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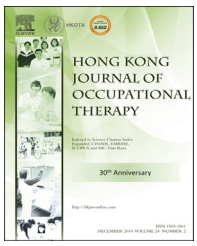

ORIGINAL ARTICLE

Efficacy of Static Progressive Splinting in the Management of Metacarpophalangeal Joint Stiffness: A Pilot Clinical Trial

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hand rehabilitation;
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traumatic hand injury

Summary *Objective:* To evaluate the efficacy of a static progressive metacarpophalangeal (MCP) joint flexion splint in managing MCP joint stiffness in patients suffering from traumatized hands.
Methods: A total of 31 patients with stiff MCP joints ($n = 116$) were recruited for this prospective study. A static progressive MCP flexion splint was designed to manage the MCP joint stiffness of traumatized hands, which is a common problem after surgery. The values of the initial and final passive range of motion (PROM) and active range of motion (AROM) were compared. In addition, the Disabilities of the Arm, Shoulder, and Hand (DASH) scores before and after surgery were also compared. Spearman correlation matrix was used to determine the relationship of the DASH score with PROM and AROM separately.
Results: The PROM increased from 23.47 ± 16.26 degrees to 59.01 ± 14.75 degrees after treatment, and the difference between the initial and final PROM is 35.54 ± 16.92 degrees ($t = 22.63$, $p < .001$, $df = 115$). The AROM also significantly increased from 10.29 ± 10.67 degrees to 25.03 ± 18.25 degrees, with a mean difference of 14.74 ± 15.40 degrees ($t = 10.31$, $p < .001$, $df = 115$). The DASH score improved from 40.71 ± 13.22 to 24.26 ± 11.33 ($t = 7.00$, $p < .001$, $df = 30$), which indicates a significant negative correlation with the AROM of MCP joints following treatment.
Conclusion: The static progressive MCP flexion splint promotes both physical and functional outcomes. The increased AROM of the MCP joints improves the functional outcomes in patients with traumatized hands.

Conflicts of interest: All contributing authors declare no conflicts of interest.

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Introduction

Hand crushing, avulsion, and laceration are common among manual workers and automobile accident victims in developing countries. In general, these injuries involve multiple tissues, including bones, joints, ligaments, muscles, tendons, nerves, and arteries. Restoring the range of motion (ROM), function, and independence of patients remains a challenge for hand surgeons and therapists. Immobilization helps regain skeletal stability and promotes growth of soft tissues. However, prolonged immobilization increases the risk of joint stiffness, particularly in the metacarpophalangeal (MCP) joints (Bell-Krotoski & Figarola, 1995; Cyr & Ross, 1998).

Patients with crush injuries lose the passive ROM (PROM) of MCP joints mainly due to the formation of scar over the soft tissues of the hand and the anatomical structure of the MCP joint. Inelastic collagen fibres cross-link tendons, bones, skin, and soft tissues around the wound, which results in inhibition of proper tendon gliding and shortening of soft tissues such as the collateral ligaments of the MCP joint. Scar tissues occupy the space around the joint, reducing the PROM of the joint. The MCP joints easily develop extension contracture due to the tendency of the collateral ligaments of MCP joints to contract. In this situation, the patient cannot maintain a functional grasp or properly manipulate objects, resulting in severe loss of hand function (Stewart, 2002).

The benefits of static progressive splinting in treating joint stiffness have been described in previous studies (Colditz, 2002; Schultz-Johnson, 2002). However, most studies focused on practical orthotic fabrication skills and physical management, such as the use of physical modalities and passive stretching (Fess & McCollum, 1998; Glasgow, Tooth, & Fleming, 2010; Susan, Bette & Mary, 2004; Zhang, Yue, Shou, Qian, & Zhou, 2003).

Previous studies (Colditz, 1983, 1996; Flowers, 2002; Flowers & LaStayo, 1994; Glasgow, Fleming, Tooth, & Hockey, 2012; Glasgow, Wilton, & Tooth, 2003) have revealed the relationships between total end range time (TERT) or daily TERT and the efficacy of a static progressive splint (SPS). The duration of splint application is positively correlated to the motion regained in stiff finger joints (Flowers & LaStayo, 1994; Glasgow et al., 2003). Lucado, Li, Russell, Papadonikolakis, and Ruch (2008) assessed the efficacy of an SPS by assessing ROM, grip strength, and subjective hand function evaluation, and their results showed that the SPS can increase the ROM of the wrist and the grip strength of patients with fractures on the distal radius. The same study showed that the Disabilities of the Arm, Shoulder, and Hand (DASH) score is negatively correlated with wrist extension and forearm supination. To date, only a few studies have focused on the application of SPS in regaining MCP joint motion [including PROM and active ROM (AROM)] and hand function of patients who have sustained traumatic injuries to the hand.

The purpose of this study is to determine the efficacy of static progressive MCP joint flexion splint, which is designed to address the anatomical and pathophysiological issues related to MCP joint stiffness. Most splints designed in the past are dynamic, and patients often find the splints clumsy and difficult to apply. Moreover, the tension from the coil or elastic bands cannot be easily adjusted by patients. The splint designed in this study is simple and easy to apply. Patients can also adjust the tension themselves after therapists have given demonstration and instructions. The total wear time can be closely monitored by therapists. The efficacy of this splinting programme has been proven by PROM, AROM, and hand function measurements derived through the DASH questionnaire. The relationship of DASH score with PROM and AROM has also been clarified.

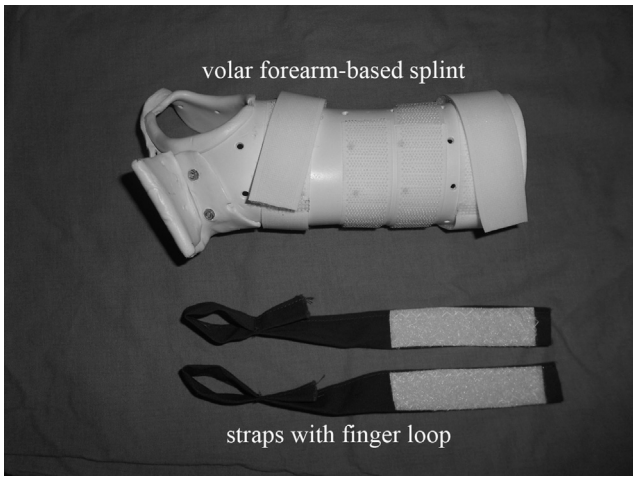

Figure 1 Splint materials.

Methods

Participants

This prospective study was approved by the Institutional Review/Ethics Committee of Wuxi Hand Surgery Hospital in Jiangsu Province, China. All patients involved in this study signed consent forms prior to implementation.

Thirty-one inpatients suffering from hand trauma and multiple soft-tissue contractures at any MCP joint in digits two to five were recruited by convenience sampling. These patients were admitted consecutively to our hospital. The inclusion criteria were as follows: The patient must be aged 18 years or older; the patient must have been diagnosed with MCP joint stiffness caused by hand trauma, with limitations in the MCP joint PROM in the flexion range of digits two to five; and the patient must not have joint fractures as verified by X-rays.

Patients with MCP joint fractures (fractures of the metacarpal head and the base of proximal phalanx), patients with bony MCP joint end feels in PROM, and patients who were referred to hand therapy for 3 months or more after injury were excluded. Subsequently, the selected patients were instructed to join a rehabilitation programme composed of a splinting programme (a static progressive MCP flexion splint) and an exercise programme under the instruction of a qualified therapist.

Treatment programme

Splinting fabrication and wearing. A volar forearm-based splint, which extends 10 cm proximal to the wrist crease,