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Original Article

Osteosynthesis of mallet finger using plate and screws: evaluation of 25 patients☆

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ABSTRACT

Objectives: To evaluate the results from surgical treatment of patients with mallet finger injury using a hook plate and screw.
Methods: Twenty-five patients (19 males and six females) between the ages of 20 and 35 years were analyzed between May 2008 and December 2012. They were evaluated in accordance with Crawford's criteria and the mean follow-up was 18 months.
Results: The results from 10 patients (40%) were excellent and from 15 (60%), good. Twenty-one patients (84%) reported no pain, 18 months after the operation. There was no limitation to range of motion in 14 cases (56%), limitation of extension in seven (28%) and limitation of flexion in four (16%).
Conclusion: Surgical treatment by means of open reduction and internal fixation using a hook plate and screw proved to be an excellent option for treating mallet finger fractures and was considered to be a safe and effective method.

Osteossíntese do dedo em martelo com placa e parafuso: avaliação de 25 pacientes

Palavras-chave:
Articulação interfalangeana distal
Falanges dos dedos da mão
Fraturas ósseas
Dedo em martelo
Osteossínteses

RESUMO

Objetivo: Avaliar os resultados do tratamento cirúrgico de pacientes com lesão de dedo em martelo com o uso de placa-gancho e parafuso.
Métodos: Foram analisados 25 pacientes entre 20 e 35 anos, 19 do sexo masculino e seis do feminino, de maio de 2008 a dezembro de 2012. Os pacientes foram submetidos à avaliação de acordo com os critérios de Crawford e o acompanhamento médio foi de 18 meses.
Resultados: Os resultados obtidos foram excelentes em 10 pacientes (40%) e bons em 15 (60%); 21 pacientes (84%) não referiram dor no 18° mês de pós-operatório. Foi verificada ausência de limitação da amplitude de movimento em 14 casos (56%), limitação da extensão em sete (28%) e limitação da flexão em quatro (16%).

☆ Study conducted at the Hospital Ifor, São Bernardo do Campo, SP, Brazil.

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Conclusão: O tratamento cirúrgico com redução aberta e fixação interna com placa-gancho e parafuso demonstrou ser uma ótima opção de tratamento nas fraturas em martelo e é considerado um método seguro e eficaz.

Introduction

The mallet finger deformity with bone involvement is determined by an intra-articular fracture of the dorsal lip of the distal phalanx, in which the traumatic mechanism is an axial load on the extended distal interphalangeal (DIP) joint, as occurs, for example, in sport injuries.[1]

The fracture may involve a large area of the articular surface and may sometimes also be associated with volar subluxation of the distal phalanx. In such cases, surgery is usually indicated, due to the inability to achieve or maintain an appropriate reduction without directly addressing the fracture focus.[2]

The treatment options for this type of injury may involve indirect fracture reduction with stabilization that could be achieved by immobilization or even by surgical fixation with Kirschner wires, percutaneous pins, absorbable devices, screws and other methods. Although the results of conservative treatment with immobilization splints apparently leads to good results, an argument among those who defend this method is the risk of complications involving surgical techniques, such as infection, nail deformity, osteomyelitis, hypertrophic scar, synthesis material migration, recurrent subluxation, and bone fragment fracture in the attempt of osteosynthesis, among others.[3]

Some authors defend surgical therapy, especially when there is involvement of more than one-third of the articular surface of the distal phalanx or DIP joint subluxation.[4] The need for anatomical reduction is also fundamental in these cases. Also with regard to surgical treatment, there are several techniques and devices that aim to facilitate the implementation of osteosynthesis and also determine better future outcomes. Among the articles that demonstrate the efficacy of surgical intervention, some used direct or indirect reduction, which differences are related to the stabilization systems for these injuries. The literature describes Kirschner wires fixation in various configurations,[5,6] pull-out suture with transarticular fixation,[2] tension band,[7] hook plates, sutures, and miniscrews.[8]

This study aimed to demonstrate the results of surgical treatment of mallet finger using hook-plate and screws, assessing its effectiveness.

Material and methods

This study was approved by the Research Ethics Committee under the No. CEP-786.101. The study consisted of a review of 25 patients who underwent surgical treatment between May 2008 and December 2012. Of these, 19 were male and six were female, aged between 20 and 35 years.

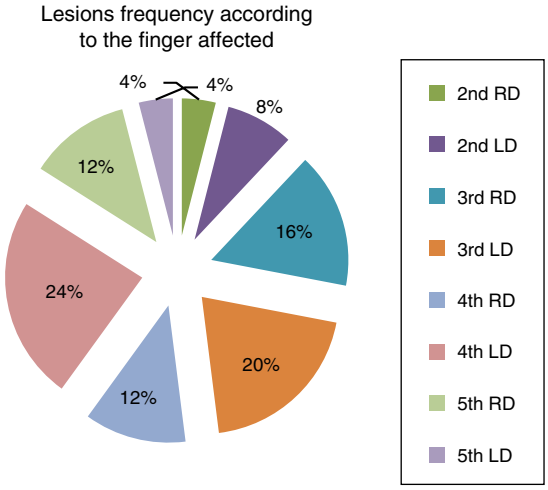

Fig. 1 – Distribution of frequency of occurrence of injuries, considering the affected finger.

Of the 25 patients, 17 (68%) had the injury in the dominant hand, while eight (32%) had it in the non-dominant hand.

Six patients (24%) had involvement of the fourth left digit (LD); five patients (20%), of the third LD; four patients (16%), of the third right digit (RD); three patients (12%), of the fourth RD; three patients (12%), of the fifth RD; two patients (8%), of the second LD; one patient (4%), of the second RD; and one patient (4%) of the fifth LD, as shown in Fig. 1.

The inclusion criteria comprised patients of both genders with history of acute traumatic injury in the 15 previous days and without surgical intervention; without previous injury in the affected finger; without previous or current inflammatory disease, such as rheumatoid arthritis, or degenerative disease of the fingers; and signing the Free and Informed Consent Form. Only those categorized as type C2 according to the Albertoni classification[9] were included.

Surgical treatment was indicated for patients with an avulsed bone component corresponding to one-third of the articular surface of the distal phalanx, evidenced on a finger lateral view radiograph (Fig. 2) or when volar subluxation of the distal phalanx was observed during physical examination.

The study excluded patients who had undergone any previous treatment in the affected finger, including those who failed to non-surgical treatments. Patients who had contralateral finger involvement were also not selected, as this segment would serve as a comparative model in the postoperative evaluation.

Fig. 2 – X-ray in lateral view showing the fracture of the distal phalanx.

Patients were placed in the supine position and submitted to axillary trunk nerve block. After the usual preparatory steps to the injured finger, a tourniquet (Penrose drain) was placed to control local bleeding during the procedure.

A dorsal H-shaped incision was performed at the base topography of the distal phalanx of the affected finger, followed by soft tissue dissection when the distal portion of the extensor tendon and the focus of the distal phalanx fracture were identified. The fracture site was then prepared, followed by reduction in direct view. Osteosynthesis was achieved with the aid of a special prefabricated plate, developed and manufactured for the treatment of this type of injury, which is characterized by the presence of hooks at one end (hook plate; Fig. 3). The fixation was performed with a 1.2- or 1.5-mm minifragment cortex screw, according to the thickness of the compromised phalanx. Additional stabilization of the DIF joint was made by placing a transarticular 1-mm Kirschner wire. Intraoperative control was performed with a radioscopy device, followed by radiographic examination.

After cleaning the wound with 0.9% saline solution, releasing the tourniquet, and ensuring local hemostatic control, the suture was performed and a dressing was placed. A metal splint was used in the postoperative period.

Table 1 – Crawford criteria (1984) to assess mallet finger.

Classification	Characteristics
Excellent	No pain; full flexion and extension of the DIP joint
Good	No pain; 0°–10° extension deficit, full flexion of the DIP joint
Fair	No pain; 10°–25° extension deficit, loss of some degree of flexion
Poor	Persistent pain; >25° extension deficit

Patients were discharged on the day after the intervention. Patients were followed-up weekly; immobilization, stitches, and the transarticular Kirschner wire were removed in the second week of the postoperative period. Thereafter, patients were instructed to begin the process of rehabilitation under the supervision of physiotherapists who followed a pre-established protocol. Pain control was recommended; range of motion gain was initiated four weeks after surgery.

Plain X-rays of the fingers in the anteroposterior and lateral views were made weekly to monitor the fracture consolidation process (Fig. 4).

At six weeks post-operative, patients were subjected to an assessment of their degree of satisfaction with the treatment in accordance to the criteria proposed by Crawford.[10] The functional score of this method compares the loss of flexion and extension of the DIP joint measured in degrees using a finger goniometer, comparing it to the normal contralateral side. To determine the level of satisfaction, complications during treatment and the impairment of labor activities are considered.

Crawford[10] devised a classification in which the results can be classified into four categories, through the analysis of predetermined parameters (pain and mobility of the DIP joint) related to work activities and the degree of satisfaction of the individual (Table 1).

After 18 months of follow-up, an evaluation of the pain on the operated finger was conducted and range of functional motion for flexion and extension of the DIP joint was measured with the aid of an appropriate device.

Fig. 3 – Pre-assembled plate for the treatment of mallet finger.

Fig. 4 – Postoperative X-ray in anteroposterior and lateral views showing the fracture healing process.

Results

In the present study, 10 patients (40%) had excellent and 15 (60%) had good results in the sixth postoperative week according to the Crawford classification.

After 18 months of surgery, the presence of pain in the injured site was assessed. It was observed that 21 patients (84%) had no pain complaints and four (16%) reported symptoms of mild intensity.

The data in Fig. 5 show that 14 patients (56%) had no range of motion limitation of the DIP joint 18 months after surgery; seven (28%) had limited extension; and four (16%) had limited flexion. Functional motion limitation did not exceeded 10° for flexion and 5° for extension (Fig. 6).

Discussion

Mallet finger is an injury caused by avulsion of the terminal part of the extensor tendon, which is inserted into the base of the distal phalanx, and which in turn may be associated with a fracture and lead to flexion deformity of the DIP joint.[1] This

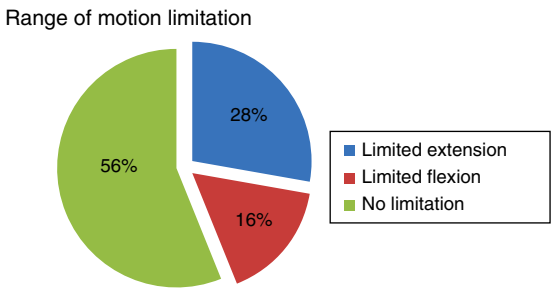

Fig. 5 – Distribution of patients in percentages, considering the range of extension or flexion of the DIP joint.

study assessed the results of surgical treatment for injuries classified as type C2 in the Albertoni classification,[9] in which over one-third of the articular surface would be involved.

Despite the many studies in the orthopedic literature since 1956 featuring the term "mallet finger" in the PubMed database, the level of evidence of publications addressing this theme is not ideal to define the best therapeutic option for this condition.[2] Relative to this theme, in 2014 Gruber et al.[11] published an article that prospectively compared on a randomized study the effectiveness of the use of a nocturnal orthosis *versus* non-use. However, not even in the Cochrane Library database we could retrieve studies that had compared the different methods of surgical treatment.

Regardless of the therapeutic method, it is known that an inappropriate choice of treatment will lead to poor results due to finger deformities, symptomatic secondary degenerative osteoarthritis, and functional deficiencies.[12] To decrease the risk of these problems, the orthopedic surgeon should select the best method of treatment available and apply it properly.

Some authors argue that non-surgical treatment is among the therapeutic options, and support the thesis that a failure to obtain an anatomical reduction would not lead to a significant functional loss, as finger mobility depends more on the proximal interphalangeal joint. Local anatomical damage, even if significant, would also not be considered a problem, given the potential for remodeling of fractures in that region.[13]

However, it appears to be a consensus that surgical treatment is the most appropriate choice in cases where the injury involves over one-third of the articular surface.[2] These injuries would otherwise evolve to persistent subluxation caused by inadequate reduction of the bone fragment and a significant functional deficit of the DIP joint. Failure to achieve an appropriate reduction of the bone fragment on maximum extension would also be an indication for surgical treatment, regardless of the device used for osteosynthesis. Therefore, the

Fig. 6 – Functional limitation of the fifth finger in the late postoperative period.

authors consider that anatomical reduction and stable internal fixation are essential to prevent these complications. Other studies, such as those by Lubahn,[13] corroborate this premise and advocate in favor of surgical treatment.

Over time, various surgical techniques have been described, with or without open reduction, featuring various methods and devices used for stabilization of fractures. Kirschner wires have been often used in internal fixation of fractures, and various configurations have been described, such as the intramedullary, interfragmentary, "umbrella handle", and combined techniques. Tension bands with wires, fixation with screws, absorbable pins, plates and screws, among others have also been used.[2,5–8]

Damron et al.,[2] when assessing tension bands, demonstrated that their association with suture showed unacceptable rates of failure and attributed this to the inability of this synthesis to control the energy dissipated in the fracture site.

As described in the study by Kronlage and Faust,[8] six cases of fixation with screws had considerable prominence of the synthesis material when assessed by plain radiography of the operated finger. However, their patients had no pain complaints and remained asymptomatic and without postoperative complications. This shows that the techniques with direct reduction have good results. Some authors, such as Hamas et al.,[5] claim that adequate open reduction prevents loss of motion and the onset of degenerative diseases. However, such complications can also be related to the degree of damage of the involved tissues. The shape of the head of the traction screw could influence the protuberance of this device; a second approach might be necessary to remove the implant.[8] Another important fact that should be mentioned when considering bone stabilization through screws is the potential for fragmentation of the bone segment that needs to be stabilized. If adequate and good quality instruments are not used and if the principles of osteosynthesis are not followed, the possibility of failure and complications increases greatly. It is noteworthy that Yamanaka and Sasaki[14] did not observe bone fragment fractures during surgery, achieving anatomical reduction in all their patients. Their findings match the intraoperative data observed in the present study.

We can find some studies where hook plates were used and based on the following arguments: they allow for anatomical reduction; avoid the use of implants through a small dorsal fragment and reduce the risk of fracture and/or fragmentation; use a superior biomechanical principle, which is the tension band; allow for a stable fixation and therefore early mobilization; and they bring comfort, confidence, and acceptance to the operated patient.[3] These characteristics were also observed by the authors of the present study.

The interest in running this research was based on the small number of studies in the literature that assessed the effectiveness of the use of hook plates. Therefore, this study aimed to evaluate its efficiency and benefits of surgical treatment of mallet finger fracture. Regarding the analysis of data, the present results were similar to those observed in the literature.

However, despite presenting good results, surgical techniques are not free of complications, with rates ranging from 3% to 53%, including marginal skin necrosis, loss of reduction, progressive joint incongruity, superficial or deep infection, and failure in synthesis stability. Among the different fixation systems, it was observed that techniques using Kirschner wires have higher complication rates, according to King et al.[15] and Stern and Kastrup.[16]

In our study, presence of pain at the 18th postoperative month was observed in 16% of cases. Despite adequate reduction on radiographic imaging, this finding may be justified by early secondary degenerative osteoarthritis, neuromas, regional neuropathy, chondrolysis, and presence of the implant, among others.

The injury site was qualitatively analyzed in the present study, and it was observed that 68% of patients had injury in the dominant hand. In the studies by Badia and Riano[17] and by Lucchina et al.,[18] all injuries were in the dominant hand.

Conclusions

Considering the facts presented, it was observed that there is no consensus on the best treatment method for mallet finger. The level of evidence of studies that address this issue is still not ideal, and the conclusions on this subject need further evidence. Therefore, to settle this issue, studies with better methodological quality are needed.

The surgical treatment with open reduction and internal fixation with hook plate and screw is safe and effective, and was proven to be a excellent treatment option in mallet fractures.

Conflicts of interest

The authors declare no conflicts of interest.

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