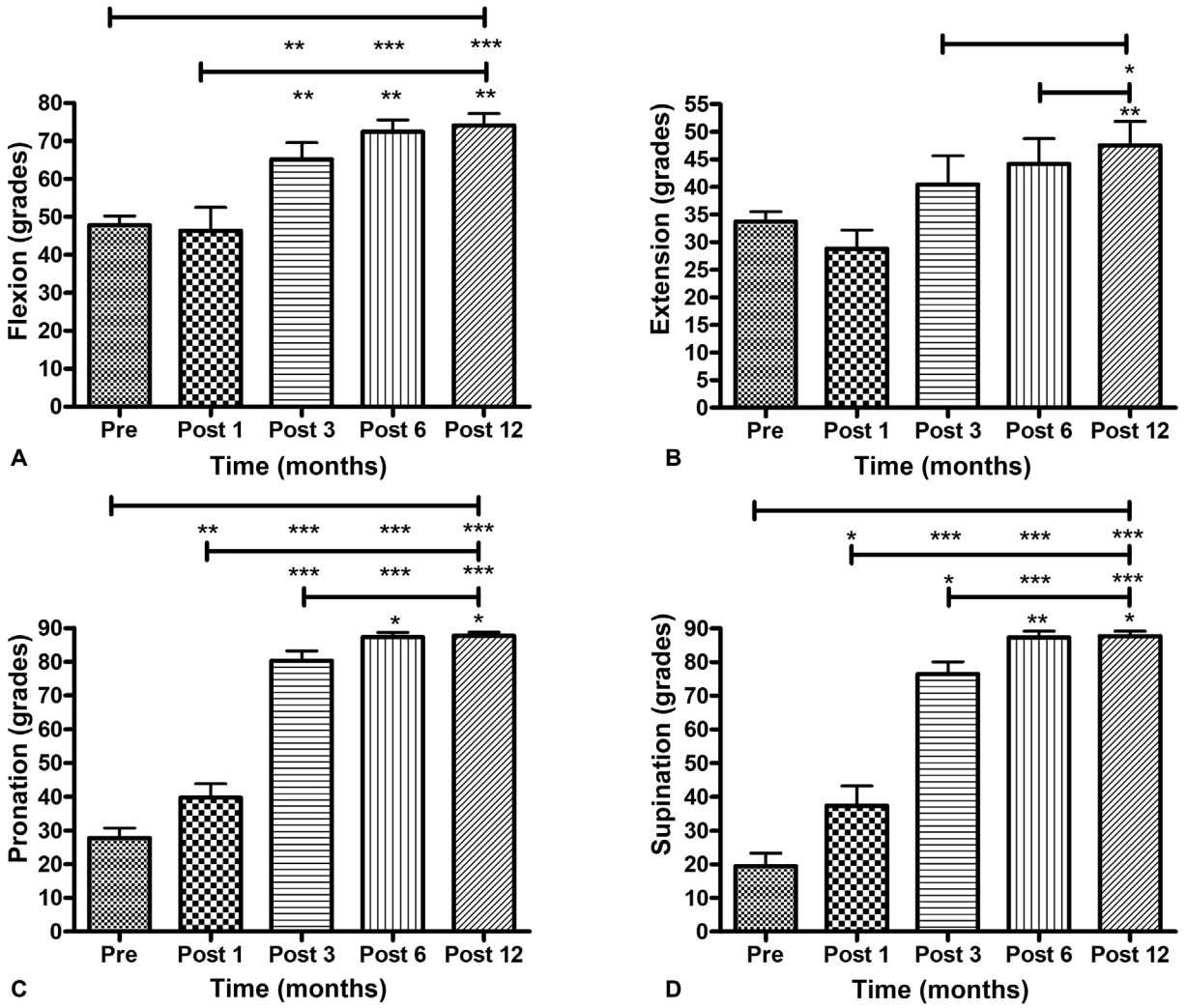

Fig. 7 Evaluation of the joint range in flexion (**A**), extension (**B**), pronation (**C**), and supination (**D**) (in degrees) before the intervention (pre) and in the postoperative period (post 1, 3, 6, and 12 months). Significantly differences, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$. 1. Flexion (grades), 2. Pre, 3. Post 1, 4. Post 3, 5. Post 6, 6. Post 12, 7. Time (months), 8. Extension (grades), 9. Pre, 10. Post 1, 11. Post 3, 12. Post 6, 13. Post 12, 14. Time (months), 15. Pronation (grades), 16. Pre, 17. Post 1, 18. Post 3, 19. Post 6, 20. Post 12, 21. Time (months), 22. Supination (grades), 23. Pre, 24. Post 1, 25. Post 3, 26. Post 6, 27. Post 12, 28. Time (months).

One subject presented pain 3 months postoperatively due to skin friction with the head of the arthrodesis screw. The pain stopped after osteosynthesis material removal after confirming complete DRUJ consolidation. Hardware removal was not necessary in the remaining cases.

All patients declared their satisfaction with the outcomes at the end of the follow-up period.

Discussion

The S-K technique for treating distal radioulnar arthropathy is a useful procedure that improves the transmission pattern of loading forces from the hand to the forearm by maintaining the ulnar head in normal alignment with the radius and carpus. This alignment plays a major role in effective load transmission, especially in young patients with high demands. This fact explains why S-K is the procedure of choice in these subjects and active elderly patients with DRUJ osteoarthritis.[15] At the same time, maintaining the ulnar head brings some advantages due to ECU stabilization in its compartment, ulnocarpal ligament sparing, and a more aesthetic wrist appearance.[16]

However, this procedure is not free of potential complications. Lluch[17] and Coulet et al.[18] described the complications directly related to the S-K technique, including nonunion or delayed arthrodesis consolidation and failed arthrodesis resulting from incomplete articular cartilage resection, incorrect Kirschner wire or screw placement or protrusion, fibrous or bony union, and symptomatic instability of the proximal stump due to radioulnar impingement or extensor tendon involvement. In our series, using the arthroscopic S-K technique and proximal tendon stabilization, all cases presented arthrodesis consolidation, and there was no case of osteotomy consolidation. Screw removal because of discomfort was necessary in one patient.

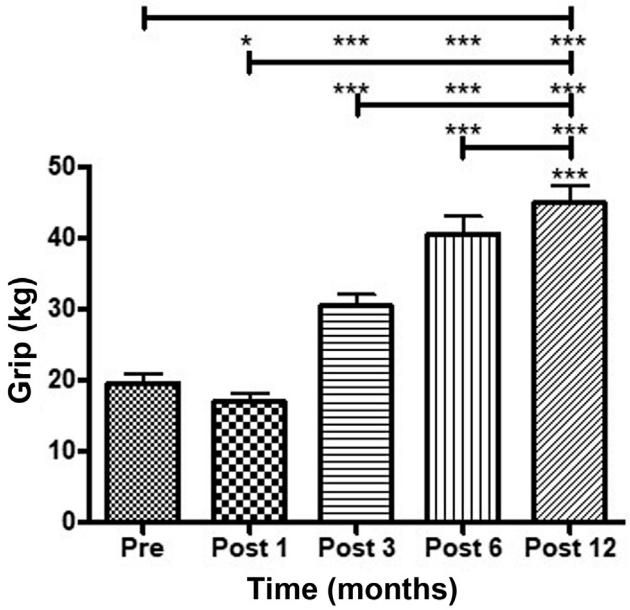

Fig. 8 Assessment of grip strength (in kg) before the intervention (pre) and in the postoperative evolution (post 1, 3, 6, and 12 months). Significantly differences, * $P < 0.05$, *** $P < 0.001$. 1. Grip (kg), 2. Pre, 3. Post 1, 4. Post 3, 5. Post 6, 6. Post 12, 7. Time (months).

The main complication described was painful instability of the proximal ulna stump, which is usually difficult to correct.[19] Painful instability of the proximal ulna stump is more common after the S-K procedure compared with the Darrach technique because the ulnar osteotomy is more proximal in the S-K procedure. Since the axis of rotation of the forearm runs obliquely from the center of the radial head proximally to the center of the ulnar head distally, the osteotomy must be as close to the head of the ulna as possible. A more proximal osteotomy will cause a motion divergence between the proximal stump and the ulnar head, which was already attached to the radius. For all this, Lluch

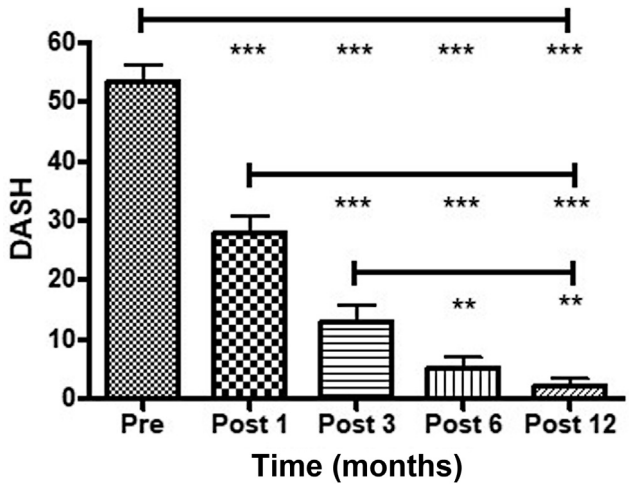

Fig. 9 Results of the functional assessment with the Quick Disability of Arm, Shoulder and Hand (DASH) score before the intervention (pre) and in the postoperative period (post 1, 3, 6, and 12 months). Significantly differences, ** $P < 0.01$, *** $P < 0.001$. 1. Pre, 2. Post 1, 3. Post 3, 4. Post 6, 5. Post 12, 6. Time (months).

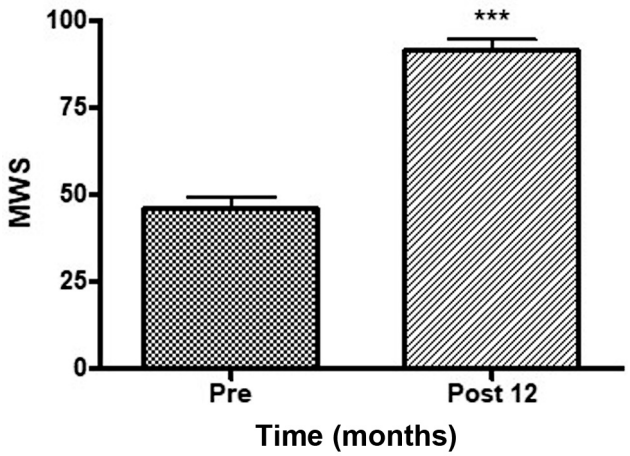

Fig. 10 Results of the functional assessment with the Mayo Wrist Score (MWS) before the intervention (pre) and 12 months after the procedure (post 12). Significantly differences, *** $P < 0.001$. 1. Pre, 2. Post 12, 3. Time (months).

recommended performing the osteotomy just proximal to the ulnar head, removing only 5 mm of bone to obtain the best outcomes.[20] Another reason for performing the ulnar osteotomy as distal as possible is to avoid altering the static structures and dynamics providing stability to the proximal ulna, such as the pronator quadratus (PQ), ECU, and FCU muscles, and the interosseous membrane (IOM) attachment. The PQ deep head is the main dynamic stabilizer of the proximal ulna, and it is not advisable to use it as an interposition between both ends of the ulna, as is done in several techniques. To avoid proximal stump instability, a tenodesis with a tendon band of the ECU[13] or FCU[21] has been recommended, preserving its distal attachment to the pisiform bone. The fibrous ECU tendon tunnel plays a significant role in DRUJ stabilization.[22] Although the arthrodesed ulnar head does not need the ECU for its stabilization, it still provides some proximal stump stabilization, which is more effective if the osteotomy is very close to the ulnar head, there is no tendon sheath division, and the ECU is placed dorsal to the osteotomy. García-López et al.[23] presented a series of cases operated on using the open technique, in which six of the 27 patients had symptomatic proximal ulnar stump instability. Two of their patients required a new surgical intervention combining stabilization using the ECU and the FCU. One patient presented postoperative sensory changes in the area of the dorsal ulnar cutaneous branch, and two subjects had a lack of fusion of the arthrodesis at one year of follow-up, which required a new surgical intervention to achieve it. In two cases, there was no radiographical or clinical fusion. One patient continued to present pain at the distal radioulnar level, which required a new intervention for a distal radioulnar arthroplasty. In our series, there were no symptomatic instabilities or nerve involvement, and no patient had pain at one year of follow-up. In addition, there was no lack of arthrodesis or fusion consolidation at the osteotomy level. The hemitendon stabilization of the ECU used by García-López et al. was a variant of the Minami technique[13] in the form of a tie or scarf over the

proximal ulnar stump and suturing the hemitendon over itself but with no interposition at the osteotomy level.

In the series reported by García-López et al., 13 patients (48.15%) returned to work with no limitations, 10 patients (37%) returned to work with restrictions, and three patients (11.11%) were unable to return to work.[23] In contrast, in our series, 91% of the patients returned to their previous jobs, and a single subject required a work readjustment.

Abe et al.[24] used the arthroscopic technique to stabilize the proximal stump by suturing the PQ muscle and tightening the periosteum of the remaining ulna. However, 25% of their patients presented discomfort in the proximal stump. These authors also reported five tendon ruptures and five subjects required osteosynthesis material removal due to pain. Our series had no tendon ruptures and a single patient required screw removal.

Carter and Stuart[25] published a series of complications in their study of 37 patients undergoing open surgery. They observed that forearm rotation and grip strength were 92% and 62% compared with the contralateral side, respectively. Nine patients (24%) complained of ulnar stump pain, and five (14%) presented DRUJ nonunion. Voche et al.[26] reported 21 patients who underwent an open S-K procedure, with a mean forearm rotation and grip strength of 87% and 55% compared with the contralateral side, respectively. Eight patients presented stump instability, and three subjects had ossification of ulnar arthrodesis. In our series, all patients had consolidated arthrodeses, no subject presented pseudoarthrosis ossification, and there was a single case of sensation of instability of the proximal stump one month after surgery. This instability resolved completely with forearm muscle strengthening with no need for more interventions. At the end of the follow-up, our patients had no pain (VAS, 0.45), presented almost complete rotation (pronation, 87.30; supination, 87.30), and their strength improved more than 100% compared with the preoperative period and an absolute value consistent with the one described for healthy wrists by other studies.[27]

The S-K procedure also poses technical issues. Since it occurs on the hand table with the forearm pronated, it is difficult to achieve an adequate reduction of the ulnar head over the sigmoid fossa, sometimes resulting in a poor reduction with dorsal protrusion of the ulnar head. Additionally, the extensor mechanism requires addressing to expose the ulnar head, potentially leading to extensor tendon adhesion, even if repaired afterward. With the arthroscopic technique, the visualization of the arthrodesis position of the ulna head is direct, minimizing these risks.

Although the nonunion rate in the open S-K procedure remains unclear, some studies have reported it as high.[17] This complication is minimized using arthroscopy, avoiding arthrotomy, and damaging the vascular supply and capsular attachment of the DRUJ, and reducing the need for bone grafting. Joint fusion using arthroscopic techniques has become popular in recent years due to the preservation of the surrounding soft tissue providing vascularity to the joint.[28] In our series, all patients had arthrodesis fusion with an average period of 3.25 months. This period is consistent with the report from Abe et al.,[24] who achieved bone union in all patients between 2 and 3.5 months after surgery. In addition, arthroscopy allows a complete assessment of the joint status before making decisions regarding the treatment and evaluating the exact amount of required joint resection. The arthroscopy-assisted technique reduces postoperative pain and allows a more comfortable rehabilitation start. The lack of arthrotomy avoids capsular, extensor compartments, ligamentous, and nervous structures of the ulnar edge and reduces post-reconstruction joint stiffness. Moreover, it preserves the ECU position intact because of the lack of an incision and the vertical position of the wrist with neutral pronosupination. The vertical placement of the wrist during arthroscopy facilitates the ulnar head reduction over the sigmoid fossa of the radius. All this leads to an earlier mobility improvement. Furthermore, arthroscopy minimizes the need for fluoroscopy since direct visualization from the v-DRU portal allows us to see how the screw compresses the DRUJ (►**Fig. 3b**).

Luchetti et al.[2] published the results of the arthroscopic S-K technique with no proximal stump stabilization with several advantages and favorable outcomes, no notable complications, a significant increase in pronosupination strength and mobility, and a decrease in pain, which allowed patients' return to their previous manual work. Regarding joint balance, our study shows a statistically significant improvement in flexion-extension and pronosupination arcs, as well as in subjective parameters and functional assessment scores. DASH, MWS, and pain results are consistent with other studies using the arthroscopic technique.[2,29] In addition, the range of mobility in pronation and supination ($> 87^{o}$) was superior in our series. The differentiating factor of our study is the addition of tendon stabilization of the proximal stump since no long-term works demonstrate the lack of stump instability symptoms.

Although, indeed, the distal location of the osteotomy, just proximal to the ulnar neck, and the resection of a small amount of bone are essential to avoid instability of the ulnar stump, and PQ interposition or other stabilization techniques were not usually required, we advocate stabilization with ECU using the Minami technique[13] for two reasons. First, the interposition of the tendon through the diaphysis makes the bone fusion of the osteotomy difficult, and second, a short osteotomy (5 to 8 mm) spares the deep head of the tendon. The pronator teres is a palmar stabilizer of the stump, but dorsal stabilization occurs with ECU tenodesis. Tomori et al.[12] demonstrated in their study with three different stump stabilization techniques (without stabilization, with stabilization and an ECU hemiband from proximal to distal, and with stabilization from distal to proximal)[13] that although there were no significant differences in wrist pain, ulnar stump pain was significantly different between the non-stabilized group and the stabilized groups.

Conclusion

The arthroscopic S-K technique with proximal tendon stabilization is a safe, less invasive, and effective procedure with

better aesthetics and outcomes than the classic open and arthroscopic technique with no tendon stabilization. However, further studies are required to determine whether additional techniques are necessary to stabilize the proximal stump.

Conflict of Interest
None declared.

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