The Functional Metacarpal Fracture Brace: A Viable Alternative

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ABSTRACT : A locally-available functional metacarpal fracture brace was developed based on an imported one and its use in four cases of closed metacarpal shaft fractures was evaluated. Functional bracing could be a viable alternative in closed treatment of metacarpal shaft fractures of the index, middle, ring, and little fingers.

INTRODUCTION

Closed treatment of closed metacarpal shaft fractures of fingers II to V has been long limited to confining splints after closed reduction. Range of motion of the wrist and even the interphalangeal joints of the involved and adjacent digits is greatly impaired during treatment. Disabling hand and wrist stiffness may be post-treatment effect. Aside from invasive measures such as open reduction and internal fixation with closed intramedullary pinning, no other means of treatment is currently acceptable and available in the local setting. It is therefore the objective of this study to develop and present a viable alternative closed treatment of closed metacarpal shaft fractures of the second to the fifth digits and to evaluate its use in some cases.

MATERIALS AND METHODS

A functional metacarpal fracture brace was developed and manufactured based on the design of the Galveston Metacarpal Brace (Fig.1). Indigenous materials were used to ensure availability to Filipino orthopaedic surgeons.Materials were chosen to duplicate the physical characteristics of the original brace, mainly sturdiness, adjustability, and water-resistance. Materials included : strips of Orthoplast, velcro, rubber sheets, sponge material, metal buckles, and mucilage (Fig.2). All of these were available at market places except for Orthoplast, which had to be ordered from the local dealer.

The main C-frame and volar two-point crossbar consisted of the orthoplast material (Figs.3-4). The three pressure pads (two volar and one dorsal) were constructed from rubber pads and sponge material to ensure soft points of contact so as to prevent skin necrosis. Velcro fasteners were attached to the above main pieces by mean of mucilage. Rivet fasteners were not used in the brace's construction. This modification enhanced the radiolucency of the brace, ensuring better x-rays monitoring of the fracture during treatment.

The brace could be finely adjusted to the hand of the

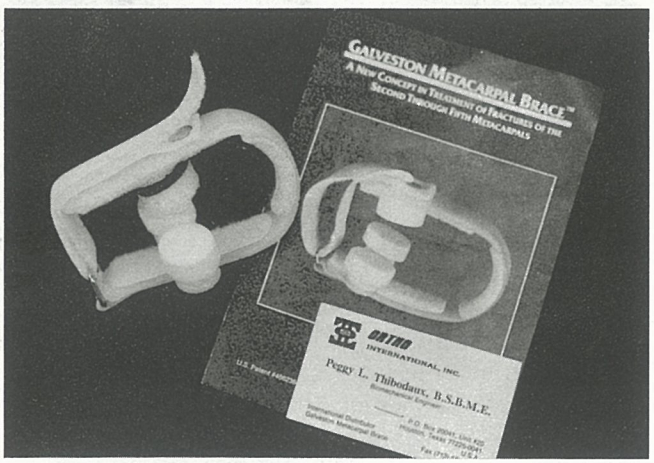

Fig. 1 The Galveston metacarpal brace

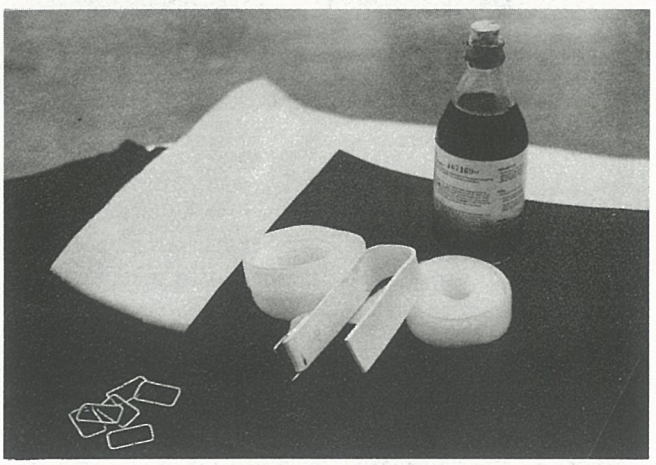

Fig. 2 Materials used in brace construction

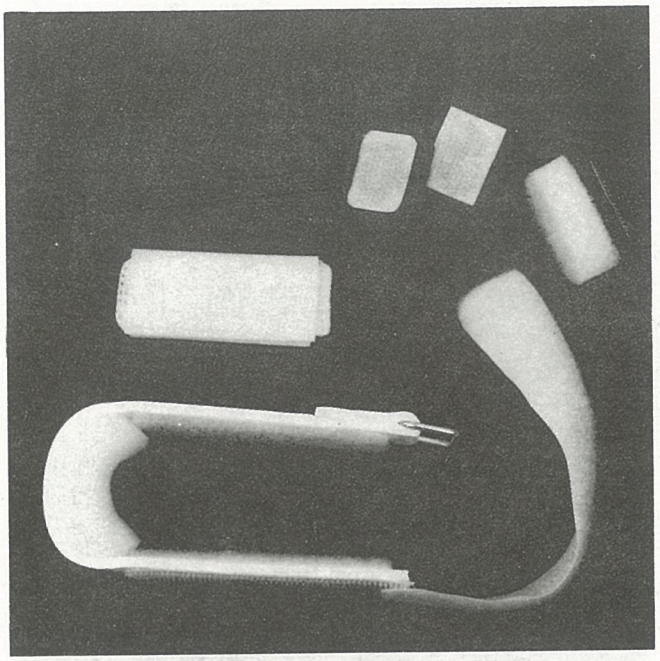

Fig. 3 Brace components

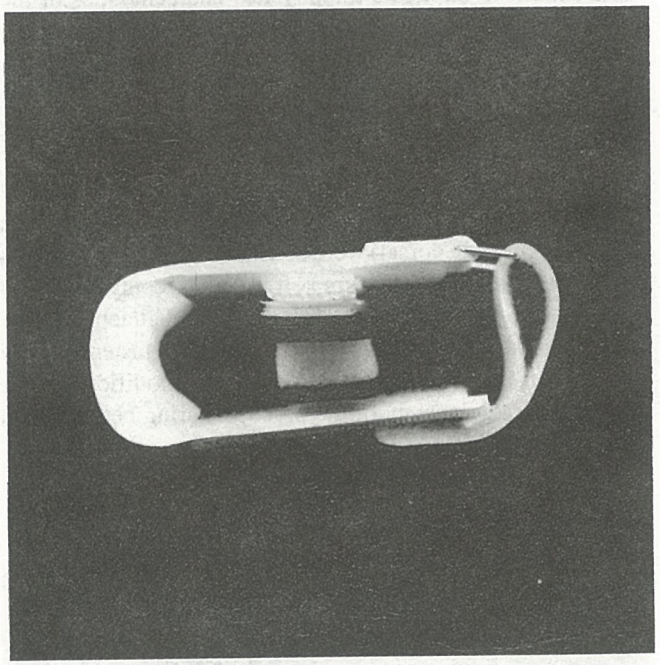

Fig. 4 The assembled brace

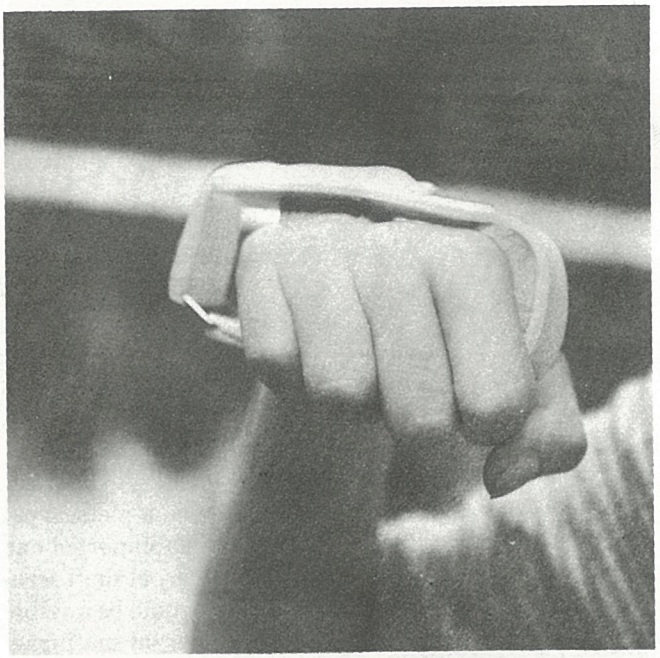

Fig. 5 Placement of dorsal pad over fracture apex

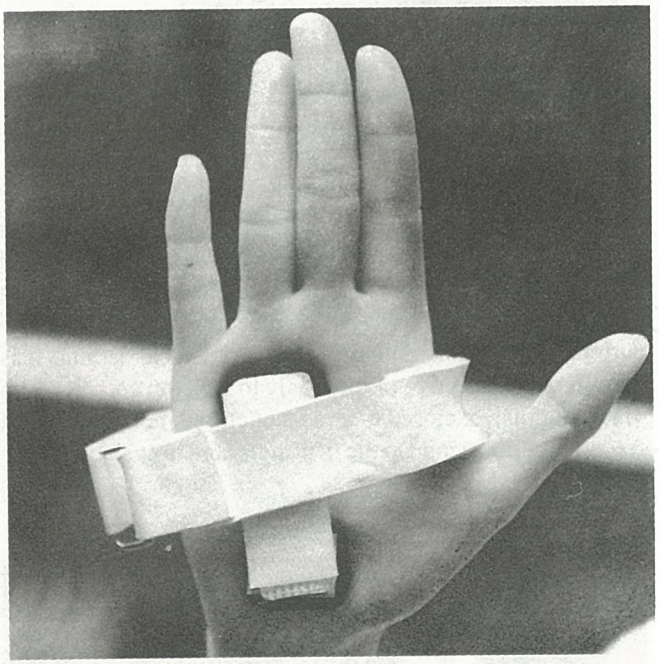

Fig. 6 Placement of crossbar with volar pads

patient. It could be used on any of the four digital metacarpals. The single dorsal pad was placed over the apex of the fracture (Fig.5). The crossbar, which provided two pressure points, was oriented over and in line with the long axis of the fractured metacarpal with one pad proximal and another distal to the fracture site (Fig.6). Aside from maintaining reduction, the brace could also facilitate reduction.

A velcro adjustable strap allowed tightening or loosening of the brace. Either the physician or the patient could therefore adjust the brace as edema from the initial injury recedes.

The brace was used on four cases of closed metacarpal shaft fractures. Initial closed reduction was done under wrist block anesthesia and/or sedation with the brace in place and aiding in the procedure. The brace was maintained until early union was achieved, usually at around three to four weeks (See Discussion). Non-strenuous activities of daily living involving the injured hand were allowed. The patient was allowed to use the hand in eating, writing, bathing, dressing up, and even typing and cooking. Heavy lifting, sports, driving, and other strenuous activities were not allowed.

Evaluation of the results during and after treatment included the following criteria : Physical appearance -lumps or depressions and overall symmetry of the hand, Functional result:- range of motion, pain, ability to do activities of daily living, and status at previous line of work, Subjective assessment patient's assessment of treatment with, regard to comfort and conveninece and roentgenographic appearance.

CASE # 1

R.C. a twenty-four-year-old, right-handed male messenger was treated a few minutes post-injury. X-rays revealed a complete oblique minimally-displaced fracture of the shaft of the third metacarpal with a dorsal angulation of eighteen degrees. Post-reduction film showed correction to zero degrees of the angulation. He experienced no pain, crepitus, or motion over the fracture site on range of motion of the wrist and hand throughout the treatment period of three and a half weeks. The patient developed erythema over the palmar pads by the middle of the second week, this resolved with loosening of the brace. Upon removal of the brace, range of motion was full for the wrist and fingers. X-rays revealed bridging callus over the fracture line.

CASE # 2

B.C., a fifty-six-year-old, right-handed male carpenter was seen several minutes post-injury. X-rays showed a complete spiral minimally- displaced shaft fracture of the ring finger metacarpal (Fig.7). Dorsal angulation was twenty degrees. Post-reduction x-rays showed correction of angulation to zero degrees. During the treatment period, he was able to go back to work immediately, even with the brace in place. He was able to resume writing activities, activities of daily living, and non-strenuous work-related activities without any pain or motion at the fracture site on range of motion. Complaints during treatment were limited to occasional pain during cold weather or at night. Erythema was also noted by the second week of treatment underneath the dorsal pad. This resolved after loosening of the brace.

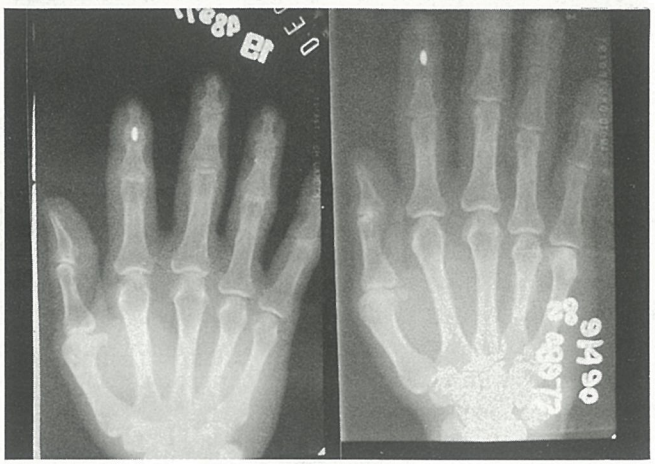

Fig. 7 Injury film 4 weeks after treatment

At four weeks, upon examination, the fracture was clinically healed. The patient experienced neither pain nor motion over the fracture even upon range of motion. X-rays revealed moderate external callus formation. Dorsal angulation of ten degrees was measured.

CASE # 3

E.E., a twenty-five-year-old, right-handed male mechanic who, a day prior to consultation slapped a basketball downwards and accidentally hyperextending his right ring finger. On x-rays, there was note of a complete oblique displaced fracture of the shaft of the middle finger with a dorsal angulation of thirty degrees (Fig.8). Closed reduction and brace application were done with a resulting correction to zero degrees of the dorsal angulation. Upon range of motion of the hand and wrist, he did not experience any discomfort or any movement at the fracture. Stress views with the wrist and fingers in flexion and extension were done revealing no motion of the fracture (Fig.9). Ten years after injury the fracture was noted to be stable even with range of motion. He was able to go about his activities of daily living.

Fig. 8 Injury film

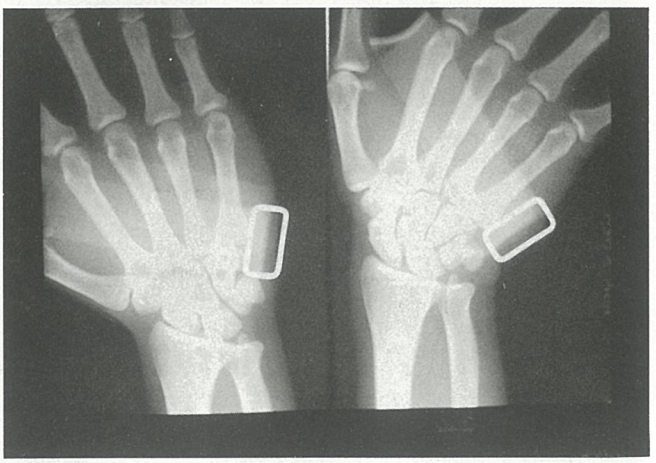

Fig. 9 Stress views - radial and ulnar deviation

CASE # 4

A.C., a twenty-one-year-old, right-handed male amateur boxer, sustained a displaced transverse shaft fracture of his fourth metacarpal (Fig.10). Dorsal angulation was forty-five degress. Closed reduction and brace application were done with correction of the angulation to zero degrees. Skin necrosis was noted by the second week of treament. At this time, the fracture was noted to be moveable, yet, the patient experienced no pain. X-rays revealed angulation of thirty degrees (Fig.11). Treatment was discontinued. It was at this time that he had to be tied off to Beijing for the Asian Games where the patient won the bronze medal.

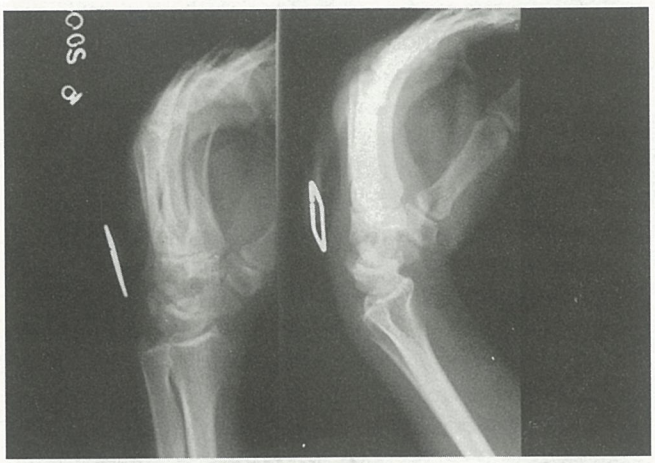

Fig. 9 Stress views - flexion and extension

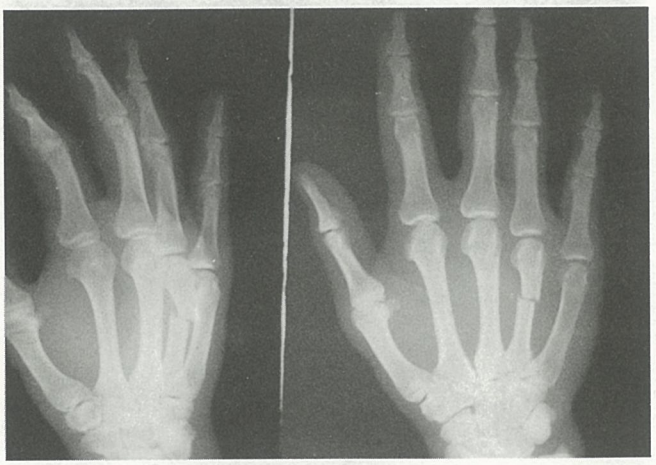

Fig. 10 Injury film

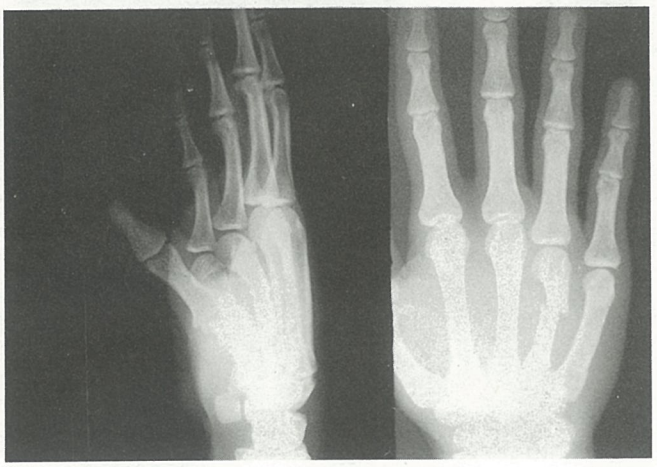

Fig. 11 Inujry film 2 weeks after treatment

DISCUSSION

Treatment of hand fractures should not be taken with a grain of salt for, nowhere else in the human body is motion and function more intimately related to anatomic structure. One must remember that the best result is achieved if the bony framework of the hand is restored as closely as possible to normal.[1]

Koch[2] described the hand disabilities that resulted from stiffness when the metacarpophangeal joints were immobilized in extension, currently, hands are immobilized in functional position. Brown[3] stated that sustained finger traction may be disastrous and potentially dangerous complications of which may exceed complications of neglect in both quality and quantity. Treatment of metacarpal fracture is focused on correction of shortening, angulation and rotational malalignment. As mush as two to three millimeters of shortening is acceptable[4]. Varying degress of dorsal angulation are accepted. Criterias for angulation are less stringent for the ring and the little fingers since a certain amount of motion at the carpometacarpal joints of these two digits can compensate for this. In spite of the fact that dorsal angulation rarely results in functional disability, it must be remembered that many patients can be unnerved by the resulting cosmetic result - a lump or bump on the hand. Malrotation is considered a serious complication since this can result in compromise of normal flexion of the fingers[5]. Closed treatment of metacarpal fractures in more recent times has generally been limited to use of dorsal or volar splints and gutter, which are often extended to the tips of the fingers to control rotation. These splints severely restrict the range of motion of the wrist and fingers of the involved digits. Hand stiffness develops faster than stiffness in larger joints due to the relatively greater area of the joint surface, capsule, ligament, and tendon. Generally, the smaller the joint, the more predisposed is the part to stiffness.[1]

A new alternative method was found in the form of the Galveston metacarpal brace. This was developed in 1985 at the University of the Texas Medical Branch in Galveston, Texas to effect a closed treatment of second to fifth metacarpal fractures without limiting function of the hand and without immobilizing the wrist and the metacarpophalangeal joints. A study by Viegas[6] comparing the brace and ulnar gutter treatment in twenty- seven patients showed union achieved in both groups with a greater degree of correction of angulation in brace-treated patients.

Currently, the brace is unavailable in the Philippines. To avail of this, one would have to place an order for one from the

manufacturer at a cost of fifty dollars a piece. The brace developed in this study approximates the actual Galveston brace in physical characteristics. It had been shown to effect a good treatment in the few cases presented. Like its original counterpart, it can provide many advantages over conventional non-invasive treatment.

The study had shown that functional bracing can be used as an alternative form of closed treatment of closed metacarpal shaft fractures which had some advantages over conventional treatments. The disadvantage of possible development of skin necrosis although present can be prevented by diligent monitoring of skin condition by both patient and physician. This was one limitation that few cases were presented with limited follow-up. The subjects were actually included in an ongoing prospective study comparing the use of the brace with the use of conventional splint and study was just started three months ago.

CONCLUSION

A functional metacarpal fracture brace can be manufactured with the use of locally-available materials at a low relative cost. It can serve as a viable, inexpensive alternative in closed treatment of closed metacarpal fractures of the index, middle, ring, and little fingers.

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