Comparison of 2 Methods of Immobilization of Fifth Metacarpal Neck Fractures: A Prospective Randomized Study

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Purpose  The objective of this study was to prospectively compare the effectiveness of 2 methods of cast immobilization for fifth metacarpal neck fractures with respect to the time required for cast application, durability and tolerability of the cast, efficacy of maintaining reduction, and postimmobilization range of motion.

Methods  After closed reduction, 81 predominately young, active-duty patients were prospectively randomized to a short-arm cast with volar outriggers (SAC-VOR) or to a short-arm cast extended to the proximal interphalangeal joint with a 3-point mold (MCP-ext). Radiographs were obtained before reduction and after reduction at 1 and 4 weeks. Outcome measures (Disabilities of the Arm, Shoulder, and Hand questionnaire), cast durability, radiographic parameters, and complications were evaluated at each visit. Final range of motion and grip strengths were obtained at the 3-month follow-up.

Results  The average time for cast application was less for the MCP-ext group compared with that of the SAC-VOR group. An equal number of casts in each group (7) required replacement during treatment. There were no statistically significant differences in range of motion or final grip strength between the 2 techniques. Radiographic callus was seen in all patients at 4 weeks, and there was no difference in the 4-week postreduction angulation in the lateral or posteroanterior planes. In comparing the maintenance of the reduction, there was no difference in alignment in either the posteroanterior or lateral planes based on cast type.

Conclusions  There was no difference between the 2 groups on maintaining the reduction on final lateral radiographs. Stiffness was not a complication of either group. Advantages of the MCP-ext cast include quicker application and, to a much lesser degree, better tolerability, range of motion, and final grip strength. (J Hand Surg 2008;33A:1362–1368. Copyright © 2008 by the American Society for Surgery of the Hand. All rights reserved.)

Type of study/level of evidence  Therapeutic I.

Key words  Boxer’s, cast, hand fracture, fifth metacarpal, upper extremity.

Fractures of the fifth metacarpal neck, also known as boxer’s fractures, are common and are typically caused by a longitudinal compression force while the hand is in a clenched fist posture. The fracture usually has an apex dorsal angulation and is unstable because of its volar comminution and the deforming forces of the interossei.
Because of the relatively high degree of motion of the fifth carpometacarpal joint, patients can tolerate a marked amount of angulation in the sagittal plane. Several authors have reported that functional results can be achieved with little or no correction of these fractures in the anteroposterior plane. Marked angulation and resultant malunion, however, can result in a dorsal bump in addition to loss of prominence of the metacarpal head when making a fist. The shortening and angulation of the metacarpal greater than 30° can also lead to difficulties secondary to the altered mechanics of the hand in patients who are manual laborers required to perform forceful gripping activities.

Initial treatment typically is nonsurgical and involves some type of immobilization. A majority of reports of treatment of this injury consist of a closed reduction of the fracture and immobilization with the metacarpophalangeal (MCP) joint in flexion. Flexion of the MCP joint has been advocated to neutralize the deforming forces of the intrinsic musculature and primarily prevent collateral ligament contracture with resultant loss of MCP joint motion. Advocates of this type of reduction technique maintain flexion of the MCP joint commonly by an ulnar gutter splint or a short-arm cast incorporated with volar aluminum outriggers (SAC-VOR; Fig. 1). Disadvantages of this method of immobilization include technical difficulty in positioning of the outriggers or plaster splint, ineffectiveness of maintaining the reduction, and difficulty assessing radiologic alignment due to obstruction of the aluminum volar outriggers or plaster (Fig. 2).

Another method of immobilization relies on a 3-point molded cast about the fifth metacarpal neck fracture. This cast extends to the proximal interphalangeal (PIP) joint of the small finger and immobilizes the MCP joint in extension and reduces the fracture with a 3-point mold (MCP-ext; Figs. 3 and 4). Results from previous studies have reported ease of application of the cast and that it offers freedom of the interphalangeal joints, which may be better tolerated while maintaining fracture reduction. The disadvantage of this method has been the theoretical MCP joint stiffness that may ensue from immobilization in extension.

An evidence-based systematic review using the Cochrane Database states, “Most studies were of poor quality,” and “No single nonoperative treatment regimen for fracture of the neck of the fifth metacarpal can be recommended as superior to another in result. Further research is definitely warranted.”

The purpose of this study was to prospectively compare these 2 commonly used methods of immobilization and maintenance of reduction of closed, isolated fifth metacarpal neck fracture in skeletally mature patients with respect to radiographic parameters of fracture alignment, range of motion, and outcome measures. Time required for cast application and the...
durability and tolerability of each cast were also evaluated.

MATERIALS AND METHODS
The institutional review board and the committee for protection of human subjects of the Naval Medical Center San Diego approved the study, and all patients consented and agreed to participate in this study. A power analysis was performed, based on previous reports,\textsuperscript{17} to determine the number of patients necessary in each group to have $\beta = .80$. The standard deviation of overall radiographic evaluation of carpal measurements based on previous studies was $5^\circ$,\textsuperscript{17} and it was thus determined that 40 patients in each group would allow sufficient power of the study. Alignment for each radiograph was measured using the angle determined from the dorsal border and a second angle using the center of the shaft of the metacarpal. These 2 values were then averaged.

All skeletally mature patients with an acute (less than 7 days old) isolated fracture of the fifth metacarpal neck seen in the acute fracture clinic were invited to participate. Exclusion criteria included patients who had a history of metabolic bone disease, an open fracture, concomitant tendon injury, additional fractures of the ipsilateral extremity, open physis, neurologic involvement, or inability to return for follow-up care. Randomization was performed based on a computer-generated randomization program determining the order of 1 of 2 cast types. The cast type was printed on a 3 × 5 inch card and placed into an envelope, the various envelopes were placed in a box and mixed around, and then a staff member not involved in the study blindly drew an envelope from the box. The box contained an equal number of each group.

All patients were evaluated by history, physical examination, and initial radiographs. All consenting patients were randomly assigned to either casting with the MCP joint in flexion in a short-arm cast with volar outriggers with ring and small finger interphalangeal joints in extension (SAC-VOR; Fig. 1)\textsuperscript{4,11–15} or with the MCP joint in neutral extension and a cast with a 3-point mold about the fracture site (MCP-ext; Fig. 3).\textsuperscript{8}

A hematoma block using 5 mL 1% lidocaine without epinephrine (Hospira Inc., Lake Forest, IL) was performed, and 4.5 kgf of longitudinal traction on the small and ring fingers was applied via finger traps for 10 minutes followed by a closed reduction maneuver of stabilizing the proximal metacarpal segment, flexing the MCP and PIP joints in 90° of flexion to relax the deforming intrinsic muscles and tighten the collateral ligaments, and applying an upward dorsal force to the flexed PIP joint with a concurrent palmar force on the dorsal proximal metacarpal. The casts were then ap-
plied; trained cast technicians were used in assisting the surgeon with the cast placement after fracture reduction.

Postreduction anteroposterior (AP) and lateral radiographs were obtained after cast placement to assess the adequacy of the initial reduction. Residual angulation in the lateral plane of greater than 45° or any clinical rotational deformity necessitated a repeat manipulation. If we were unable to achieve an acceptable reduction after 3 attempts, the patient was excluded from the study, and a discussion of operative fixation ensued. The number of attempts at reduction and casting was recorded, as was the time from start to completion of the cast. At 4 weeks, the cast was discontinued, a removable ulnar gutter splint was applied, and range of motion was initiated. In addition to standard posteroanterior (PA), oblique, and lateral hand radiographs, a clinical examination to include assessment of rotation, skin breakdown, and durability of the cast was performed.

The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire was used. This is an outcome measures score that attempts to discern disabilities from musculoskeletal disorders of the upper limb, with Section 2 pertaining to athletes and Section 3 to performing artists. A score of 0 equates with no disability, and a score of 100 equates with maximum disability. Patients completed a DASH questionnaire at their initial visit and at each subsequent follow-up. Two board-certified orthopedic hand surgeons (E.P.H., A.Y.S.) evaluated all radiographs and were blinded to the casting technique when evaluating the final radiographs.

Statistical analysis was performed using a Fisher’s exact test for categorical data and Wilcoxon rank sum test for continuous data to determine significant differences. Statistical significance was set at \( \alpha \leq .05 \) and analysis performed using SPSS software (SPSS Inc., Chicago, IL).

Eighty-one patients were enrolled in this study, and 40 were randomized to the SAC-VOR group and 41 to the MCP-ext group. All participants were men except for 1 woman in the MCP-ext group. The average age was 25 years (range, 16–49 years). No patient required operative fixation of his or her fracture.

RESULTS

All patients were able to complete the study and were included in the analysis. There were no statistically significant differences between the 2 groups in relationship to age (\( p = .984 \)), handedness (\( p = .194 \)), time from fracture to presentation (\( p = .553 \)), number of reduction attempts (\( p = .123 \)), or initial fracture angulation in the AP plane (\( p = .485 \)) or lateral plane (\( p = .896 \)) (Table 1). The most common mechanism of injury was punching a hard object (57), followed by a fall (18) or being involved in a fight (6). There was no difference between the 2 groups in regard to the mechanism of injury (\( p = .670 \)). As there was only 1 woman in the cohort, differences based on gender were not able to be discerned.

The immediate postreduction angulation showed no significant differences in the lateral plane between the 2 groups (\( p = .453 \)), but there was statistically significant improvement in the AP plane in the SAC-VOR group (14° vs 5°; \( p < .005 \)) (Table 1). However, at 4 weeks, there was no significant difference in maintaining the postreduction alignment in either plane based on cast type or mechanism of injury (AP plane, \( p = .636 \);
lateral plane, \( p = .372 \). All patients showed radiographic callus and healing at 4 weeks.

There was a statistically significantly faster application with the MCP-ext cast versus the SAC-VOR cast (11 minutes vs 15 minutes; \( p = .025 \)). An equal number of casts in each group required replacement during treatment (7 in each group), owing to either patient discomfort or inappropriate care of the cast.

The initial DASH scores between the 2 groups were similar (Table 2), as were all subsequent follow-up DASH scores. Although there was generally less disability occurring with the MCP-ext cast compared with the SAC-VOR cast, this was not statistically significant.

Final MCP joint range of motion was slightly better with the extension cast (MCP-ext; loss of only 1° of extension) compared with having the MCP joint in flexion (SAC-VOR; loss of 7° of extension) (\( p = .118 \)). Final PIP joint range of motion showed an average loss of 3° of extension for the MCP-ext group and 2° of extension for the SAC-VOR group (\( p = .686 \)). However, overall there were no statistically significant differences in range of motion of the digits. Final grip strength when comparing with the contralateral hand was slightly better in the MCP-ext group but again did not reach statistical significance (loss of 1.09 kg vs 3.31 kg; \( p = .291 \)).

There was only 1 complication in the study: a persistent postimmobilization stiffness of the MCP joint 6 weeks after the removal of the SAC-VOR cast (range of motion = 40° to 85°). However, after 4 weeks of formal hand therapy, this nearly completely resolved (final range of motion = 0 to 90°).

### DISCUSSION

Although some studies espouse that the fifth metacarpal neck can tolerate up to 70° of angulation in the sagittal plane because of the compensatory 20° to 30° mobility in the fifth carpometacarpal joint, biomechanical studies have shown that more than 30° of angulation can result in decreased grip strength of the flexor digiti minimi and loss of digital motion.

Historically, closed reduction involved the “Jahss maneuver,” in which the proximal metacarpal segment is immobilized and the fracture is reduced with the metacarpal and PIP joints in 90° of flexion. The MCP joint is flexed to 90° to relax the deforming intrinsic muscles and tighten the collateral ligaments. An upward dorsal force is applied to the flexed PIP joint with a concurrent palmar force on the proximal metacarpal, thereby exerting upward pressure on the metacarpal head. Immobilization in this position of 90° of flexion of the MCP joint and PIP joint has been abandoned secondary to complications of PIP joint stiffness and skin complications.

A myriad of variations of this technique has been described to maintain reduction and allow fracture healing. Whereas the optimal and most effective immobilization technique remains controversial, advocates of MCP joint flexion maintain that prolonged immobilization in extension leads to collateral ligament contracture and subsequent loss of MCP joint flexion. Current guidelines, therefore, are to neutralize the deforming forces of the intrinsic muscles on the reduced fracture and to prevent loss of MCP joint flexion by immobilizing metacarpal neck fractures in the “intrinsic-plus” position of the hand or the MCP joint in 90° of flexion and the interphalangeal joints in extension.

Two studies have challenged this premise by treating these fractures with the MCP joint in extension. In a technique paper, King et al. introduce casting the MCP joint in extension and maintaining the closed reduction with a 3-point mold; they reported that 86% of patients maintained their reduction from retrospective studies but admit that their retrospective reviews failed to provide adequate functional outcome data. Recently, a retrospective review of 263 charts of patients with extra-articular metacarpal fractures reported that patients treated with the MCP joint in extension and the interphalangeal joints free did equally well compared with patients treated with other casting techniques in regard to motion, grip strength, and fracture alignment. However, this study failed to report outcome measures and had the limitations associated with retrospective chart reviews.

In our prospective and randomized study, we found

### TABLE 2. DASH Scores

<table>
<thead>
<tr>
<th>Measure</th>
<th>SAC-VOR</th>
<th>MCP-ext</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial DASH</td>
<td>36</td>
<td>34</td>
<td>.734</td>
</tr>
<tr>
<td>Initial athlete</td>
<td>63</td>
<td>48</td>
<td>.264</td>
</tr>
<tr>
<td>Initial artist</td>
<td>53</td>
<td>45</td>
<td>.284</td>
</tr>
<tr>
<td>1 week DASH</td>
<td>36</td>
<td>36</td>
<td>.754</td>
</tr>
<tr>
<td>1 week athlete</td>
<td>71</td>
<td>82</td>
<td>.953</td>
</tr>
<tr>
<td>1 week artist</td>
<td>67</td>
<td>5</td>
<td>.209</td>
</tr>
<tr>
<td>4 week DASH</td>
<td>35</td>
<td>29</td>
<td>.341</td>
</tr>
<tr>
<td>4 week athlete</td>
<td>69</td>
<td>61</td>
<td>.523</td>
</tr>
<tr>
<td>4 week artist</td>
<td>53</td>
<td>52</td>
<td>.895</td>
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<td>3 month DASH</td>
<td>8</td>
<td>9</td>
<td>.981</td>
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<tr>
<td>3 month athlete</td>
<td>24</td>
<td>18</td>
<td>.505</td>
</tr>
<tr>
<td>3 month artist</td>
<td>16</td>
<td>15</td>
<td>.605</td>
</tr>
</tbody>
</table>
that both methods of immobilization were equally effective in maintaining fracture reduction. Additionally, despite immobilization of the MCP joint in extension, range of motion was significantly similar to that of patients immobilized with MCP joint flexion.

The current study differs from the existing literature in the narrowed focus of treating only small finger metacarpal neck fractures as opposed to all extra-articular metacarpal fractures. In addition, it is a randomized, prospective comparison of 2 immobilization techniques as opposed to being a retrospective review of several different treatment methods. The randomized patient groups for each cast were well matched, and both casts were equally tolerated as demonstrated by relatively low DASH scores both during and after immobilization, with a trend toward improved strength and range of motion for the MCP-ext cast. The concept that fifth metacarpal neck fractures need to be immobilized with the MCP joint flexed to prevent contractures was challenged in this study and was found to be unsubstantiated. Patients immobilized in extension had significantly similar motion compared with those immobilized in flexion.

We recognize the inherent flaws in this study, which include the interobserver and intraobserver variability in radiographic measurement of the fifth metacarpal neck fracture, postreduction angulation, and maintenance of reduction. The fifth metacarpal neck is naturally angulated at 15° in the lateral plane, and the obliquity of the hand also alters the angulation on the radiograph. Radiographic assessment of fifth metacarpal fractures has been shown to have some degree of interobserver and intraobserver variability in other studies. To minimize this deficiency, 2 different techniques for measuring the fracture angulation were used.

With respect to casting technique, several cast technicians were used to aid in placement of the casts, and unintended bias may have been introduced as the MCP-ext cast, with its 3-point mold, may have received more physician attention because of its unconventional nature. To minimize this flaw, all cast technicians were trained and demonstrated competency in both casting techniques prior to the initiation of this study.

The age of the patients of this study should be noted (average age, 25 years; range, 16–49 years). The participants of this study were predominately active-duty military members, and there were no elderly patients in this study or patients who had concomitant injuries that may predispose them to stiffness (such as open injuries or concomitant tendon lacerations). Use of the MCP-ext cast in this population may not yield such results, and the conclusions we make are only applicable to a young, active patient population.

A final result that deserves further discussion is the difference in time required for cast application. Prior to this study, it was our perception that placing metal volar outriggers was tedious and highly time consuming in comparison with molding of a plaster cast. Although the MCP-ext cast was significantly quicker to place (by 4 minutes), this was not nearly as much of a difference as we had predicted and recognize that this may be of little practical value to the treating surgeon.

These limitations notwithstanding, this randomized, prospective study has successfully challenged conventional teaching that isolated fifth metacarpal fractures need to be immobilized with the MCP joint in flexion. Immobilizing the MCP joint in extension demonstrated no significant differences in regard to fracture healing, range of motion, grip strength, and durability compared with those of traditional methods. Advantages of the MCP-ext cast include its efficacy, ease of application, and freedom of interphalangeal joint motion. This study demonstrates that both techniques are effective in maintaining reduction and result in minimal disability and effective fracture healing. The extension cast with 3-point mold has the advantages of quicker application and better tolerability compared with the short-arm cast with volar outriggers.

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