# Arthroscopically-Assisted Foveal Repair of the Triangular Fibrocartilage Complex: Anchor Fixation versus Trans Osseous Tunnel – A Comparative Study

## *Reinserción foveal del complejo fibrocartílago triangular con asistencia artroscópica: Túneles transóseos versus fijación con anclaje óseo – Un estudio comparativo*

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## Abstract

**Introduction** The triangular fibrocartilage complex (TFCC) plays a fundamental role in the stability of the wrist, and its foveal insertion is the primary structure that performs this function. Surgical repair of the CFCT is challenging given the complexity of the anatomical structures, and arthroscopically-assisted reinsertion has shown certain benefits. The most commonly used techniques are reinsertion with anchors (RAs) and transosseous tunnels (TOs).

**Objective** To compare the functional results of patients with acute foveal lesion of the CFCT operated through RAs versus TOs, both with arthroscopic assistance.

**Materials and methods** A retrospective, observational study of patients operated on for foveal disinsertion of the TFCC. We included patients older than 18 years of age, with a traumatic history and conservative treatment lsting 3 months, with persistent pain and arthro-computed tomography (arthroCT) compatible with foveal disinsertion

**Keywords**
- triangular fibrocartilage complex
- arthroscopy
- foveal reinsertion

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of the TFCC. Patients treated with the RA technique versus TOs were compared, both with arthroscopic assistance. The variables studied were pain during load according to the visual analog scale (VAS), Mayo score, and ranges of motion of the wrist. Values of $p < 0.05$ were considered statistically significant.

**Results** We included 24 patients (11 in the RAs group and 13 in the TOs group) With an average age of 28.5 years, 58% of whom were male, without statistically significant differences between the groups. In the whole sample, a decrease in pain of 4.33 points (standard deviation [SD]: 1.16) on the VAS was found, with no statistically significant differences between the groups ($p = 0.98$). The Mayo score improved in both groups, with an average of 30.09 points (SD: 0.94) in the RAs group, and 31.92 points (SD: 1.32) in the TOs group, and this difference was statistically significant ($p = 0.0004$). Flexion-extension increased by 5.2° (SD: 2.3°) in the RAs group, and by 6.9° (SD: 1.32°) in the TOs group, and this difference was also statistically significant ($p = 0.01$). Pronation improved by 15.9° (SD: 1.7°) in the RAs group, and by 15.8° (SD: 1.72°) in the TOs group, which was not statistically significant ($p = 0.46$), and supination improved by 17.09° (SD: 2.46°) in the RAs group, and by 17.5° (SD: 1.61°) in the TOs group, which was statistically significant ($p = 0.004$).

The mean duration of ischemia was of 34.2 minutes (SD: 4.36 minutes) in the TOs group, and of 78.9 minutes (SD: 9.39 minutes) in the RAs group, and this difference was statistically significant ($p = 0.000$).

**Discussion** In the surgery for foveal reinsertion of the TFCC, both the techniques with anchors and with TOs, are effective in reducing load-bearing pain, improving the ranges of motion of the joints and the functional score. Although we found statistically significant differences between the groups regarding the Mayo score, flexion-extension and supination, these do not exceed the minimally-significant clinical differences.

**Conclusion** Both techniques are effective in reducing weight bearing pain and improving function and range of motion of the wrist. TO surgery has a significantly shorter ischemia time than RA surgery.

## Resumen

**Introducción** El complejo fibrocartílago triangular (CFCT) cumple un rol fundamental en la estabilidad de la muñeca, y su inserción foveal es la estructura primordial en esta función. La reparación quirúrgica del CFCT es un desafío dada la complejidad de las estructuras anatómicas, por lo que la reinserción con asistencia artroscópica ha mostrado ciertos beneficios. Las técnicas más utilizadas son la reinserción con anclaje óseo (RA) y con túneles transóseos (TOs).

**Objetivo** Comparar los resultados funcionales de pacientes con lesión foveal aguda del CFCT operados por RA o TOs, ambos con asistencia artroscópica.

**Materiales y métodos** Estudio retrospectivo, observacional, de pacientes operados por desinserción foveal del CFCT. Se incluyeron pacientes mayores de 18 años, con antecedente traumático y manejo médico de 3 meses de evolución con persistencia de dolor, y artrotomografía computarizada (artroTC) compatible con desinserción foveal del CFCT. Se compararon pacientes operados por técnicas de RA y TOs, ambas con asistencia artroscópica. Las variables estudiadas fueron dolor en carga según la escala visual análoga (EVA), puntaje de Mayo, y rangos de movilidad de la muñeca. Se consideraron significativos aquellos valores de $p < 0.05$.

**Resultados** Se incluyeron 24 pacientes (11 en el grupo RA y 13 en el grupo TOs), con edad promedio de 28,5 años, 58% del sexo masculino, sin diferencias estadísticamente significativas en ambos grupos. En toda la muestra, se encontró una disminución de 4,33 puntos (desviación estándar [DE]: 1,16) en el putaje de la EVA, sin diferencia estadísticamente significativa entre los grupos ($p = 0,98$). El puntaje de Mayo mejoró

**Palabras Clave**
- complejo fibrocartílago triangular
- artroscopia
- reinserción foveal

 

en ambos grupos, con un promedio de 30.09 puntos (DE: 0,94) en el grupo RA, y de 31,92 puntos (DE: 1.32) en el grupo TOs, siendo esta diferencia estadísticamente significativa ($p = 0{,}0004$). La flexoextensión aumentó en 5,2° (DE: 2,3°) en el grupo RA, y en 6,9° (DE: 1,32°) en el grupo TOs, siendo esta diferencia estadísticamente significativa ($p = 0{,}01$). La pronación mejoró en 15,9° (DE: 1,7°) en el grupo RA, y en 15,8° (DE: 1,72°) en el grupo TOs, lo cual no fue significativo ($p = 0{,}46$), y la supinación mejoró en 17,09° (DE: 2,46°) en el grupo RA, y 17,5° (DE: 1,61°) en el grupo TOs, siendo esta diferencia estadísticamente significativa ($p = 0{,}004$).
El tiempo de isquemia promedio fue de 34,2 minutos (DE: 4,36 minutos) en el grupo TOs, y de 78,9 minutos (DE: 9,39 minutos) en el grupo RA, siendo esta diferencia estadísticamente significativa ($p = 0{,}000$).
**Discusión** En la cirugía de reinserción foveal del CFCT, tanto el anclaje óseo como los TOs son efectivos en disminuir el dolor en carga, y mejorar los rangos articulares y el puntaje funcional. Si bien encontramos diferencias estadísticamente significativas entre los grupos con relación al puntaje de Mayo y a la flexoextensión y supinación, éstas no superan las diferencias clínicas mínimamente significativas.
**Conclusión** Ambas técnicas son efectivas en disminuir el dolor en carga y mejorar función y rangos de movilidad de la muñeca. La cirugía de TO tiene un tiempo de isquemia significativamente menor a la cirugía de RA.

## Introduction

The triangular fibrocartilage complex (TFCC), initially described by Palmer and Werner,[1] plays a fundamental role in stabilizing the distal radioulnar (DRU) joint.[2–6] It plays a key role during pronosupination, and in softening the axial load in the ulnocarpal joint.[4] Its complex structure and anatomical location predispose it to a high risk of acute injuries due to wrist trauma and degenerative injuries.[5]

Currently, biomechanical and anatomical studies[7] confirm the relevance of deep fibers and foveal insertion in DRU joint stability.

Tears to the TFCC, both chronic and acute, are one of the most common causes of ulnar wrist pain, especially during pronosupination, causing a decrease in fist strength and in global function.[8] These lesions may go unnoticed and therefore underdiagnosed, and are found in 42% of the patients with posttraumatic wrist pain and a negative initial radiological study.[9]

Many of these injuries, especially those that are peripheral, can be successfully managed conservatively and rarely require immediate surgical intervention.[3] However, given the failure of the conservative treatment, with persistent pain, or the presence of DRU instability that is more frequently observed in larger lesions or those involving the foveal portion, surgical repair of the TFCC would be indicated.[3]

Lesions to the TFCC have been classified by Palmer[10] according to their chronicity and compromised structure, and more recently by Atzei and Luchetti,[3] who subdivide Palmer Type-1B lesions and take into account the severity of the damage, make a therapeutic proposal, and provide a prognosis. Certain Palmer Type-1B lesions, which correspond subclasses 2 and 3 in the classification by Atzei and Luchetti, are those that generally present with DRU joint instability, frequently requiring a surgical intervention that consists of the reinsertion of the deep or foveal fibers of the TFCC to the distal ulna.

The surgical alternatives for foveal reattachment can be divided into two large groups: open surgery and arthroscopically-assisted surgery. Both techniques have shown to be effective in restoring stability and reducing pain.[4,11–13] Arthroscopic-assisted techniques have become popular in recent years due to their high diagnostic accuracy[3,4] of the injury, and because they minimize soft tissue damage, which in many cases translates to a reduction in postoperative pain.[12]

Within the fixation options of the foveal portion to the distal ulna, the most commonly used methods are reinsertion with bone anchors (RAs) and reinsertion with sutures through transosseous tunnels (TOs).[4,8,14–17] Both techniques have shown satisfactory results,[4,8,14–17] but no studies comparing them have not been found in the international literature.

The present study aims to compare the functional results of the foveal reinsertion of the TFCC in acute lesions, performed with arthroscopic assistance and RAs versus TOs.

## Materials and methods

A retrospective observational study comparing patients undergoing surgery for a foveal lesion of the TFCC, operated on with arthroscopic assistance by the same senior hand surgeon. They were divided into two groups according to the type of fixation to the distal ulna, either with by RAs or TOs.

 

We included 24 patients (11 in the RAs group, and 13 in the TOs group) with a mean age of 28.5 years (range: 19 to 44 years), 58% of whom were male, with no statistical differences between both groups.

Patients older than 18 years of age, with ulnar wrist pain with a history of a traumatic event, who underwent orthopedic treatment for 3 months and persisted with pain, were included. The patients had an arthro-computed tomography (arthroTC) scan compatible with a foveal lesion of the TFCC (Palmer 1B or Atzei 2 and 3). Patients with concomitant acute injuries of the same wrist and those with a history of previous surgery of the ipsilateral upper limb were excluded. The demographic and clinical data were obtained from the electronic medical records (Medysin 3.0, TISAL S.A, Santiago, Chile), and the arthroTC images in the IMPAX (Agfa Healthcare, Mortsel, Bélgica) software were informed by a radiologist specialist in musculoskeletal pathology and evaluated by a senior hand surgeon. Surgical treatment was indicated to patients with persistent pain despite adequate conservative treatment for a minimum of 3 months, with immobilization for 6 weeks and later rehabilitation treatment. The surgical technique applied in both groups involved upper limb ischemia, in a wrist traction tower and classic 3-4 arthroscopic portals, and a mini-ulnar incision. In the RAs group, a 3.5-mm anchor (Corkscrew FT, Arthrex, Naples, FL, Unites States) was used, while in the TOs group, the technique with 2 bone tunnels described by Nakamura et al.[4] was used. The surgical techniques used are shown in **figures 1** and **2**. The lesions found on arthroscopy were correlated with those found on the arthroTC in all cases.

The surgical time was equivalent to the ischemia time described in all cases, since emptying begins just before making the incision, and the ischemia is removed immediately after skin closure.

All patients were managed with a sugar-tong cast postoperatively for 6 weeks, and then underwent at least 10 sessions of rehabilitation therapy with exercises for wrist and elbow range of motion and DRU joint stability. The clinical assessment of the load-bearing pain was performed with the visual analog scale (VAS) and the Modified Mayo Wrist Score (MMWS),[18] and ranges of motion were evaluated with a goniometer in the preoperative period and six months postoperatively.

For the statistical analysis, the differences found in means and medians of the evaluated variables were analyzed. Values of $p < 0.05$ were considered statistically significant. The STATA software (Statacorp LLC, College Station, TX, United States), version 15, was used.

## Results

The time of evolution until surgery averaged 13.9 weeks (range: 12 to 16 weeks) in the RAs group, and 14.2 weeks (range: 12 to 18 weeks) in the TOs group, without statistical significance ($p = 0.7266$). In the two groups, a pain reduction of 4.33 points was observed on the VAS (standard deviation [SD]: 1.16), with no statistically significant difference between the two groups ($p = 0.98$). The MMWS improved in both groups, with an average of 30.09 points (SD: 0.94) in the RAs group and of 31.92 points (SD: 1.32) in the TOs group, and this difference was statistically significant ($p = 0.0004$). Flexion-extension increased by 5.2° (SD: 2.3°) in the RAs group and by 6.9° (SD: 1.32°) in the TOs group, and this difference was also statistically significant ($p = 0.01$). Pronation improved by 15.9° (SD: 1.7°) in the RAs group and by 15.8° (SD: 1.72°) in the TOs group, which was not statistically significant ($p = 0.46$), and supination improved by 17.09° (SD: 2.46°) in the RAs group and by 17.5° (SD: 1.61°) in the TOs group, and this difference was statistically significant ($p = 0.004$). The results are shown in **tables 1** and **2** and **charts 1**, **2**, and **3**.

The mean ischemia time was of 34.2 minutes (SD: 4.36 minutes) in the TOs group and of 78.9 minutes (SD: 9.39 minutes) in the RAs group, and this difference was also statistically significant ($p = 0.000$). The result is shown in **chart 4**.

There were no complications associated with the techniques described in the present series of patients.

## Discussion

The TFCC is a primary stabilizer of the DRU joint, and its foveal portion is the most important that performs this function.[2–7] In patients with lesions of this structure and who, despite medical treatment, remain symptomatic and with an unstable DRU joint, it is necessary to perform a reinsertion of the foveal portion of the TFCC to the distal ulna to recover the correct biomechanics of the wrist and thus reduce pain and improve overall function.[4,8,11–17]

Currently, arthroscopic techniques have become very important, since, as a result of the magnification and implementation of small instruments, it enables an accurate diagnosis of these injuries.[4,8] In addition, they enable the performance of advanced techniques that have shown clinical results similar to those of open techniques, and with even better results in terms of the remaining ulnar pain.[12] This may be due to the minimization of soft-tissue damage and the full preservation of other structures relevant to the stability of the DRU joint.

Both the technique of foveal reinsertion of the TFCC with bone anchorage and that with TOs are effective in reducing load-bearing pain, and improving the range of motion of the joints and the functional score,[3,4,8,11–17] and the present work is the first to compare both techniques with arthroscopic assistance. Regarding the limitations of the present study, it is necessary to highlight that it presents the limitations of a retrospective study, which is why it is necessary to carry out prospective and randomized studies in the future.

Although we found statistical differences in the improvement in the MMWS, in flexion-extension, and in supination, these did not exceed the minimally-significant clinical differences, which is why they are irrelevant to the daily function of our patients.

We found significant differences with respect to surgical time, which was longer in the RA technique. This last

 

**Tabla 1:** Resumen de Resultados por Paciente en Grupo de Reinserción con Anclaje Óseo

| PACIENTE | EDAD | EVA PREOP | EVA 6 MESES | FLEXO - EXTENSIÓN PREOP | FLEXO - EXTENSIÓN 6 MESES | SUPINACIÓN PREOP | SUPINACIÓN 6 MESES | PRONACIÓN PREOP | PRONACIÓN 6 MESES | ESCALA MAYO PREOP | ESCALA MAYO 6 MESES | TIEMPO A LA CIRUGÍA (SEMANAS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30 | 8 | 2 | 94 | 102 | 53 | 70 | 60 | 78 | 37 | 65 | 16 |
| 2 | 27 | 7 | 4 | 101 | 106 | 50 | 65 | 57 | 75 | 40 | 70 | 14 |
| 3 | 19 | 9 | 3 | 110 | 114 | 48 | 63 | 55 | 70 | 42 | 72 | 13 |
| 4 | 22 | 9 | 2 | 95 | 105 | 42 | 55 | 45 | 60 | 45 | 75 | 12 |
| 5 | 33 | 7 | 3 | 94 | 100 | 46 | 61 | 47 | 65 | 35 | 65 | 16 |
| 6 | 37 | 8 | 3 | 110 | 114 | 45 | 60 | 51 | 67 | 48 | 80 | 12 |
| 7 | 22 | 8 | 4 | 114 | 118 | 54 | 70 | 54 | 68 | 47 | 78 | 13 |
| 8 | 31 | 8 | 3 | 98 | 105 | 50 | 60 | 50 | 65 | 38 | 68 | 16 |
| 9 | 23 | 9 | 4 | 104 | 108 | 45 | 65 | 46 | 62 | 40 | 70 | 14 |
| 10 | 44 | 8 | 4 | 112 | 115 | 53 | 67 | 60 | 77 | 44 | 74 | 14 |
| 11 | 31 | 7 | 2 | 108 | 110 | 42 | 58 | 57 | 70 | 45 | 75 | 13 |

**Tabla 2:** Resumen de Resultados por Paciente en Grupo de Reinserción con Túneles Transóseos

| PACIENTES | EDAD | EVA PREOP | EVA 6 MESES | FLEXO - EXTENSIÓN PREOP | FLEXO - EXTENSIÓN 6 MESES | SUPINACIÓN PREOP | SUPINACIÓN 6 MESES | PRONACIÓN PREOP | PRONACIÓN 6 MESES | ESCALA MAYO PREOP | ESCALA MAYO 6 MESES | TIEMPO A LA CIRUGÍA (SEMANAS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 39 | 7 | 3 | 100 | 105 | 35 | 55 | 45 | 60 | 40 | 72 | 16 |
| 2 | 33 | 6 | 3 | 105 | 110 | 45 | 63 | 48 | 62 | 32 | 65 | 16 |
| 3 | 20 | 9 | 5 | 102 | 108 | 55 | 70 | 58 | 75 | 48 | 80 | 12 |
| 4 | 26 | 8 | 4 | 92 | 100 | 52 | 68 | 55 | 70 | 50 | 80 | 13 |
| 5 | 37 | 9 | 4 | 108 | 116 | 35 | 55 | 55 | 70 | 30 | 64 | 18 |
| 6 | 29 | 6 | 3 | 110 | 116 | 42 | 60 | 50 | 65 | 45 | 78 | 12 |
| 7 | 18 | 6 | 3 | 96 | 105 | 50 | 66 | 42 | 58 | 35 | 65 | 14 |
| 8 | 25 | 7 | 2 | 95 | 102 | 46 | 65 | 60 | 75 | 35 | 66 | 15 |
| 9 | 20 | 6 | 4 | 100 | 106 | 37 | 55 | 56 | 74 | 44 | 76 | 14 |
| 10 | 24 | 6 | 2 | 103 | 110 | 40 | 58 | 46 | 60 | 42 | 75 | 13 |
| 11 | 22 | 9 | 4 | 105 | 112 | 49 | 65 | 51 | 68 | 42 | 75 | 12 |
| 12 | 30 | 7 | 4 | 95 | 102 | 42 | 60 | 50 | 65 | 38 | 70 | 14 |
| 13 | 42 | 7 | 2 | 105 | 114 | 50 | 66 | 52 | 72 | 40 | 70 | 15 |

 

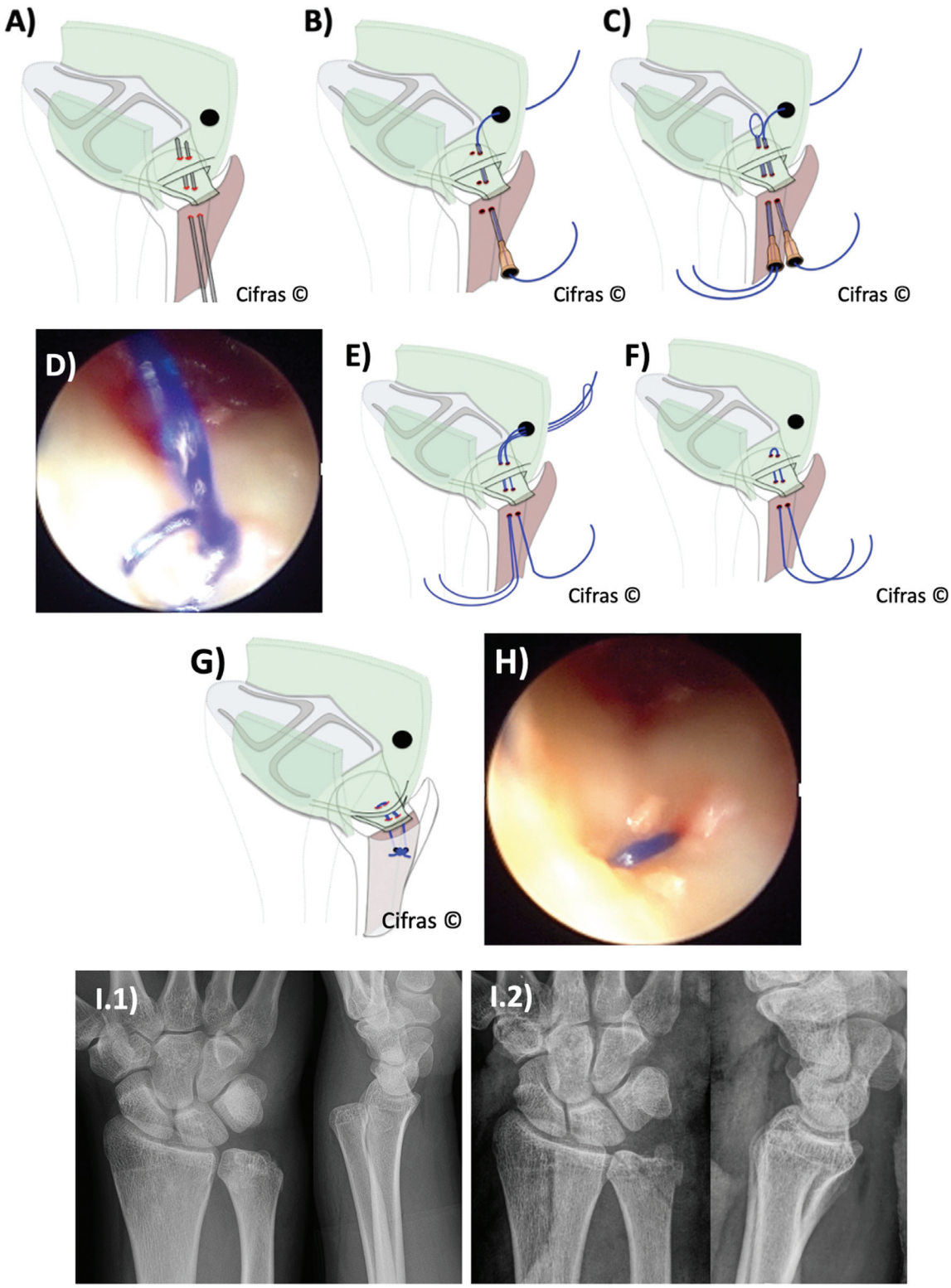


**Fig. 1 Diagram of the Reinsertion Technique with Transosseous Tunnels.** [4] (**A**) A 2-cm incision is made on the ulnar edge of the wrist at 1 cm from the tip of the styloid, in which 2 tunnels are made with 1.25-mm Kirschner Wires, displaying the correct exit through the triangular fibrocartilage complex (TFCC) in the area of the fovea, with arthroscopic assistance. (**B**) A hypodermic needle is passed using a 3-0 non-absorbable monofilament suture through one of the bone tunnels, which is taken out through the 6R portal. (**C-D**) A second hypodermic needle with a suture loop is passed through another bone tunnel, which is rescued through the same portal. (**E**) Outside the wrist, the first suture is passed through the loop, and (**F**) the loop filaments are pulled from the ulnar incision. (**G**) Finally, the two ends of the suture are tied on the ulnar cortex, and the stability of the TFCC is checked arthroscopically. (**H**) Example of a patient managed with this technique: (**I.1**) preoperative radiograph and (**I.2**) postoperative radiographic control. The arrow shows the transosseous tunnels.

 

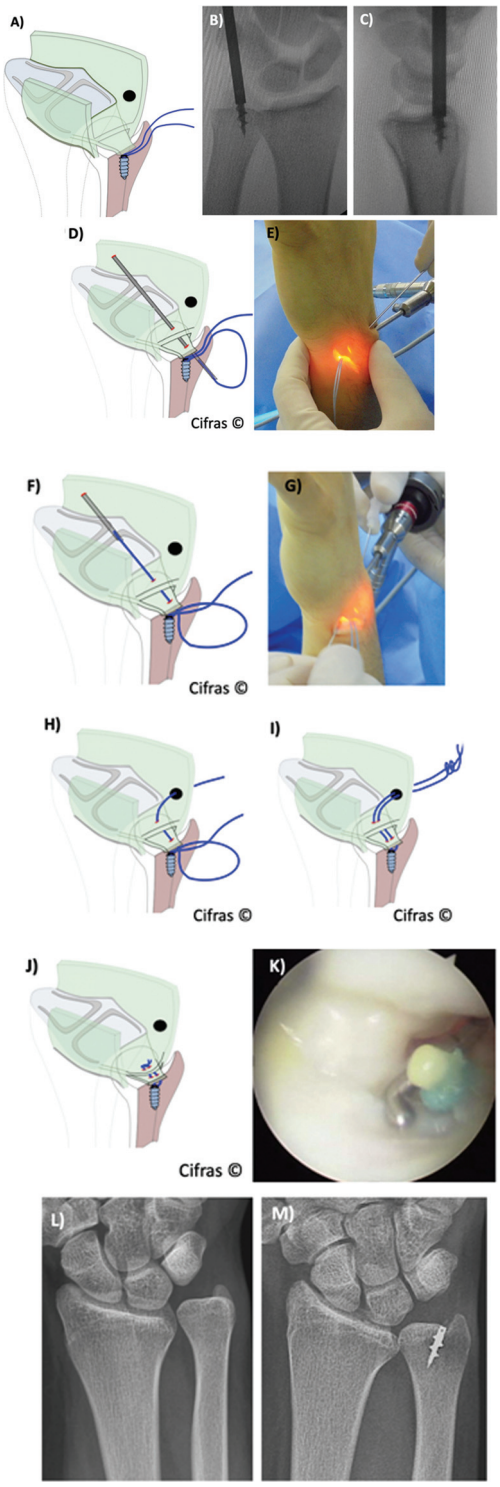


**Fig. 2 Diagram of the Reinsertion Technique with Anchors.** (**A**) A bone anchor is inserted through a mini-ulnar incision, and (**B-C**), under fluoroscopy, it is positioned in the fovea, and (**DE**), through the dorsal radiocarpal capsule, an epidural anesthesia trocar is passed through the TFCC and exits through the mini-ulnar incision. (**F-G-H**) Outside the skin, one of the anchor sutures is threaded into the anesthesia trocar and passed over the TFCC, the anesthesia trocar is removed, and the suture thread is rescued through the 6R portal. The same procedure is repeated for the second filament of suture. (**I-J**) Outside the skin, an arthroscopic knot is made and with a Knot Pusher, the suture is placed on the TFCC. (**K**) The filaments are cut over the knot, and the stability is tested with a probe. (**L-M**) Pre- and postoperative radiographs of the reinsertion with anchors.

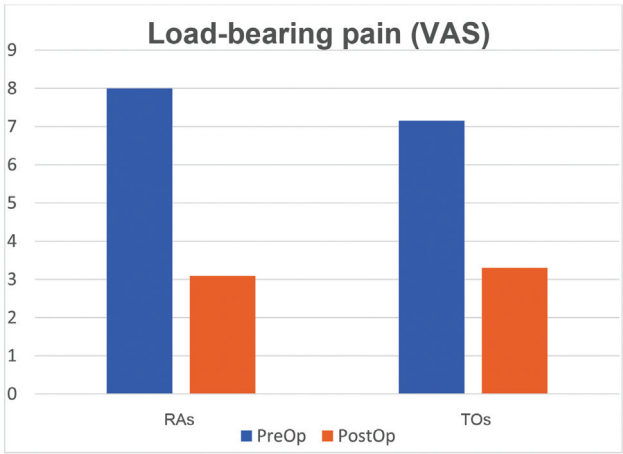


**Chart 1 Pre- and Postoperative Load-Bearing Pain in Both Surgical Techniques.** Abbreviations: VAS, Visual Analog Scale; RAs, reinsertion with anchors; TOs, transosseous tunnels.

difference can be attributed to a change in behavior in the management of the patients, with the first patients being operated by RAs and, currently, through TOs, so that the surgeon's experience in the arthroscopic management of these lesions could be the cause of the shorter surgical time. Similarly, in none of the cases did the ischemia time exceeded the 120 minutes recommended to safely maintain the vitality of the tissues.

Our functional clinical results are similar to those found in the international literature.[3,4,8,11–17] Clinically, both groups of patients had a satisfactory and similar evolution. We believe that both techniques are effective in reducing pain and improving wrist functional ranges of motion, with suturing through TOs being our surgery of choice given its shorter ischemia time.

## Conclusion

Both techniques are effective in reducing load-bearing pain and improving the function and ranges of motion of the wrist. There is a significant difference in the functional scores and flexion-extension and supination ranges in favor of TOs; this difference does not exceed the minimally-significant clinical difference. The TO surgery has a significantly shorter ischemic time than the RA surgery.

 

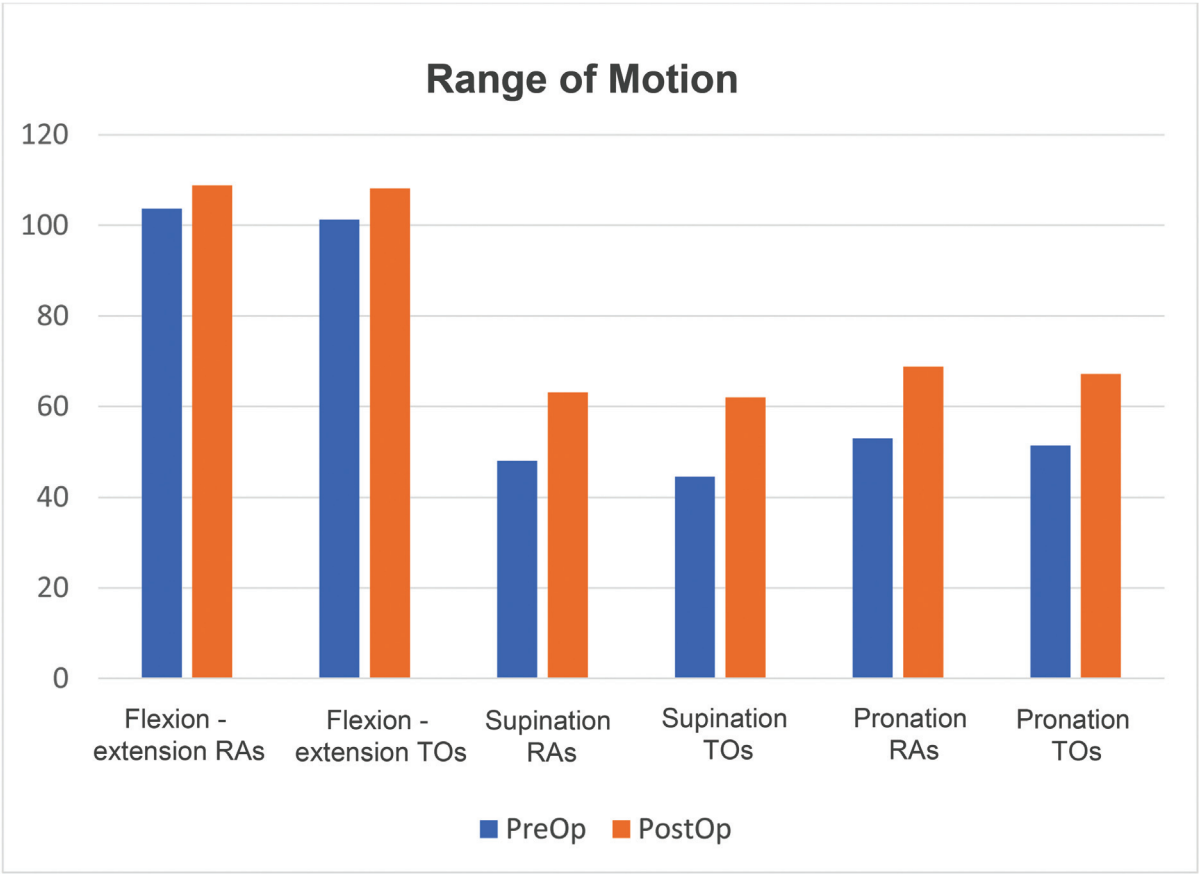


**Chart 2 Pre- and Postoperative Ranges of Motion in Both Surgical Techniques.** Abbreviations: RAs, reinsertion with anchors; TOs, transosseous tunnels.

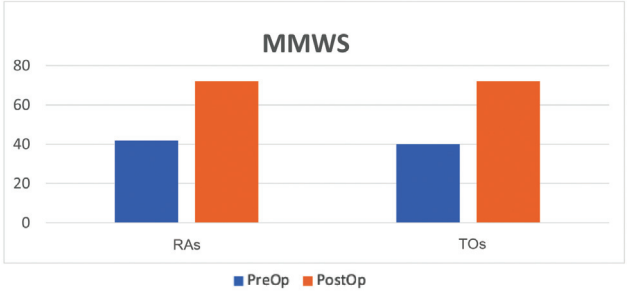


**Chart 3 Pre- and Postoperative Modified Mayo Wrist Score (MMWS) [18] in Both Surgical Techniques.** Abbreviations: RAs, reinsertion with anchors; TOs, transosseous tunnels.

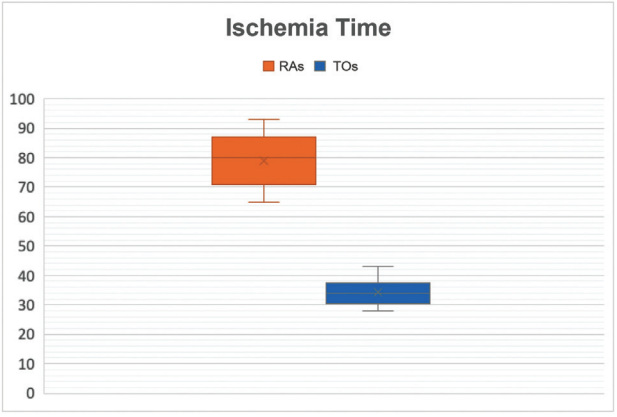


**Chart 4 Ischemia Time in Minutes in the reinsertion with anchors (RAs) and transosseous tunnels (TOs).**

Conflict of interests
The authors have no conflict of interests to declare in this work.

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