ORIGINAL ARTICLE

Comparison of four different immobilization methods in the treatment of tendinous mallet finger injury

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ABSTRACT

BACKGROUND: Although there is consensus that closed tendinous mallet finger injuries should be treated conservatively, the best method of immobilization to be used is not clear and the existing data in the literature are not conclusive. The aim of this study is to compare the results of four different immobilization methods used in the conservative treatment of tendinous mallet finger injury.

METHODS: Ninety-six patients with tendinous mallet finger injury were treated with four different immobilization methods (stack orthosis, thermoplastic orthosis, aluminum orthosis, and Kirschner wire [K-wire] immobilization). The patients then were assessed with distal interphalangeal joint extensor lag, total active motion (TAM), grip strength, and Abouna and Brown Criteria.

RESULTS: No significant difference was found between four immobilization methods in extensor lag and TAM at the 8th and 12th weeks. According to grip strength assessment, stack orthosis group was found to have significantly better results than the K-wire and aluminum orthosis groups at 12 weeks, while the difference was not significant versus the thermoplastic orthosis group.

CONCLUSION: In this first study making multiple comparisons between four immobilization methods used in the treatment of tendinous mallet finger injury, the only significant difference detected between the groups was the superior grip strength with stack orthosis compared with K-wire immobilization and aluminum orthosis.

Keywords: Conservative treatment; extensor lag; grip strength; mallet finger; orthosis.

INTRODUCTION

Mallet finger is an injury characterized by the flexion deformity of the fingertip due to the detachment of the extensor digitorum communis tendon at the base of the distal phalanx. It is one of the most common hand injuries and usually occurs during ball sports, bed making, and trips/falls by forced hyperflexion in the distal interphalangeal joint (DIPJ).[1] Majority of mallet finger injuries are closed and are most commonly treated conservatively.[2,3] During conservative treatment, the DIPJ is immobilized in full extension for 6 weeks. Following this period, two additional weeks of continuous immobilization with an extension orthosis are applied while flexion exercises are started.[4–6] After the first 8 weeks described above, the patient wears the orthosis only at night for an additional 2–4 weeks.[7,8] Immobilization methods used for the treatment of mallet finger injury include various types of orthoses such as aluminum orthosis, stack orthosis, and thermoplastic orthosis. In addition, Kirschner wire (K-wire) can also be used as a means of internal orthosis.[9]

Although there is a certain level of consensus in the literature that closed tendinous mallet finger injuries (Doyle type I) should be treated conservatively, the best method of immobilization is unclear, especially regarding the type of orthosis to be used.[10] The results of mallet finger treatment are evaluated by various assessments, including extensor lag, grip strength, and the criteria defined by Abouna and Brown, which include the assessment of the extensor lag and active flexion of the DIPJ (Table 1).[5,6,11]

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Table 1. Abouna and Brown Criteria

Result	Extension loss (degrees)	Flexion limitation
Success	0–5	No stiffness, Normal active flexion and extension
Improved	6–15	No stiffness, Normal flexion
Failure	>15	Stiffness or impaired flexion

The aim of this study is to compare the outcomes of different immobilization methods used for the conservative treatment of tendinous mallet finger injury.

MATERIALS AND METHODS

Between February 2016 and February 2019, 158 patients were admitted to our clinic with a diagnosis of mallet finger. They included patients for whom the diagnosis had been made and conservative treatment had been started at another center. These patients then continued to be followed in our clinic without changing the initial treatment started. A total of 96 patients with a closed tendinous mallet finger injury (a total of 98 injured fingers), between 7 and 65 years of age, were included in this study. Sixty-two patients for whom the treatment was delayed for more than 6 weeks, who had a fracture as a part of the mallet finger injury, who had any significant concomitant injury on the same hand, who had a diagnosis of rheumatoid arthritis, and who had mallet thumb injury were excluded from the study. This study was approved by the Institutional Review Board of our institution (August 9, 2019–13).

Patients were conservatively treated with one of four immobilization methods which included stack orthosis (34 patients), thermoplastic orthosis (21 patients), K-wire (20 patients [two patients with two injured fingers]), and aluminum orthosis (21 patients) (Fig. 1). The patients in the orthosis groups wore the device full time during the first 8 weeks. At the end of the 6th week, flexion exercises were started if there was no extensor lag. In the K-wire group, the wire was removed at the end of 6 weeks, followed by thermoplastic orthosis worn full time for 2 weeks, with flexion exercises being started if there was no extension lag. Night orthosis was subsequently applied for 4 additional weeks for all groups. Patients were evaluated by goniometric measurements of the range of motion of DIPJ and proximal interphalangeal joint (PIP) and extensor lag in the DIPJ at the 8th and 12th weeks. In addition, grip strength assessment was made at the 12th week (Fig. 2). The total active motion (TAM) measurements were made using a standard steel finger goniometer with 1-degree increments using a dorsal approach. The TAM values from the affected side were compared to the same digit on the unaffected side. The extensor lag in the injured finger's DIPJ was also measured with a standard steel finger goniometer using a dorsal approach. Grip strength was measured using a Jamar dynamometer (Preston, Jackson, MI, USA). Grip strengths were also compared between the affected and unaffected sides. In addition to the aforementioned assessments, qualitative feedback from the patients related to their level of satisfaction with their treatment was also collected. Data collected were analyzed by IBM SPSS statistics 21 software. Paired samples t-test was used for intragroup analyzes, one-way ANOVA test was used for between-group analyses and Tukey HSD test was used to determine which group was different from the others. $P<0.05$ was considered to be statistically significant.

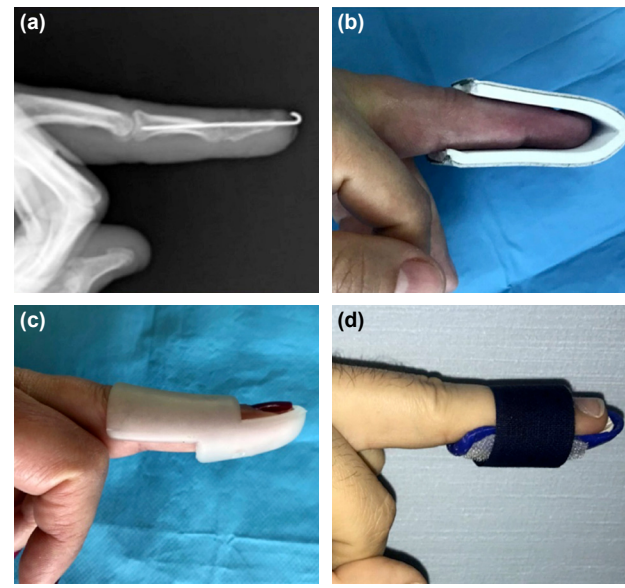

Figure 1. Utilized immobilization methods in conservative treatment, **(a)** Kirschner wire, **(b)** aluminum orthosis, **(c)** stack orthosis, **(d)** thermoplastic orthosis.

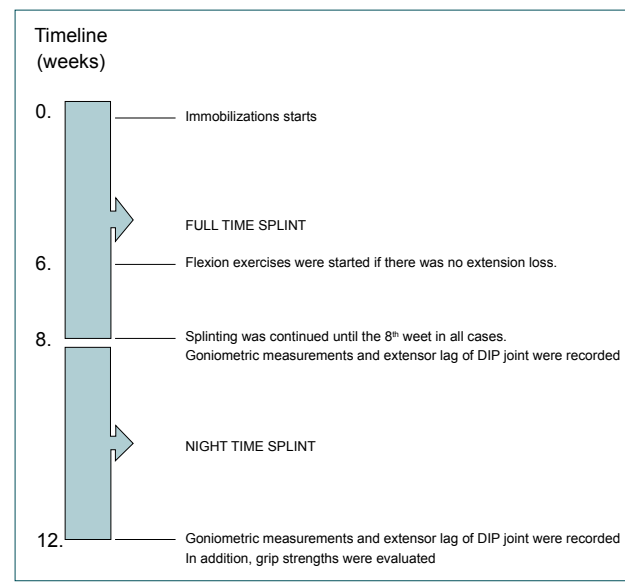

Figure 2. Summary of the treatment protocol and timing of assessments.

RESULTS

Ninety-six patients with a mean age of 42.28±13.93 (range: 7–65) were included in the study. Fifty patients were female. The right hand was injured in 50 patients. In 50 (52%) of the patients, the mallet finger injury was on the dominant side. The mean delay between the injury and the initiation of therapy was 1.43±1.21 weeks. Demographic and clinical characteristics of the patients in different immobilization groups are summarized in Table 2. The immobilization groups were generally similar in terms of demographic and clinical characteristics such as gender, side of injury, and delay before treatment initiation.

According to the results of the assessments, no significant difference was found between four immobilization methods for extensor lag and TAM at the 8th and 12th weeks. However, grip strength assessments at 12 weeks showed that stack

Table 2. Demographic and clinical characteristics of the patients

	K-Wire (n=20)*	Aluminum orthosis (n=21)	Stack orthosis (n=34)	Thermoplastic orthosis (n=21)
Female gender, n (%)	7 (35)	11 (52)	19 (56)	13/8 (62)
Age, year (mean±SD)	34±14	39±16	46±12	45±9
Dominant side injured, n (%)	9 (45)	11 (52)	21 (62)	9 (43)
Injured finger				
Index	7	2	3	4
Middle	8	8	11	7
Ring	4	8	10	8
Little	3	3	10	2
Delay before the initiation of immobilization, week (mean±SD)	1.45±1.59	1.43±1.07	1.24±0.74	1.71±1.48

*Two patients had mallet finger injuries in two fingers. SD: Standard deviation.

Table 3. Treatment results by immobilization group according to clinical assessments

	K-Wire (n=22)	Aluminum orthosis (n=21)	Stack orthosis (n=34)	Thermoplastic orthosis (n=21)
Total active motion*, %				
8th week	69.24±12.21	74.22±10.72	76.37±11.39	75.09±11.69
12th week	82.50±7.31	84.20±11.88	86.13±8.82	86.11±11.00
Extensor lag				
8th week	-8.32°±7.67°	-3.33°±5.55°	-5.18°±5.38°	-8.10°±9.30°
12th week	-7.41°±6.94°	-4.62°±8.05°	-4.65°±7.11°	-5.05°±7.73°
Grip strength, %				
12th week	70.98±14.21	70.36±16.55	82.26±12.10	76.57±17.68

*Total Active Motion as a percentage between the affected and unaffected fingers, respectively.

Table 4. Treatment results by immobilization group according to Abouna and Brown Criteria

n (%)	K-Wire (n=22)	Aluminum orthosis (n=21)	Stack orthosis (n=34)	Thermoplastic orthosis (n=21)
Success	6 (27)	16 (76)	24 (71)	16 (76)
Improved	14 (63)	2 (10)	7 (21)	4 (19)
Failure	2 (10)	3 (14)	3 (8)	1 (5)

Table 5. Insights from the study team on the immobilization methods used

	Advantage	Disadvantage
Kirschner wire	Robust immobilization	Invasive procedure
	No patient compliance	Avoid moving in the early period
		Cannot be used in swan neck deformity
Aluminum orthosis	Low cost	Difficulty in adapting to the patient, failure to provide the desired angle
		Difficult to remove and reattach
Stack orthosis	PIP can move freely	Difficult to use in edema due to circular design
	Ready and easy to reach	Can slide through the finger
	Relatively affordable	Maceration
		Cleaning difficulties
		Not suitable for swan neck deformity
Thermoplastic orthosis	Optimal position	More expensive
	Minimal skin problem	Proximal interphalangeal joint flexion may cause position changes
	Adaptable to patient	

orthosis group had significantly better results compared with the K-wire (p=0.034) and aluminum orthosis groups (p=0.025), while the difference was not significant versus the thermoplastic orthosis group (p=0.516). The results of the assessments from all immobilization groups are summarized in Table 3. The treatment results according to the Abouna and Brown criteria are shown in Table 4. Table 5 summarizes the insights from the study team regarding advantages and disadvantages of the four immobilization methods evaluated in the study.

DISCUSSION

There are several studies in the literature which compared different types of immobilization methods in the treatment of mallet finger injury. Results from these studies are heterogeneous and not conclusive in terms of the superiority of any single method evaluated.

The parameters frequently used to assess the outcomes in the previous studies which compare different immobilization methods used in mallet finger treatment are loss of extension (extensor lag), range of motion, and grip strength. In our study, four different immobilization methods were compared according to these three parameters. The results did not show any significant difference between these four methods in terms of extensor lag and range of motion; however, the stack orthosis was found to deliver significantly better results in grip strength than K-wire and aluminum orthosis.

Similar to our findings, various investigators have not found significant differences between different immobilization methods in terms of extensor lag. Vernet et al.[12] reported in 100 cases that there was no difference between stack orthosis and dorsal orthosis (dorsal glued orthosis) in extensor lag at the 9th week, O'Brien et al.[13] compared dorsal aluminum, thermoplastic, and stack orthoses in 64 cases and they also did not find any significant difference in extensor lag at 12 weeks. Pike et al.,[5] in their prospective, randomized, controlled study including 77 patients, failed to detect any significant extensor lag difference at 12 weeks between volar and dorsal aluminum orthosis and custom-made thermoplastic orthosis methods. Other studies, however, found differences between various immobilization methods regarding extensor lag. In a comparative study conducted by Renfree et al.[14] using percutaneous pinning (K-wire) and thermoplastic orthosis for 6 weeks in closed mallet finger cases, it was stated that the extensor lag was less in the K-wire group (5 degrees) compared to thermoplastic orthosis group (10 degrees). In this study, night orthosis was also used by the patients for an additional 6 weeks. Nagura et al.,[15] who used thermoplastic orthosis or K-wire immobilization for 8 weeks in 59 patients with acute tendinous mallet finger injury, reported that the extensor lag was 2.1 and 13.8 degrees with K-wire immobilization and thermoplastic orthosis, respectively.

In our study, the highest grip strength at the 12th week was achieved in the stack orthosis group, the difference being significant versus the K-wire and aluminum orthosis groups. Thermoplastic orthosis, although not statistically significant, resulted in numerically better grip strength versus K-wire and aluminum orthosis.

In addition, despite not having found significant differences between four immobilization methods in extensor lag and range of motion, we observed a tendency to have lower rates of failure according to Abouna and Brown criteria, which is a composite of these two parameters, with stack and thermoplastic orthoses compared to aluminum orthosis and K-wire immobilization.

There may be various possible explanations for more favorable results observed with stack and thermoplastic orthoses. In our opinion, the stack orthosis, while supporting the DIP joint in extension, allows PIP joint flexion to a larger extent than aluminum orthosis and K-wire immobilization, potentially leading to a lower risk of PIP joint stiffness. This may explain the higher grip strength observed with this method in our study. Thermoplastic orthosis, being a custom-made device, also has certain advantages. The fact that the thermoplastic orthosis is easier to manage from the hygiene perspective has been seen as an advantage compared to the stack orthosis.[16] Witherow et al.[8] (2015) stated in their meta-analysis that skin complications were more frequent with stack orthosis compared with thermoplastic orthosis, with no difference between these two in terms of treatment success and extensor lag. Similarly, in our study, better ability to position the injured finger, lower incidence of skin problems, and readjustability were the observed advantages for thermoplastic orthosis. Patients' statements also mentioned that cleaning of the stack orthosis was difficult and skin problems were less with thermoplastic orthosis. However, the higher cost and the time needed for the preparation were disadvantages observed with thermoplastic orthosis.

An important limitation of our study is that the treatment groups are not randomized and thus not stratified according to demographic and clinical characteristics.

Conclusion

Comparing four different immobilization methods for the treatment of tendinous mallet finger injuries in 96 patients, we found significantly better grip strength with stack orthosis versus aluminum orthosis and K-wire immobilization. Extensor lag and finger range of motion were not different between the four methods.

To the best of our knowledge, this is the first study which made multiple comparisons between four different types of immobilization methods in this patient population. In addition, given the fact that the data in the literature on the results of conservative treatment options on grip strength are not extensive, we believe that these results are a valuable contribution to the existing knowledge and can contribute to evidence-based decision-making during the treatment of this common hand injury.

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Ethics Committee Approval: This study approved by the Istanbul University Istanbul Faculty of Medicine Ethics Committee (August 9, 2019–13).

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ORİJİNAL ÇALIŞMA - *ÖZET*

Tendinöz çekiç parmak yaralanmalarının tedavisinde kullanılan dört farklı immobilizasyon yönteminin karşılaştırılması

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AMAÇ: Kapalı tendinöz çekiç parmak yaralanmalarının konservatif olarak tedavi edilmesi gerektiğine dair fikir birliği olmasına rağmen, kullanılacak en iyi immobilizasyon yöntemi net olarak belirlenmemiştir ve literatürdeki mevcut veriler kesin bir sonuca varmamaktadır. Bu çalışmanın amacı, tendinöz çekiç parmak yaralanmasının konservatif tedavisinde kullanılan dört farklı immobilizasyon yönteminin sonuçlarını karşılaştırmaktır.

GEREÇ VE YÖNTEM: Tendinöz çekiç parmak yaralanması olan 96 hasta, dört farklı immobilizasyon yöntemi ile (Stack ortez, termoplastik ortez, alüminyum ortez ve K-teli immobilizasyonu) tedavi edildi. Tedaviyi takiben hastalar distal interfalangeal eklem ekstansiyon kaybı, total aktif hareket, kavrama gücü ve Abouna ve Brown kriterleri ile değerlendirildi.

BULGULAR: Sekiz ve 12. haftalarda ekstansiyon kaybı ve total aktif hareket değerlerinde, dört farklı immobilizasyon yöntemi arasında anlamlı fark bulunmadı. Kavrama gücü değerlendirmesine göre, Stack ortez grubunda 12. haftada K-teli ve alüminyum ortez gruplarına göre anlamlı derecede daha iyi sonuçlar elde edildi, ancak fark termoplastik ortez grubuna göre anlamlı değildi.

TARTIŞMA: Tendinöz çekiç parmak yaralanmasının tedavisinde kullanılan dört farklı immobilizasyon yöntemi arasında çoklu karşılaştırmalar yapan bu ilk çalışmada, gruplar arasında tespit edilen tek anlamlı fark, K-teli ve alüminyum ortez ile karşılaştırıldığında Stack ortez ile daha yüksek kavrama gücü elde edilmesi olmuştur.

Anahtar sözcükler: Çekiç parmak; ekstansiyon kaybı; kavrama gücü; konservatif tedavi; ortez.

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