

Comparison of wire versus Nylon in Bonny-Mallet Finger treated with pull-out surgery

Comparación de alambre y nailon en Bonny-Mallet Finger tratado con cirugía de pull-out

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Abstract

Introduction: Zone I extensor tendon lesion accompanies an avulsion fracture of the bone insertion. A common complication of traditional pull-out is the necrosis of the site of the button in the finger pad. Zhang described an alternative way of anchoring the cerclage to the Kirschner Wire (K-wire) to relieve the pressure in the finger pad. He describes the use of wire cerclage, for fracture reduction. The objective of this paper is to perform a comparison between wire and nylon using Zhang pull-out technique. **Material and methods:** We performed a cohort study comparing Nylon versus Wire in Zhang technique. Comparing cosmetic satisfaction, stiffness, residual pain, and Crawford scale. **Results:** When comparing the outcomes between both groups, we found no statistical difference in cosmetic satisfaction ($p = 0.285$), stiffness ($p = 0.460$), and residual pain ($p = 1.000$), overall complications ($p = 1.000$), or Crawford scale ($p = 1.000$). We only found a significant statistical difference in pain when removing the cerclage, being greater in Group B ($p = 0.008$). **Conclusions:** We found no significant outcome difference between nylon and wire cerclage. However, at the time of removing it, patients experience less pain.

Keywords: Mallet-finger. Pull-out. Hand surgery. Tendon surgery.

Resumen

Introducción: Una complicación común del pull-out tradicional es la necrosis del sitio del botón en la yema del dedo. Zhang describió una forma alternativa de anclar el cerclaje al clavo de Kirschner para aliviar la presión en la yema del dedo. Describe el uso de cerclaje de alambre para la reducción de fracturas. El objetivo de este trabajo es realizar una comparación entre el alambre y el nailon utilizando la técnica de extracción de Zhang. **Material y métodos:** Realizamos un estudio de cohorte comparando la técnica de nailon versus alambre en Zhang. Comparación de satisfacción cosmética, rigidez, dolor residual y escala de Crawford. **Resultados:** Al comparar los resultados entre ambos grupos, no encontramos diferencias estadísticas en la satisfacción cosmética ($p = 0.285$), rigidez ($p = 0.460$) y dolor residual ($p = 1.000$), complicaciones generales ($p = 1.000$) o escala de Crawford ($p = 1.000$). Solo encontramos una diferencia estadística significativa en el dolor al retirar el cerclaje, siendo mayor en el Grupo B ($p = 0.008$). **Conclusiones:** No encontramos diferencias significativas en los resultados entre el cerclaje de nailon y el cerclaje con alambre. Pero, al momento de retirarlo, los pacientes experimentan menos dolor. **Tipo de estudio:** terapéutico Nivel de evidencia III.

Palabras clave: Dedo en martillo. Pull-out. Cirugía de la mano. Cirugía del tendón.

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Introduction

The Bony-Mallet finger (BMF) is a widespread synonym for a Zone I extensor tendon lesion. It accompanies an avulsion fracture of the bone tendon insertion¹. It is a frequent lesion among athletes, and it represents 2% of all hand injuries². When this lesion does not receive adequate treatment, it can result in loss of distal extension, chronic finger pain, subluxation of the distal phalange, deformity of inter-phalangeal articulations, among others³.

The actual recommendation for surgical treatment is when 30% of the articulation is involved³. Several techniques for reduction and fixation have been described, with advantages and disadvantages, in each case^{1,3-9}. The most common techniques used are the pull-out and pull-in, with multiple variants among them. Today, there is no consensus or evidence to recommend one over the other¹⁰. Pull-out technique appears to need minor dissection, and it may be more replicable¹¹. A usual complication of traditional pull-out is the necrosis of the site of the button in the finger pad. Zhang et al.¹¹ described an alternative way of anchoring the cerclage to the Kirschner Wire (K-wire) to relieve the pressure in the finger pad. In his technique, it describes the use of wire cerclage for fracture reduction¹¹. In our experience, wire removal can be laborious. Therefore, we choose nylon as an alternative to our procedures.

To the best of our knowledge, there is no prior evidence comparing wire versus nylon in the pull-out technique and therefore, no evidence of the advantages and disadvantages among them. We found this topic to be, feasible, noteworthy, novel, ethical, and relevant. This paper aims to perform a comparison between wire and nylon in patients with BMF using Zhang pull out technique.

Materials and methods

It was performed a prospective experimental study with simple randomization. For sample calculation, the following epidemiologic data were used. The Institutional Review Board approved the study, and each patient signed a consent report. Every year there is an incidence of hand injury of 1500 cases in 100,000 inhabitants¹². Mallet's fingers are 2%, around 30 cases for 100,000 inhabitants^{2,8}. In Mexico City are 8.9 million people and 365,000 inhabitants in the Miguel Hidalgo municipality¹³. From those data, it can be

assumed that 90 cases/year could be reported with mallet finger. With the prior data, and after applying a confidence interval of 95% with an interval of confidence of ± 5 , our objective sample was 21 cases. The population is, patients with BMF derived to our center in a period of 3 months¹⁴.

Inclusion criteria were patients with BMF with 30% or more articular compromise. Exclusion criteria were patients with no fracture, patients that did not accept to be included in the study, and patients with another lesion representing confounding factors (phalangeal fractures, a neurovascular compromise, and among others). The elimination criteria were also patients that failed to return to follow-up for data collection. Simple randomization was made to form two groups of 11 patients each. Group A, corresponding to a cerclage with nylon, and Group B to cerclage with wire.

The variables included were: age, gender, comorbidities, occupation, hand dominance, hand affected, finger injured, mechanism of the lesion, Doyle classification, Wehbe classification, articular compromise percentage, time of injury, surgical time, nylon/wire, functional conformity, cosmetic conformity, residual pain, residual stiffness, complications, pain referred at the moment of removing cerclage, and Crawford scale.

Surgical technique

The technique was standardized to have high reproducibility in each step. The surgeons involved in this study had prior training in performing this particular procedure; described as follows:

A tourniquet was applied on the fingers to the patient positioned with the hand placed palm down. A procedure was performed under a digital nerve block, with 3 mL 2% lidocaine injection. The distal interphalangeal (DIP) joint was exposed through a dorsal incision over the DIP joint and care to avoid extension above the germinal matrix. The fragment connected with the extensor tendon was released and retracted proximally after that fracture surface site was exposed. The hematoma was removed as well as the interposed soft tissue to inspect the articular surface better (Fig. 1A). Two drill holes were then made, one needle distal to the bony fragment and one proximal to it and both through the distal phalanx using a 14 G needle (Fig. 1B). A 3-0 nylon (or a 0.016" surgical wire) was passed, anchoring the bony fragment with the extensor tendon, and passed through the needle, and adequate reduction of the bony fragment is ensured

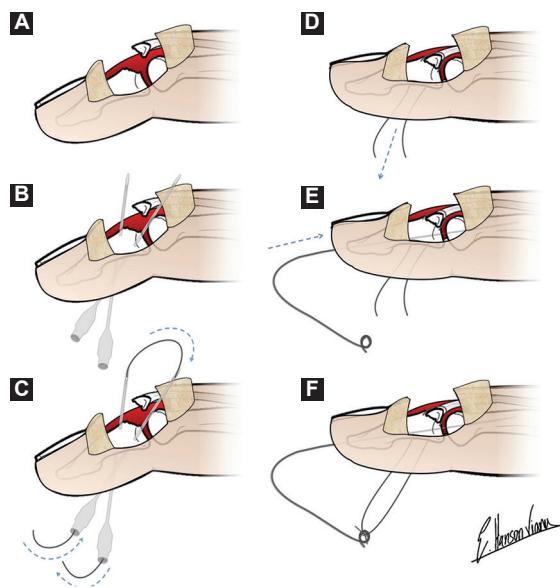


Figure 1. A-D: surgical incision description. **A:** bone fragment and angulation for nylon/wire fixation. **D-F:** surgical technique. Traction during K-wire fixation through the joint. This traction ensures perfect reduction of the bone fragment.

(Fig. 1C and D). At this moment, the K-wire (0.035") was passed through the DIP with the distal phalanx in 0-5° degrees extension. After the DIP is locked, 1 cm distal to the finger, the K-wire was bent, in the volar direction at 45° until reaching the end of the cerclage (Fig. 1E). It is then essential to pull the nylon or wire at a 45° in a volar direction to ensure a 100% fracture reduction (Fig. 1F). The surgical technique is schematized afterward (Fig. 2A-H). In figure 3 and 4, we show example cases of nylon and wire (Figs. 3 and 4).

Statistical methods

We used an Excel data sheet for data collection and R-studio® and StatGraphics® centurion for statistical analysis. The statistical formulas were X², T-student, No inferiority test, and equivalence analysis with $p < 0.05$.

Results

Ninety-eight patients with **BMF** were received, and only 25 were with insertion site fracture > 30%. A total of 22 patients were randomized into two groups of 11 patients, Group A, corresponding to a cerclage with nylon, and Group B to cerclage with wire.

The mean age was 44 years (IC 95%, 44 ± 17.74). Males accounted for 73% (n = 16), most common comorbidity diabetes mellitus in three patients, followed by hypertension in 2. Most predominant occupation was construction worker with 32% (n = 7). In 86% of cases (n = 19), the right hand was dominant, and the most injured in 55% (n = 12) of the cases. The most injured finger was the second in 32% (n = 7) of the cases, followed by the thumb and third finger with 23% (n = 5) each. The mechanism of injury most prevalent was crush injury in 41% (n = 9). The most prevalent Doyle classification was IV B, with 59% (n = 13). Whereas, the most common Wehbe-Schneider classification was III with C subtype in 36% (n = 8). The open injury was the most common in 64% (n = 14) of the patients. The time of injury had a mean of 5.27 h with a minimum of 2 and a maximum of 10 (IC 95%, 5.12 ± 1.57). The percentage of articular injury was 30-50% in 59% (n = 13), and 41% of them had an articular injury greater of 50%.

Outcome statistics

When evaluated the survey, the patients referred a cosmetic satisfaction in 95% (n = 23). No patient was referred to as residual pain after surgery. And only 23% (n = 5) referred residual stiffness of the articulation at the third month after K-wire extraction. Only one patient presented with infection and partial dehiscence, secondary to poor patient hygiene. When evaluating the Crawford scale, 55% showed excellent results, 41% good, and only one case presented a fair result, secondary to infection complications. Moreover, among the patients with a III C Wehbe-Schneider classification (n = 8); two patients showed excellent results, 5 good and 1 fair results in the Crawford scale. When removing the cerclage, the pain ranged from 2 to 8 on a visual analog pain scale with a mean of 4.9, Group B with an average of 6.7, and 3.0 in Group A.

When comparing the outcomes between both groups no statistical difference was found between duration of the procedure ($p = 0.20$), cosmetic satisfaction ($p = 0.68$), stiffness ($p = 0.363$) and residual pain ($p = 0.6895$), overall complications ($p = 6.895$), or Crawford scale ($p = 0.19$). We only found a significant statistical difference in pain when removing the cerclage, greater in patients with wire cerclage ($p = 0.00015$) (Fig. 5).

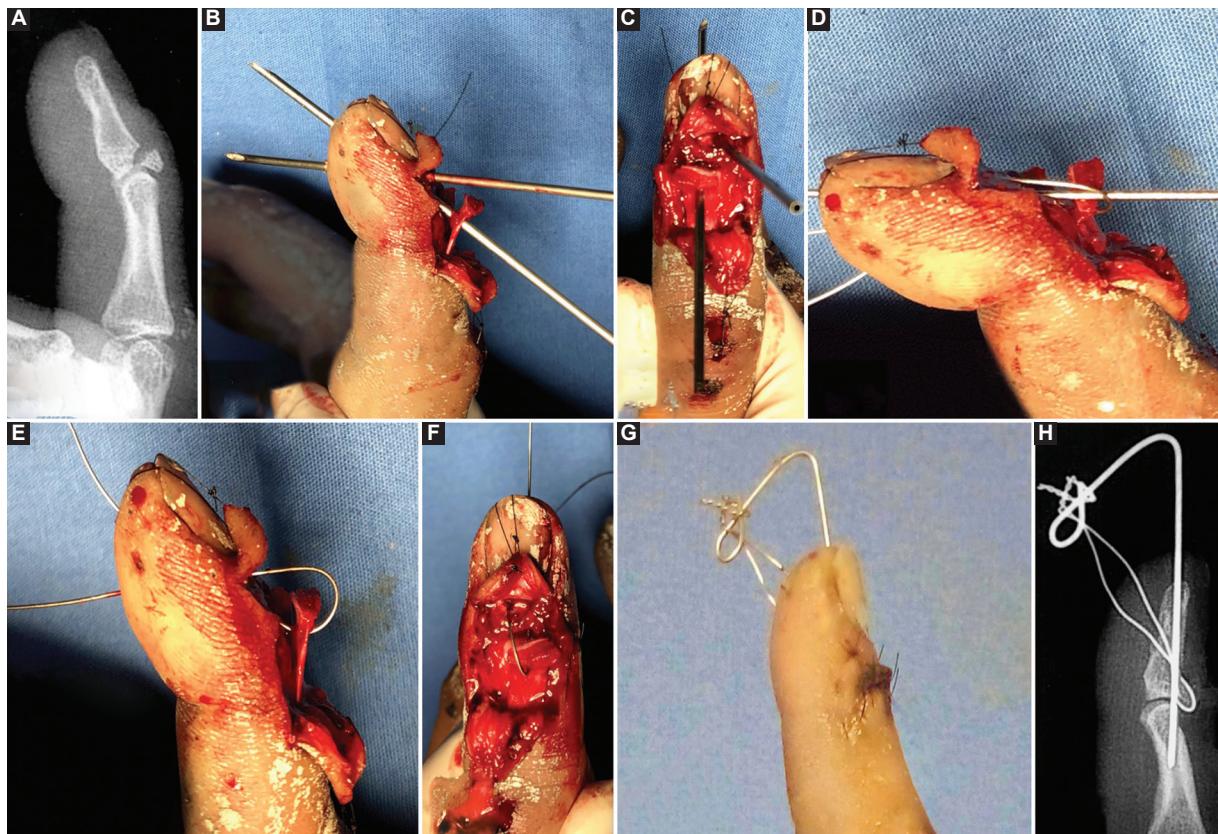


Figure 2. Case example showing the technique. **A:** radiograph. **B:** the two trochars on the respective place. **C:** dorsal view of trochar placement. **D:** lateral view. **E:** The bony fragment. **F:** dorsal view. **G:** 7 days after surgery. **H:** control radiograph.

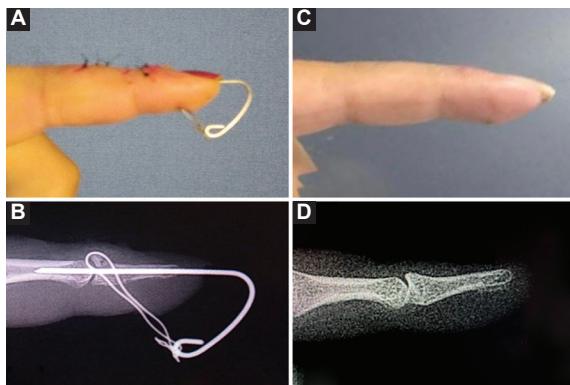


Figure 3. Example case of wire. **A:** postoperative lateral view. **B:** postoperative lateral radiograph. **C:** lateral view 15 days after removing wire and K-wire. **D:** radiograph follow-up.

Discussion

We described some benefits in executing the previously described technique by Zhang et al.¹¹. We consider that nylon cerclage is an adequate substitute to the wire. Furthermore, nylon handling is uncomplicated to control the given tension to the cerclage, without

apparent tension loss in the time needed. Further, patients experience less pain when removing the cerclage, resulting in a much better alternative since nylon is cheaper with easy access in most centers.

Zhang et al.¹¹ previously described a replicable technique with a successfully controlled direction of the bony fragment reduction, based on wire fixation. While this present work could corroborate those results, it is recommended to use nylon as a substitute for the wire.

Prior papers had evaluated the tensile force of nylon available in the United States of America¹⁵. And they proved that there is a small variability between brands, but we consider that the percent of elongation and failure is far from *in vivo* scenarios, and it is useful in cerclage fixation.

Several authors had described an extensive range of surgical and orthopedical solutions for bony mallet fingers. Minimal invasive procedures such as Ishiguro's et al.¹⁶ blocking technique had been suggested. In that specific technique, the surgeon uses a dorsal blocking pin with flexion of the distal phalange to trap the bony fragment, and then another pin is used with an extension of the same phalange to reduce the fragment.

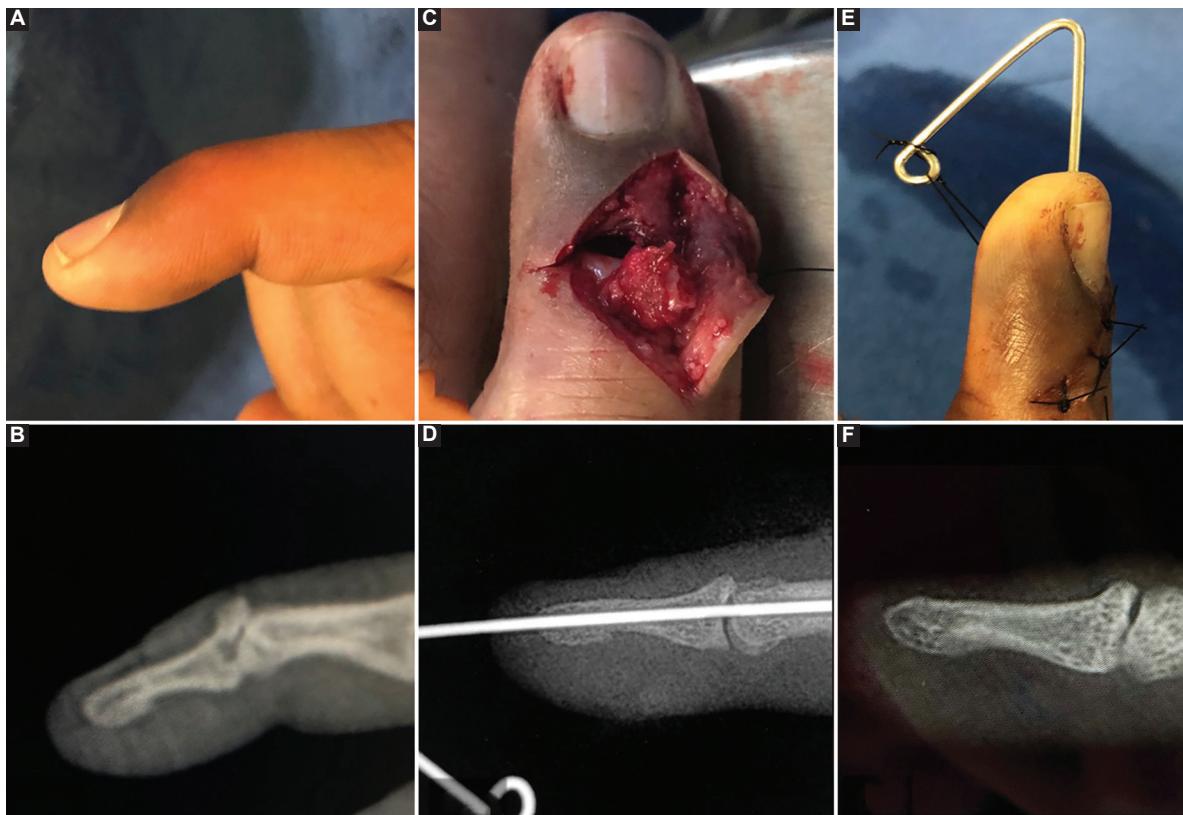


Figure 4. Example case of wire. **A:** preoperative image. **B:** lateral view. **C:** surgery. **D:** lateral view immediate radiograph. **E:** lateral view the immediate photograph. **F:** follow up without K-wire and nylon.

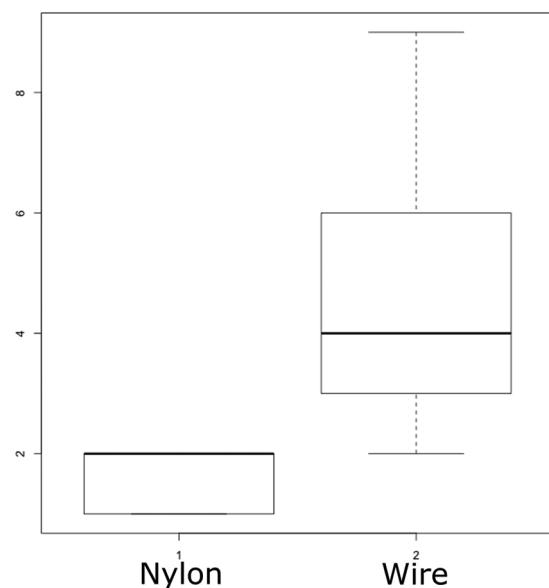


Figure 5. The histogram representing difference in pain at the moment of removing the wire or nylon.

They concluded that this procedure is straightforward with better results than open surgical approach. The

present work performed a prospective randomized trial, comparing both therapeutical procedures, which is mandatory to reach such conclusions.

Consequently, we cannot suggest that Zhang's technique is superior to Ishiguro's. Nevertheless, we can at least expose the advantages and disadvantages of both. Zhang's advantages are that the volar pulp skin is under no pressure, and the bony fragment has constant reduction and compression. Its disadvantages are that it requires a dorsal surgical approach with skin scars and articular stiffness resulting in higher relative risk. Ishiguro's, on the other hand, it is a simple technique with no surgical dissection, providing constant reduction and compression. On the other hand, no direct fragments visualization and imaging studies is mandatory during the procedure, potentially requiring multiple attempts.

Conclusions

We found no significant differences between nylon and wire cerclage. However, at the time of removing it, patients experience less pain. Furthermore, it

appears to be easier to control nylon tension and is overall more available. Therefore, nylon appears to be a more appropriate substitute for wire fixation.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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