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Necessity of Immobilizing the Metacarpophalangeal Joint in Carpometacarpal Osteoarthritis: Short-Term Effect

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Abstract

Background: Conservative treatment for carpometacarpal (CMC) joint osteoarthritis (OA) may include orthotic fabrication to decrease pain. Different types of orthoses have been used as conservative interventions to improve symptoms, but there are no guidelines specifying if inclusion of the thumb metacarpophalangeal (MCP) in an orthosis is required in the treatment of thumb CMC joint OA. The main objective of this study is to determine the effectiveness of 2 different thumb CMC joint orthotic designs on pain reduction and improved hand function: one design immobilizes both the MCP joint and the CMC joint and the other design immobilizes only the CMC joint. **Methods:** A total of 66 patients were included in the study. One group of 33 patients received a short thumb orthosis with the MCP joint excluded, and the other group of 33 patients received a short thumb orthosis with the MCP joint included. Outcomes measures included the visual analog scale for pain and the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH; Spanish version) for function. **Results:** In both patient groups, the orthoses contributed to decreased pain levels and improved functional abilities ($F_{1.0}$ = 315.467 and $F_{1.0}$ = 72.419; both, $P < .001$). There was no significant difference between the 2 groups regarding pain or improvement in daily activities ($F_{1.0}$ = 0.553 and $F_{1.0}$ = 2.539; both, $P > .05$). **Conclusion**: There are benefits of either thumb orthotic design on pain reduction and functional improvement even after 1 week of using the orthoses as the sole conservative treatment.

Keywords: thumb pain, thumb orthoses, carpometacarpal joint, osteoarthritis, hand function

Introduction

Osteoarthritis (OA) of the thumb, affecting primarily women of 60 to 70 years of age, can result in pain, decreased grip, prehension limitations, and lack of hand mobility. These physical deficits can result in functional limitations and participation restrictions.[21]

The primary goals of conservative treatment are to reduce pain and improve participation in everyday activities.[4,24] Conservative treatment may include orthotic fabrication (splinting), exercises, education in joint protection techniques, and physical modalities (such as heat) to decrease pain.[2] A thumb orthosis is a primary nonoperative treatment for carpometacarpal (CMC) joint OA. The goal of orthotic wear is improved function and comfort, by providing support and stabilization to the CMC joint, yet permitting functional movement of the hand.[5,26] Splinting the CMC joint limits the amount of movement at the joint, providing stability, reducing shearing and friction forces, and lessening pain.[17]

A variety of orthoses are used in the conservative management of patients with CMC joint OA: some include the metacarpophalangeal (MCP) joint and some leave the MCP joint unrestricted. Other devices include the wrist joint and are forearm based and some devices are hand based. There is no present evidence supporting the most effective type of orthosis for CMC joint OA, and no guidelines on whether to include the MCP joint or not.

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Several small studies report reductions in pain with the use of CMC joint orthoses.[27] Limitations of these studies include small sample sizes, short treatment duration, and other methodological flaws. Sillem et al demonstrated a statistically significant reduction in pain with long term use of the "hybrid orthosis," over the Comfort Cool orthosis.[19] According to the International Classification of Functioning,[16] pain improvements can be classified into the category of body functions/body structures. Other studies have shown that strength and range of motion gains do not necessarily correlate with the patient's perception of treatment success.[12,13,23] The correlation between objective physical measures with patient satisfaction varies, with a trend toward increased satisfaction with pain/symptom improvement. For example, decreased pain intensity translates into increased satisfaction in patients presenting with physical symptoms.[10]

The purpose for this study was to compare the short-term effect of 2 different thumb orthotic designs on pain reduction as a primary outcome and improved hand function as a secondary outcome after 1 week of treatment. One orthotic design immobilizes both the CMC joint and the MCP joint of the thumb in the orthosis, whereas the other orthotic design immobilizes only the CMC joint.

Materials and Methods

Study Design

This was a prospective and assessor-blinded study with a randomized design. The Local Ethical Committee approved this research protocol.

Participants

A total of 71 patients were referred by an orthopedic hand surgeon to the hand therapy clinic for participation in this study. Data were collected at the Tecan Hand Center clinic, Spain, between January and October 2015. Patients who were diagnosed with thumb CMC OA in the dominant hand, who had their hand surgeon classify their CMC OA as Grade 2 to 3 according the radiological staging protocol according to Eaton and Littler, and who had a pain intensity during activities of daily living (ADL) > 40 of 100 on the visual analog scale (VAS) were eligible for the study. Patients were excluded from the study if they had a neurological disorder affecting the upper limb, or had received previous treatment or surgery for their hand problem in the past 6 months (including fracture, injury, hand or finger tenosynovitis, or Dupuytren's disease), or had received an intra-articular joint injection to the wrist, fingers, or thumb, or whom exhibited thumb MCP hyperextension. Patients were excluded if they scored greater than 4 points on the Beck Depression Inventory[22] or more than 30 points in the State Trait Anxiety Inventory.[20] Also excluded were patients who did not complete the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH; Spanish version) and patients who had previously received any type of hand orthosis for this problem.

Figure 1. Thumb orthosis in which the thermoplastic material included the metacarpophalangeal joint.

Interventions

Patients were divided into 2 equal groups using a randomized allocation: half of the patients were fitted with the thumb orthosis in which the thermoplastic material included the MCP joint (Figure 1), and the other half were fitted with a CMC joint immobilization orthosis fabricated in the manner described by Colditz[5] which does not include the MCP joint (Figure 2). The same low temperature thermoplastic material was used for both orthoses (Orfit Colors NS 2.0 mm, micro perforated/Orfit Industries, Wijnegem, Belgium). The orthoses were custom fabricated for each patient by a hand therapy clinician experienced in orthopedic cases. Each patient received their custom made orthosis after completing a self-administered QuickDASH (Spanish version) questionnaire and the VAS scale.

Both groups of patients received identical orthotic wearing instructions. Patients were asked to use the orthosis during the nighttime and also during daytime ADL for 3 to 4 hours per day. Each patient was also provided with a data collection sheet to record treatment adherence. All patients were asked to report any discomfort when using the orthosis. The orthosis was the only treatment intervention received by the patients. No therapeutic exercises, modalities, or other complementary treatments were offered to the patients in order not to interfere with the individual effectiveness of the orthosis.

The testing protocol and assessment protocol were prepared according to the Strobe publishing guidelines for a randomized controlled trial.[27]

Figure 2. Thumb orthosis in which the thermoplastic material did not include the metacarpophalangeal joint.

Outcome Measures

Two outcome measures were used in this study: the VAS for assessment of pain and the QuickDASH (Spanish version) for function. The VAS scale is a unidimensional measure of pain intensity that has been widely used in diverse adult populations, including those with rheumatic diseases.[9] Sensitivity and reliability of the instrument are well defined by Breivik et al[3] and Lundeberg et al.[11] In patients with chronic inflammatory or degenerative joint pain, the VAS has demonstrated sensitivity to changes in pain.[8]

Cross-cultural adaptation process and reliability of the DASH questionnaire (Spanish version) were well defined by Rosales et al,[18] with a test-retest reliability of 0.97 and a Cronbach α of 0.95.

Each patient completed a VAS assessment and the QuickDASH questionnaire on the day prior to beginning the orthotic intervention and again 1 week after orthotic provision.

Statistical Analysis

Data were analyzed using SPSS version 21.0 (SPSS Inc, Chicago, Illinois). An intention-to-treat analysis was used for missing data using the last value forward method. Group data were summarized using means and standard deviations. The Kolmogorov-Smirnov test was used to confirm the normality of the distribution of the data. Comparison of baseline characteristics and outcome variables was performed with the use of 2-tailed independent *t* tests for the continuous variables of age and baseline scores. An analysis of variance was used to determine the level of significance of the differences between baseline to follow-up at 1 week for pain scores and QuickDASH function between groups. Paired *t* tests were used to assess the effect of each orthosis on pain intensity and QuickDASH function (within-group comparisons). Significance was accepted at a probability value of $P < .05$.

Table 1. Baseline Demographics for Both Groups.

	MCP joint excluded group (n = 33)	MCP joint included group (n = 33)	*P* value*
Age, y	63.7 ± 10.3	63.8 ± 8.9	>.05
Female gender, n (%)	27 (81.8)	28 (84.8)	—
Side, right, n (%)	33 (100)	33 (100)	—
VAS	77.9 ± 7.8	77.0 ± 7.3	>.05
QuickDASH	40.2 ± 7.6	41.7 ± 6.0	>.05

Note. Data are expressed as means ± standard deviations, unless otherwise indicated. MCP = metacarpophalangeal; VAS = visual analog scale; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand. *Statistically significant difference between group exists if $P < .05$ (95% CI).

Results

Seventy-one consecutive patients with thumb CMC OA were screened for eligibility criteria. Sixty-six patients (mean age: 63.7 ± 9.6 years; 83.3% female) satisfied all eligibility criteria and agreed to participate. We excluded patients who either did not follow the instructions for wearing their orthosis (n = 3) or did not show up for the second appointment for data collection (n = 2). Thirty-three patients received an orthosis excluding the MCP joint, and other 33 patients received an orthosis including the MCP joint. There were no significant statistical differences regarding demographic information between the control and intervention groups at baseline (Table 1).

Hand Pain Intensity (VAS)

The mean pain score decreased from 77 to 46 in the group receiving an orthosis that included the MCP joint and from 77 to 48 in the group that received an orthosis with the MCP joint excluded. Both groups achieved a clinically important difference. VAS scores revealed a significant effect of time ($F_{1.0}$ = 315.467; $P = .001$), but not for the group-by-time interaction ($F_{1.0} = 0.553$; $P = .8$) for pain intensity. The post hoc analysis revealed both statistically and clinically significant within-group differences for both group (both, $P < .001$) (Table 2).

Response to Treatment

The mean QuickDASH score decreased from 40.2 to 36.1 in the group receiving an orthosis that included the MCP

Table 2. Mean (SD) for Outcome at All Study Visits for Each Group, Mean (SD) Difference Within Groups, and Mean (95% CI) Difference Between Groups.

	Groups				Difference within groups		Difference between groups
	Pre		Post		Post minus Pre		
Outcome	MCP joint excluded (n = 33)	MCP joint included (n = 33)	MCP joint excluded (n = 33)	MCP joint included (n = 33)	MCP joint excluded (n = 33)	MCP joint included (n = 33)	MCP joint excluded minus MCP joint excluded (n = 66)
VAS	77 (7.3)	77 (7.8)	48 (9.4)	46 (5.7)	−29* (1.8)	−31* (1.8)	0.7 (−3.9 to −5.1)
QuickDASH	41.7 (6.1)	40.2 (7.6)	35.7 (6.7)	36.1 (5.7)	−6.0* (0.8)	−4.1* (0.8)	0.4 (−3.4 to 2.7)

Note. CI = confidence interval; MCP = metacarpophalangeal; VAS = visual analog scale; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand.
*Significantly different within group, $P < .05$ (95% CI).

joint and from 41.7 to 35.7 in the group that received an orthosis with the MCP joint excluded. Outcomes for the QuickDASH questionnaire demonstrated a significant time factor ($F_{1.0} = 72.419$; $P = .001$) but not for the group-by-time interaction ($F_{1.0} = 2.539$; $P = .1$) for function. The post hoc analysis revealed a statistically significant difference between the baseline and 1 week for the QuickDASH score for both groups (both, $P < .001$) (Table 2).

Discussion

Immobilization of the basilar thumb joint is a common intervention in the conservative treatment of thumb CMC joint OA. The effectiveness of thumb stabilization by wearing these orthoses is accepted practice. However, evidence is missing that supports the superiority of one specific orthotic design over another to best offer pain relief and improved thumb function.

The main purpose of this study was to compare the short-term effect of 2 different thermoplastic CMC orthoses on pain reduction and improvement of hand function. Other studies have compared the effectiveness of thermoplastic orthoses at longer intervals after 2 to 4 weeks of orthotic use, or studied the use of thermoplastic orthoses combined with other therapeutic interventions such as heat modalities (hot packs, paraffin), joint protection techniques, reeducation, and electrotherapy.[19,26,27]

There is high to moderate evidence to support the use of CMC orthoses to decrease hand pain and improve hand function, but a variety of different orthoses have been used as a conservative intervention to improve symptoms in patients with CMC joint OA. Although a number of studies compared different conservative interventions, evidence and understanding of the influence of the short-term application of an orthosis as a unique treatment for pain reduction and improved function are lacking. In this current study, the authors used 2 important outcome measures of pain and functional ability to evaluate the short-term effect of 2 different thermoplastic orthoses.

The results of this study demonstrate that the use of an orthosis as a sole treatment can produce a decrease in pain and an increase in function as the first step in a conservative treatment approach. Nevertheless, no significant differences have been found between including the MCP joint or not including the MCP joint in an orthosis in terms of pain reduction or functional improvement.

Sillem et al[19] also compared the effect of 2 different orthoses (the Comfort Cool and the Hybrid orthosis) on function and reported small differences between the 2 orthoses' effects on hand function. In the present study, all participants received orthoses for their dominant hand, and results demonstrate improved function in both groups. However, Sillem et al compared a thermoplastic orthosis with a prefabricated neoprene one, whereas in this study, 2 different models fabricated from the same thermoplastic material were compared. Because Sillem et al utilized a different outcome measure for hand function, the results cannot be easily compared.

Additional authors have reported that pain relief is correlated with improvements in functional activities.[1] We did not measure the relationship between pain and function in our study. Future studies should address the important relationship between pain reduction and functional abilities.

The present study also demonstrates a reduction in pain in both groups of patients, which is in agreement with results reported in similar studies by Weiss et al[26] and by McKee and Eason-Klatt.[14] Our results also concur with other authors who recommend providing a thermoplastic CMC orthosis is an appropriate first choice in the conservative treatment for patients with CMC joint OA despite the lack of guidelines as to which orthotic design is the most beneficial.[5,6,28]

Weiss et al also conducted a study that compared 2 orthoses constructed of different materials (neoprene vs thermoplastic material).[27] A 72% of the patients preferred

the neoprene orthosis over the more rigid thermoplastic material. These results cannot be compared with the results of this study because we used the same thermoplastic material for both patient groups and only the orthotic design differed.

In patients with CMC joint OA, a biomechanical approach to the orthosis should also be considered. Previous studies investigating the effectiveness of different orthoses for CMC joint OA focused primarily on pain reduction and improvement in function and none have analyzed the amount of thumb motion permitted by the orthoses. Hamann et al did not focus their study only on objective parameters such as pain and/or function. They also characterized the effectiveness of the stabilization and the functionality of different thumb CMC joint OA orthoses. They demonstrated that the stabilization of the CMC and MCP joints varies considerably with different orthoses.[7] We suggest that an orthosis that supports only the CMC joint and excludes all adjacent joints affords minimal stabilization to the MCP joint, but at the same time, it allows the largest mobility and functionality of the hand.

The biomechanical findings of this study might be in disagreement with the conclusions of other studies[2,6,14,19] who reported differences in pain between different orthoses. According to Mobargha et al, the muscles supporting the thumb CMC joint serve as both stabilizers and destabilizers to the joint.[15] Consequently, these thumb muscles impact the stability of the thumb and thumb joint alignment and must be taken into consideration when providing an orthosis. Many patients suffering from CMC joint OA may present with MCP joint hyperextension. If we use an orthotic based only on the results of studies that value function and pain without taking into account the need to stabilize the thumb MCP joint to prevent hyperextension for patients that present with MCP hyperextension, it might result in a maldistribution of thumb loads during ADL.

Used as a sole intervention, each orthosis demonstrated the ability to reduce pain and improve function. This information will be useful not only to the hand therapy clinician when making decisions regarding the type of orthosis to be used as an intervention in conservative care, but also for the hand surgeon who wishes to decrease a patient's pain intensity before a surgical intervention. There was no statistically significant difference demonstrated for the reduction of pain if the MCP joint was included in the orthosis, so patient preference and/or clinician experience might be the deciding factor on specific orthotic design.

Future studies should investigate pain reduction and functional improvement with different orthoses over a longer time period and determine the relationship between pain reduction and functional improvement.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All study procedures were followed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 and 2008.

Statement of Informed Consent

Informed consent was obtained from all patients included within the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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