

Custom-made finger splint versus prefabricated finger splint: finger flexion stabilization

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SUMMARY

OBJECTIVE: Finger splints are used as a treatment option in tendon, bone, and soft tissue injuries. For immobilization, custom-made splints and prefabricated finger splints are used. In splints made for immobilization, it is aimed to limit joint movement. The aim of our study is to reveal how much custom-made splints and prefabricated finger splints limit joint motion (flexion angle in proximal interphalangeal and distal interphalangeal joints).

METHODS: Custom-made splints and prefabricated finger splints were applied to the second fingers of the dominant side in a total of 40 individuals, 20 women and 20 men, not having any health problems. Individuals were asked to flex and joint motion was measured with the iPhone compass application.

RESULTS: The mean distal interphalangeal joint angle values of the participants measured by prefabricated finger splints were found to be 24.27 ± 8.29 , and the mean distal interphalangeal joint angle values measured by custom-made splints was 0.52 ± 1.50 . There was a difference between the participants' distal interphalangeal joint angle values measured by prefabricated finger splints and custom-made splints ($p < 0.001$). distal interphalangeal joint angle values measured with custom-made splints were significantly smaller than those measured with prefabricated finger splint. The mean of the participants' proximal interphalangeal joint angle values measured by prefabricated finger splints was 16.55 ± 7.90 , and the proximal interphalangeal joint angle values measured by custom-made splints was "0" for all participants. There was a difference between the participants' proximal interphalangeal joint angle values measured by prefabricated finger splints and custom-made splints ($p < 0.001$). Distal interphalangeal joint angle values measured with custom-made splints were significantly smaller than those measured with prefabricated finger splints.

CONCLUSION: According to our study, custom-made splints can significantly reduce the flexion of the finger interphalangeal joints compared to prefabricated finger splints.

KEYWORDS: Finger splint, Orthosis, Prefabricated splint, Custom-made splint.

INTRODUCTION

The metacarpophalangeal (MCP) joint, the proximal interphalangeal (PIP) joint, and the distal interphalangeal (DIP) joint maintain a complementary relationship. Injury to one joint can lead to dysfunction of adjacent joints or fingers. The first reaction in injuries is inflammation that causes edema and pain. Insufficient immobilization may have harmful effects during this period¹. The injured PIP joint tends to go into a flexed position. In untreated conditions, flexion deformity occurs rapidly². Improper mallet finger splinting causes joint dysfunction, extension lag, and swan neck deformity³.

Finger splints are a simple immobilization method used in many injuries such as finger fractures, tendon injuries, and soft tissue sprains^{4,5}, and maintaining the correct and stable position during recovery is part of the treatment⁴. Although injuries are considered simple, delayed treatment and immobilization in inappropriate positions can cause loss of hand function and deformities that cause cosmetic problems⁶.

Finger immobilization splints are produced specifically for the patient, which is called custom-made splint (CMS) or prefabricated finger splint (PFS). The advantages of PFS are that they are cheap, practical, and easily accessible. However, as it is not made for the person, adaptation problems and the inability to keep the finger in the desired position are also disadvantages. CMS is more advantageous in that it adapts to the finger. For this reason, it is thought to be more stable in terms of immobilization^{7,8}. In a study comparing splints for the DIP joint, it was found that the displacement of the finger with CMS was less than that of PFS⁵. However, it is expected that there will be no joint movement in immobilization splints, especially in mallet finger⁹ and fracture cases¹⁰. The extent to which different splints limit joint motion has been investigated in some studies¹¹⁻¹⁴. There are not enough studies in the literature for finger splints. We think that it is important to determine the most effective splint in order to prevent deformities caused

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by inadequate finger immobilization. For this reason, in this article, we aimed to reveal how much the PFS for the finger and the CMS for the patient limits the joint movement (flexion angle in PIP and DIP joints).

METHODS

The sample size of the study was calculated using the G*Power 3.1.9 (G*Power, Universität Düsseldorf, Germany) program. In the study, the amount of type I error was determined as $\alpha=0.05$, the effect size was medium effect (0.65), the targeted power of the test was $1-\beta=0.80$, whereas the sample size required for statistical analyses was determined as $n=39$ for group. To reduce the margin of error and increase its generalizability to the population, the study was planned to be completed involving 40 people.

The cases to be included in the study were selected on a voluntary basis among individuals between the ages of 18 and 40 years who did not have any health problems.

Exclusion criteria for the study were as follows: PIP and DIP joint flexion limitation/contracture, presence of rheumatoid disease, or any diagnosed disease that may affect joint movement such as degenerative arthritis, trauma, or diabetes.

Ethical approval for the study was obtained from the Clinical Research Ethics Committee of Sivas Cumhuriyet University on May 26, 2021, with the decision number 2021-05/31. Before the study, the purpose and content of the study were explained to the participants, and an informed consent form was signed, stating that they would participate voluntarily.

First, the participants' age, gender, height, weight, marital status, body mass index, musculoskeletal system problems, and diagnosed disease entities were recorded.

Then, two different types of splints were applied to the second finger of the dominant hand, and the normal joint movement was measured in the DIP and PIP joints.

Finger joint movement measurements are often done using a universal goniometer¹⁵. Recently, several new smartphone-based apps have been introduced which allow ROM measurement. With the proliferation of smartphones, these applications may offer new ways to provide accurate and reliable ROM measurements, especially in clinical situations where standard goniometers and/or radiographs cannot be used¹⁵. At present, smart phone applications are preferred because they are practical and easy to apply. In addition, the iPhone Compass application was used in the goniometric measurement of the finger joints, as there may be errors because of deviations that may occur at the pivot point during the measurement by placing the goniometer on the joint with the

splint application. In previous studies, the iPhone Compass application has been shown to be reliable¹⁵.

Finger splints, which are CMS, can be made of aluminum material as well as thermoplastic material that can be shaped at low temperatures. As it is easily shaped and practical, thermoplastic material is preferred more⁷. Therefore, in our study, the splint produced specifically for the patient was made of thermoplastic material. When Orfit brand thermoplastic material with a thickness of 2 mm was thrown into water at a temperature of 60–65° and became shaped, it was placed on the finger of the individual to be applied and shaped in the desired position.

Volar splints were performed to keep the DIP and PIP joints at 0° of extension. Two velcro splints were fixed, one over the PIP joint and the other over the DIP joint. Then, the individual was asked to flex the finger, and the range of motion was measured in degrees with the help of iPhone Compass application in the DIP and PIP joints. After the measurement of normal joint motion, the splint was removed and then the PFS was applied. PFS is of the type that fixes aluminum from the volar, distal, and proximal phalanx. After PFS application, normal joint motion was measured using the same method and recorded in degrees.

Statistical Analysis

Mean, standard deviation, median, and minimum and maximum values were given in descriptive statistics for continuous data, and percentage values were given in discrete data. Shapiro-Wilk test was used to examine the conformity of continuous data to normal distribution.

Wilcoxon signed-rank test was used to compare the angle values measured with PFS and CMS of the participants.

The IBM SPSS Statistics 20 program was used in the evaluations and $p<0.05$ was accepted as the statistical significance limit.

RESULTS

The demographic characteristics of the individuals participating in the study are shown in Table 1.

The mean of the DIP joint angle values of the participants measured with the PFS was 24.27 ± 8.29 , and the mean of the DIP joint angle values measured with the CMS was 0.52 ± 1.50 . There was a significant difference between the DIP joint angle values measured with PFS and CMS ($p<0.001$). The DIP joint angle values measured with the CMS were significantly small compared to the values measured with the PFS.

The mean of the PIP joint angle values measured with the PFS of the participants was 16.55 ± 7.90 , and the PIP joint

angle values measured with the CMS were measured as “0” in all participants. There was a difference between the participants’ PIP joint angle values measured with PFS and CMS ($p<0.001$). The DIP joint angle values measured with the CMS were significantly small compared to the values measured with the PFS (Table 2, Figure 1)

Table 1. Demographic characteristics of the participants.

	Mean±SD Median (Min–Max)
Age (years)	35.52±12.65 35 (20–66)
Body weight (kg)	71.50±12.20 70 (47–140)
Height (cm)	171.27±8.03 171 (156–187)
BMI (kg/m ²)	24.13±4.17 23.19 (18.65–42.27)
Sex, n (%)	
Women	20 (50)
Men	20 (50)

BMI: Body Mass Index; SD: standard deviation.

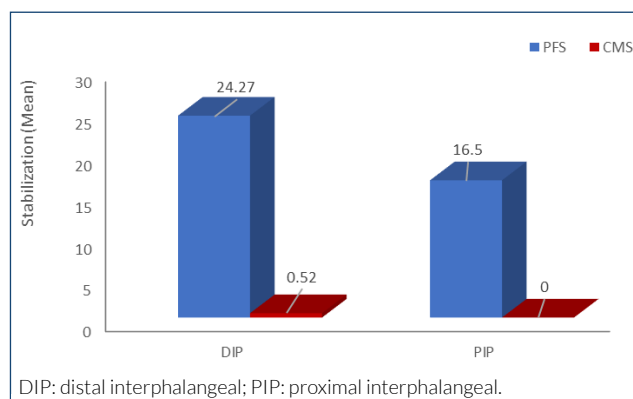


Figure 1. Angle values measured with prefabricated finger splint and custom-made splint.

Table 2. Comparison of the angle values of the participants’ distal interphalangeal and proximal interphalangeal joints measured with prefabricated finger splint and custom-made splint.

	Prefabricated finger splint	Custom-made splint	Test statistic	p
	Mean±SD Median (Min–Max)	Mean±SD Median (Min–Max)		
distal interphalangeal angle	24.27±8.29 24 (10–42)	0.52±1.50 0 (0–6)	Z= -5.513	0.000*
proximal interphalangeal ANGLE	16.55±7.90 16.5 (4–35)	– 0 (0–0)	Z= -5.514	0.000*

*Wilcoxon test. $p<0.05$.

DISCUSSION

In many injuries, especially fractures and tendon injuries, the joint position of the finger splint is important and the recovery is faster in splints that can protect it¹⁶. Finger flexion and extension can have an adverse effect on the healing of damaged DIP and PIP joints for several reasons. Finger flexion can cause changes in the lengths of the ligaments, which are considered to be stabilizers of the finger joints.⁵ In finger extensor mechanism deformation, changes occur in finger posture with flexion¹⁷. Although many studies have shown that splint gives good results in mallet finger treatment, they have drawn attention to the importance of splint type and patient compliance⁵. In a study performed on mallet finger, casting and splints made with thermoplastic material were compared and casting was found to be advantageous in terms of extensor lag in only 12 weeks of follow-up. Except this, no difference was observed in the evaluations performed in shorter and longer periods¹⁸. In a study, the position of the adjustable splint produced with a 3D printer in mallet finger was examined using x-ray and it was found that it was effective in terms of correction¹⁹. In our results, we found that the finger splint made of thermoplastic material does not allow any flexion in the PIP joint, but there is very less flexion movement in the DIP joint. This movement may be the cause of extensor lag observed in the study by Tocco et al¹⁸.

According to our study, CMS can significantly reduce the flexion of the finger interphalangeal joints compared to PFS.

The facts that the research strategy is comprehensive and that splinting, which is frequently used in the clinic, has been evaluated from a different perspective are considered to contribute to the literature.

This study has several limitations. First, measuring the active flexion motion that a healthy individual can achieve with full effort may not be the same as flexion that can be achieved after an injury. Second, there were no other symptoms such as edema that would affect the splints we applied. The force applied by the subjects was not standardized.

CONCLUSION

PFS flexion was reduced by more than 70% in PIP and more than 65% in DIP. It should only be used when this limitation of flexion is acceptable during healing of a finger injury. As the result of the present study, CMS can be used in situations where limitation of joint motion is important. The authors suggest that this study be carried out on patients with fracture, tendon injury, and so on.

According to the results of our study, clinicians should prefer CMS if they aim for more restriction and almost complete immobilization in the finger joint. Immobilization success of CMS may be higher.

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Ethical approval obtained from Sivas Cumhuriyet University, Non-Interventional Clinical Research Ethics Committee with the decision number 2021-05/11 dated May 26, 2021. This study has been conducted in accordance with the principles set forth in the Helsinki Declaration.

AUTHORS' CONTRIBUTIONS

EG: Conceptualization, Project administration, Formal Analysis, Writing – original draft. **SSK:** Conceptualization, Data curation, Formal Analysis, Writing – original draft.

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