

High-Strength Suture Fixation in Metacarpal Fractures

Alejandro Quintero, Guillermo Flynn, Pablo E. Vion, Elvia Contreras

Orthopedics and Traumatology Service, Hospital Municipal "Dr. Diego E. Thompson", San Martín, Buenos Aires, Argentina

ABSTRACT

Introduction: Metacarpal fractures are highly prevalent in traumatology. When a surgeon determines that surgical treatment is required, numerous techniques are available, including K-wire fixation, open reduction and internal fixation with plates and screws, interfragmentary screws, and intramedullary screws, among others. **Materials and Methods:** This study included 19 patients with long oblique or spiral shaft fractures of the second to fifth metacarpals, who were treated with open reduction and high-strength suture internal fixation. The average follow-up period was 20 months. Radiographs and functional scales were used to document clinical outcomes. **Results:** Fracture consolidation was achieved in all patients, and they were able to resume their previous activities after an average of 2.3 months. One patient lost the initial reduction due to a failure to comply with medical instructions but achieved fracture consolidation without the need for additional procedures. **Conclusion:** The technique described herein provided a strong metal-free fixation with good clinical outcomes at a low cost.

Keywords: Metacarpal fractures; high-strength sutures; Nice knot.

Level of Evidence: IV

Fijación con sutura de alta resistencia para fracturas de metacarpianos

RESUMEN

Introducción: Las fracturas de metacarpianos son comunes en la práctica traumatológica. El cirujano dispone de diferentes opciones cuando decide implementar un tratamiento quirúrgico, como fijación percutánea con agujas de Kirschner, reducción abierta y fijación interna con placas y tornillos, tornillos interfragmentarios y tornillos endomedulares, entre otras. **Materiales y Métodos:** Se trató a 19 pacientes con fracturas diafisarias oblicuas largas o espiroideas del 2.º al 5.º metacarpiano mediante la reducción abierta y fijación interna con suturas de alta resistencia. El tiempo promedio de seguimiento fue de 20 meses. Se utilizaron radiografías y escalas funcionales para documentar los resultados obtenidos. **Resultados:** La fractura consolidó en todos los pacientes quienes retornaron a sus actividades en un promedio de 2.3 meses. Un paciente perdió la reducción inicial por no respetar las indicaciones médicas, pero la fractura consolidó sin necesidad de una nueva intervención. **Conclusión:** El método propuesto proporcionó una reducción anatómica, una fijación estable libre de metal y buenos resultados funcionales.

Palabras clave: Fractura; metacarpianos; suturas; nudo Nice.

Nivel de Evidencia: IV

INTRODUCTION

Diaphyseal fractures of the metacarpals are common in orthopedic practice. They are usually associated with angulation, rotation or shortening deformities. For those requiring surgical treatment, surgeons now have various alternatives, including percutaneous stabilization with K-wires, open reduction and internal fixation with plates and screws, interfragmentary or intramedullary screws, among others.^{1,2}

Multiple studies have been published on the different methods of osteosynthesis for this type of fracture, with varying outcomes. Complications to consider when choosing this treatment include postoperative stiffness, tendon injury, or an additional procedure to remove the osteosynthesis material. Given the advantages and disadvantages of each method, as well as the range of outcomes reported with each method, there is currently no global consensus on how to treat these fractures.³

Received on November 11th, 2023. Accepted after evaluation on April 17th, 2024 • Dr. ALEJANDRO QUINTERO • quinteroalejandro@live.com  <https://orcid.org/0000-0002-3490-285X>

How to cite this article: Quintero A, Flynn G, Vion PE, Contreras E. High-Strength Suture Fixation in Metacarpal Fractures. *Rev Asoc Argent Ortop Traumatol* 2024;89(3):239-245. <https://doi.org/10.15417/issn.1852-7434.2024.89.3.1848>

High-strength sutures have been used for years in all types of trauma and orthopedic procedures. They are often used as an aid in the reduction of third fragments in long bones. Complex procedures have recently been successfully conducted using only high-strength sutures, such as those described by Dr. Hachem in 'metal-free' arthroscopic Latarjet surgery, resulting in adequate fixation of the bone block until consolidation.⁴

On the other hand, the Nice knot described by Pascal Boileau made with high-strength sutures has been a useful and versatile contribution. Its sliding design allows working from a distance and in reduced spaces, and its strength and resistance are remarkable.⁵ It is simple and easy to reproduce. It is currently used in a variety of arthroscopic and open procedures; nevertheless, its effectiveness in bone fragment reduction and fixation, as well as whether its usage can interfere with bone healing, remains uncertain.

The aim of this article is to present a technique for the treatment of long oblique or spiral fractures of the 2nd to 5th metacarpals without metal, using only high-strength sutures in combination with a Nice knot, and the outcomes obtained.

MATERIALS AND METHODS

Between February 2019 and November 2021, 20 patients with diaphyseal fractures of the second, third, fourth, and fifth metacarpals with long oblique or long spiral single lines and no other associated injuries underwent surgery with high-strength sutures. One patient was withdrawn from the study because he failed to attend the controls after returning to work, making it impossible to conduct the appropriate follow-up. Those with short oblique or transverse fractures, associated tendon or ligament injuries and follow-up <18 months were excluded.

Patients underwent surgery under regional anesthesia (brachial plexus block) and with a hemostatic tourniquet. A longitudinal dorsal approach was performed over the fracture site and progressed through planes, carefully separating extensor tendons and neurovascular elements. The dorsal periosteum of the metacarpal was opened longitudinally. The fracture was then looped with a double high-strength suture (USP 2 braided non-absorbable polyethylene) and a curved forceps under and outside both fragments (Figure 1) or through the fracture site (Figure 2) being careful not to bring volar structures into the loop, before tying the Nice knot and a simple locking knot (Figures 3 and 4). After the fracture was reduced, a second loop was made. The knot should lie to one side to avoid friction with the extensor tendon and it is preferred to avoid excessive loop tension.

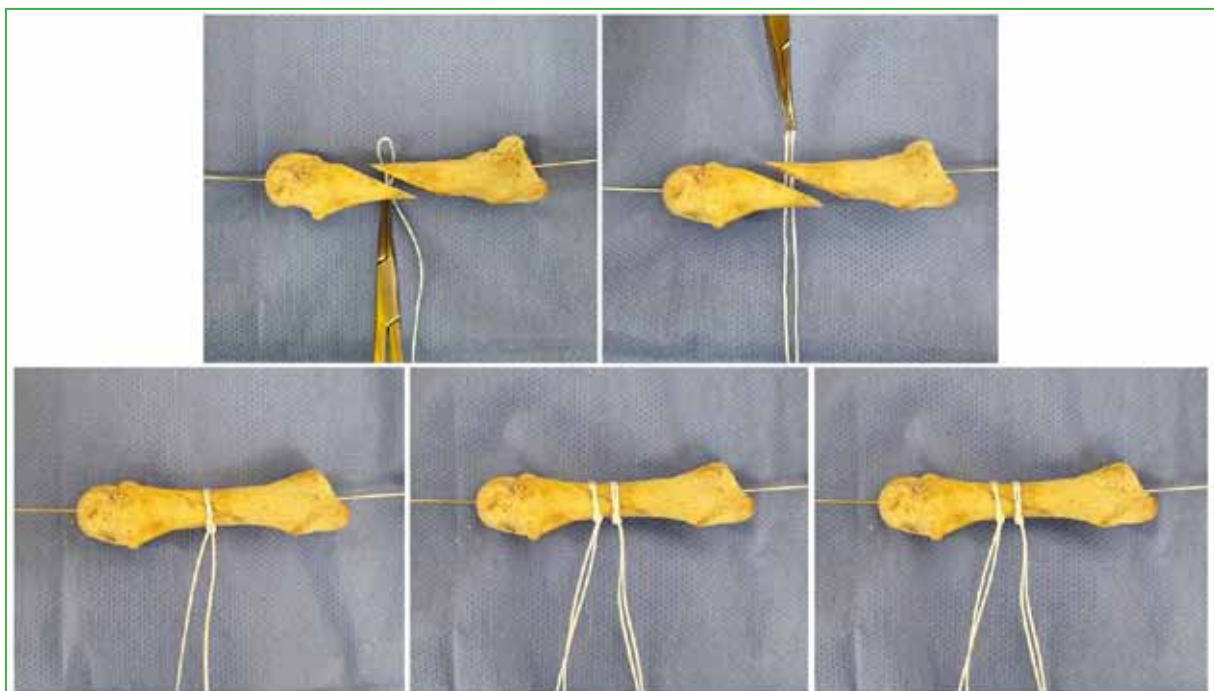


Figure 1. Fracture loop outside the fracture site.

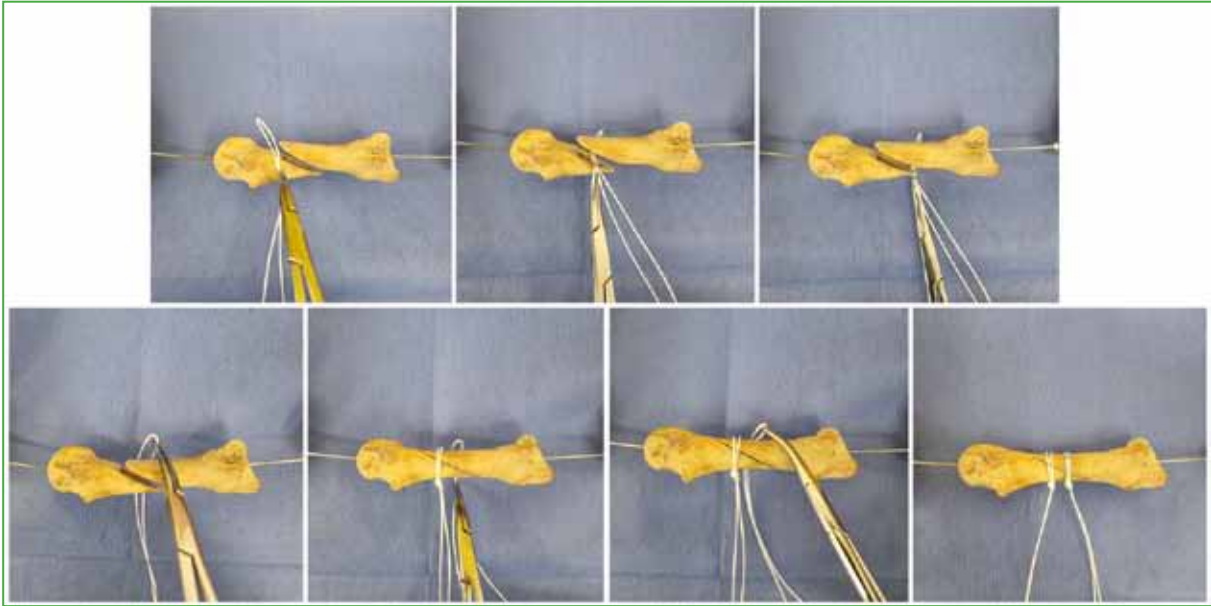


Figure 2. Fracture loop through the fracture focus.



Figure 3. Reduction and fixation with suture and Nice knot (first loop).

Fluoroscopy was used to verify fracture reduction and stability while mobilizing the fingers and wrist. Finally, the periosteum was sutured around the high-strength thread, and the skin was closed. A volar long arm plaster splint was placed with the wrist in slight 20-30° extension.

Patients were instructed to perform gentle flexion-extension movements with their fingers on the first postoperative day. Controls were performed weekly during the first month after surgery and then as needed. Two weeks after the operation, the immobilization was removed and rehabilitation with physical therapy began. Control radiographs were taken at weeks 4, 6 and 8 (Figure 5). Radiographic control was also performed 12 and 18 months after the intervention. The minimum follow-up time was 18 months (mean 20 months). At discharge, they were assessed with the QuickDASH score and the *Total Active Motion Rating Scale (TAM)*.

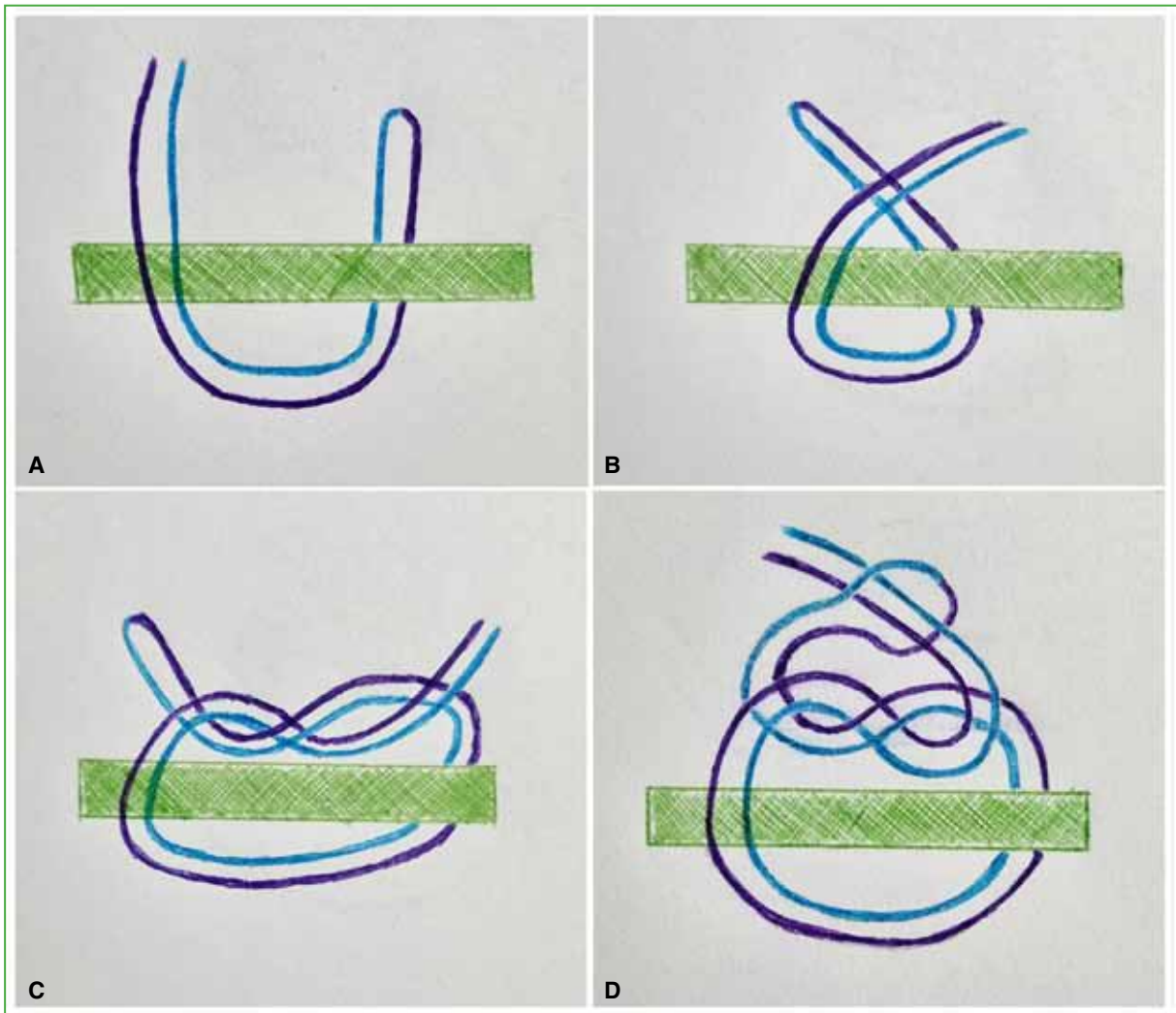


Figure 4. A. Fracture loop in double configuration. B and C. Simple knot. D. The two free ends are threaded into the loop formed by the opposite end of the suture.



Figure 5. Preoperative and postoperative hand radiographs, AP and oblique. Note the reduction without metal implant.

RESULTS

The study population consisted of 17 men and two women (age range 18-53 years; mean 28). The fractures were caused by acute trauma, and most occurred on the dominant hand (11 cases) and on the 4th metacarpal (8 cases). Surgeries were performed, on average, nine days after the trauma.

Clinical and radiological bone consolidation was observed between week 5 and 7 in all patients. The average time to discharge and return to normal activities and work was 2.3 months.

The functional outcome obtained, according to QuickDASH and TAM scores, was good (according to the *American Society for Surgery of the Hand* classification) and no second intervention was necessary. The average functional range determined by the TAM score was 245° (range 230°-260°). The mean QuickDASH score at discharge was 13.51 (range 4.54-29.54) (Table).

Table. Outcomes.

Patient	Age (years)	Sex	Bone	Side	Dominance	Surgical delay (days)	Time to discharge (months)	Follow-up (months)	QuickDASH at discharge	TAM at discharge
1	25	M	4.°	R	R	4	2	22	11.36	250
2	43	M	4.°	R	R	9	3	18	20.45	250
3	26	M	5.°	L	R	3	1.75	20	15.90	230
4	28	M	3.°	R	R	11	2.5	18	18.18	240
5	24	M	4.°	L	R	8	1.75	18	22.72	260
6	53	M	5.°	R	R	5	3	24	29.54	240
7	18	M	3.°	R	L	15	2.5	18	6.81	250
8	32	M	4.°	L	R	13	2	24	13.63	230
9	27	F	2.°	R	R	7	2.25	18	11.36	230
10	19	M	5.°	R	R	9	2.5	21	4.54	240
11	21	F	2.°	L	R	10	1.75	24	4.54	260
12	30	M	4.°	R	L	7	2	18	9.09	260
13	27	M	3.°	R	R	6	2.5	18	11.36	230
14	24	M	4.°	L	R	7	3	24	9.09	260
15	31	M	2.°	R	R	9	3	20	13.63	240
16	25	M	5.°	R	R	8	2	29	15.90	240
17	36	M	2.°	L	L	10	2	18	25	230
18	22	M	4.°	R	R	9	2.5	18	6.81	250
19	26	M	4.°	L	R	14	2.25	18	6.81	260

M = male; F = female; R = right; L = left; TAM = Total Active Motion Rating Scale.

One patient (5.26%) initially lost the reduction because he did not follow the medical indications. The displacement was tolerable and he was immobilized with a plaster splint. Consolidation was achieved and did not require further surgery.

During the follow-up time, no other complications were recorded.

DISCUSSION

When faced with metacarpal fractures, the surgeon must choose the appropriate treatment among multiple options. Variables such as location, fracture type and surgeon experience are determining factors in this choice.

Currently, high-strength sutures are used in multiple procedures as a temporary aid in the reduction of small fragments.⁶ The tightness achieved with two loops of high-strength sutures in conjunction with the Nice knot was so effective in intraoperative tests and under fluoroscopy that we soon began to notice that adding metallic material to this construct did not confer greater advantages and, on the contrary, exposed us to more complications.

In this study, we have been able to demonstrate that high-strength sutures in the described configuration can reduce this type of fracture while providing sufficiently stable fixation to eliminate the need for additional metal components such as K-wires, plates, or screws. The authors of the study observed that selecting the correct fracture type for this novel treatment was critical to its success. Short, comminuted oblique fractures have an instability that cannot be adequately controlled with this technique. Regarding concerns about the suture interfering with the process of bone callus formation, such complication was not observed in this study.

Other surgical techniques have resulted in a variety of complications, including lack of consolidation, stiffness, extensor tendon irritation, infection, loss of reduction, and osteosynthesis material failure.

In a series of 32 metacarpal fractures treated with intramedullary wires, van Bussel et al. reported excellent outcomes in all cases. However, 81% of the patients had to be operated on again to remove the used material, resulting in higher operating costs and a longer recovery period for the patient.⁷

Dreyfuss et al. compared the outcomes obtained in fractures treated with locking plates or pins, and concluded that plates provided fewer complications and better outcomes.⁸

Similarly, Ozer et al. reported 13% loss of reduction and 15 reoperations for material removal in a series of 38 metacarpal fractures treated with intramedullary nailing.⁹ In our study, the rate of loss of reduction was lower (5.26%).

Reduction and internal fixation with plates and screws appear to be related with a more rigid fixation, but also with increased stiffness and irritation of the extensor tendons.

In the study by Fusetti et al., the complication rate was 32% in a group of 81 metacarpal fractures treated with plates and screws, e.g. delayed healing (15%), stiffness (10%), loosening or breakage of the osteosynthesis material (8%).¹⁰

In 1999, Brüser et al. published a technique for the treatment of metacarpal fractures using transosseous resorbable hemi-cerclage sutures. The study included patients with oblique, spiral and comminuted fractures, both articular and extra-articular. They were discharged in an average of 6.1 weeks and only one had to be operated on again for delayed consolidation during follow-up (7.5 weeks).¹¹

During this study and follow-up, a second surgery for material removal or tenolysis was not necessary.

One limitation of this study is the small sample of patients.

CONCLUSIONS

This surgical technique for the resolution of metacarpal fractures with oblique or long spiral lines has been effective, reliable and reproducible. The complication rate was low and postoperative recovery was good.

The technique provided an anatomical reduction, stable fixation and achieved good functional outcomes.

Follow-up with further studies will provide us with more information that will allow us to evaluate this technique as an alternative method for the resolution of these fractures.

Conflict of interest: The authors declare no conflicts of interest.

REFERENCES

1. Kawamura K, Chung KC. Fixation choices for closed simple unstable oblique phalangeal and metacarpal fractures. *Hand Clin* 2006;22(3):287-95. <https://doi.org/10.1016/j.hcl.2006.02.018>
2. Ferrando Á, Belluschi G, Andreozzi R, Perrone JM, Sarmiento H, Petrucelli E. Osteosíntesis en fracturas oblicuas o espiroideas largas de metacarpianos: comparación entre tratamiento con tornillos interfragmentarios solos y placa con tornillos. *Rev Asoc Argent Ortop Traumatol* 2021;86(5):621-8. <https://doi.org/10.15417/issn.1852-7434.2021.86.5.1345>
3. Henry MH. Fractures of the proximal phalanx and metacarpals in the hand: Preferred methods of stabilization. *J Am Acad Orthop Surg* 2008;16(10):586-95. <https://doi.org/10.5435/00124635-200810000-00004>
4. Hachem AI, Del Carmen M, Verdalet I, Rius J. Arthroscopic bone block cerclage: A fixation method for glenoid bone loss reconstruction without metal implants. *Arthrosc Tech* 2019;8(12):e1591-e1597. <https://doi.org/10.1016/j.eats.2019.08.014>
5. Boileau P, Alami G, Rumian A, Schwartz DG, Trojani C, Seidl AJ. The doubled-suture Nice knot. *Orthopedics* 2017;40(2):e382-e386. <https://doi.org/10.3928/01477447-20161202-05>
6. Wu G, Chen Y-Q, Chen C-Y, Lin Z-X, Xie Q-Y, Ye J-J, et al. Clinical outcomes of doubled-suture Nice knot augmented plate fixation in the treatment of comminuted midshaft clavicle fracture. *BMC Surg* 2021;21(1):270. <https://doi.org/10.1186/s12893-021-01274-4>
7. van Bussel EM, Houwert RM, Kootstra TJM, van Heijl M, Van der Velde D, Wittich P, et al. Antegrade intramedullary Kirschner-wire fixation of displaced metacarpal shaft fractures. *Eur J Trauma Emerg Surg* 2019;45(1):65-71. <https://doi.org/10.1007/s00068-017-0836-0>
8. Dreyfuss D, Allon R, Izacson N, Hutt D. A Comparison of locking plates and intramedullary pinning for fixation of metacarpal shaft fractures. *Hand (N Y)* 2019;14(1):27-33. <https://doi.org/10.1177/1558944718798854>
9. Ozer K, Gillani S, Williams A, Peterson SL, Morgan S. Comparison of intramedullary nailing versus plate-screw fixation of extra-articular metacarpal fractures. *J Hand Surg Am* 2008;33(10):1724-31. <https://doi.org/10.1016/j.jhsa.2008.07.011>
10. Fusetti C, Meyer H, Borisch N, Stern R, Santa DD, Papaloizos M. Complications of plate fixation in metacarpal fractures. *J Trauma* 2002;52(3):535-9. <https://doi.org/10.1097/00005373-200203000-00019>
11. Brüser P, Krein R, Larkin G. Fixation of metacarpal fractures using absorbable hemi-cerclage sutures. *J Hand Surg Br* 1999;24(6):683-7. <https://doi.org/10.1054/jhsb.1999.0296>