Hand Therapy 2010; **15**: 87–93. DOI: 10.1258/ht.2010.010018

Original article

Hand therapy management of metacarpal fractures: an evidence-based patient pathway

Angela Toemen and Robyn Midgley

Hand Therapy Department, Guy's & St Thomas' NHS Foundation Trust, London, UK

Correspondence: Angela Toemen, Hand Therapy Department, 3rd Floor Lambeth Wing, St Thomas' Hospital, Westminster Bridge Road, London SE1 7EH, UK. Email: atoemen@googlemail.com

Abstract

Introduction. Metacarpal fracture injuries are commonly referred to hand therapy departments, and may account for up to 40% of all hand fractures. These fractures are managed with either a surgical or non-surgical approach depending on their location and stability. Evidence for the effective therapy management of these fractures is sparse, varied and of poor quality and does not provide a 'gold standard' therapeutic treatment approach.

Methods. A literature review was performed to develop an evidence-based patient pathway that accounts for the location and stability of a fracture, minimizes the risks associated with metacarpal fractures and prevents secondary complications from developing.

Results. An evidence-based patient pathway for metacarpal fractures is presented that prevents unnecessary immobilization of unaffected joints and facilitates timely return to function.

Conclusion. The hand therapy management of metacarpal fracture pathway accounts for the location of the fracture, stability and surgical or non-surgical management based on best available evidence. It is recommended that the patient pathway be evaluated against functional outcome measures to ensure patients achieve optimal results.

Keywords: Metacarpal, fracture, therapy, patient pathway

Introduction

Metacarpal fracture injuries are commonly referred to hand therapy departments, with their incidence being up to 40% of all hand fractures.[1] These fractures are managed with either a surgical or non-surgical approach depending on their location and stability. Fracture management needs to ensure fracture stability, reduce patient discomfort, allow early return to movement and expedite timely return to function and work. However, the treatment also needs to balance the risks of fracture malunion, non-union, skin necrosis, angular displacement and fracture rotation. Hand therapy management of metacarpal fractures is diverse with no clear guideline to provide the patient with the earliest or most favourable functional outcome.

Prior to 2009, metacarpal fracture management within our hand therapy department did not discriminate between the fracture location, stability, or surgical or non-surgical approach (see Figure 1). The maximal protection of the fractured hand was prioritized and permitted limited functional use for six weeks. This approach resulted in the occurrence of common complications including joint stiffness, extensor tendon lag and poor adherence to treatment. The additional therapy appointments required to address these complications had cost and time implications for the patient and department.

The aim of this paper is to review and evaluate the available evidence for the therapeutic management of metacarpal fractures. Examination of the existing pathway identified and facilitated discussion of key areas that required change to ensure optimal care for the patient while reducing complications. This subsequently led to the development of an evidence-based treatment pathway for metacarpal fractures. This paper will discuss the justification for the evolution of this pathway.

Methods

The databases accessed during the literature review included Medline, CINAHL and AMED. The search terms that were used to access the information included 'metacarpal AND fracture', combined using Boolean operators with *therapy*

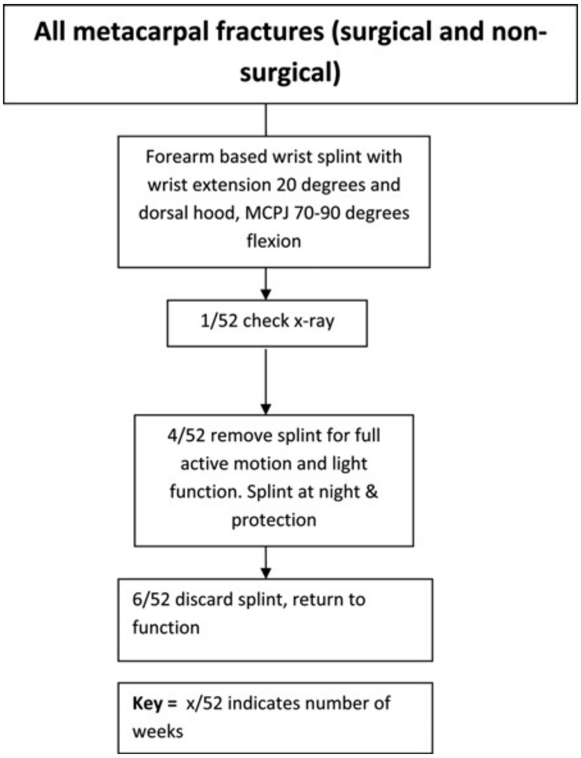

Figure 1 Original pathway. MCPJ, metacarpophalangeal joint

OR hand therapy OR physiotherapy OR physical therapy OR treatment OR management OR surgery. No year limit was used in the first instance to ascertain the number of relevant studies that could be located. One hundred and fifty-five articles were retrieved (following removal of duplicates) and subsequent review of their abstracts led to 12 further papers being excluded as they were not available in English. A total of 18 articles were accessed that discussed therapy management and outcome. All articles (regardless of year of publication) were included in the review due to the limited number of articles found that discussed therapy management and outcome.

Results

Head of metacarpal fracture

A fracture to the head of the metacarpal is rarely seen.[2] It is reported that these injuries can be treated non-surgically if the involvement of the joint is less than 25%.[2] There is little literature available regarding the therapy management of these fractures either conservatively or post surgery.

McNemar *et al.*[3] discuss non-surgical management suggesting protective immobilization of the fracture for three weeks in a forearm-based splint (including the non-injured adjacent finger) with the wrist positioned in 0–20° extensions, metacarpophalangeal joint (MCPJ) in 90° of flexion and interphalangeal joints (IPJ) in extension.

A surgical approach may include intraosseous wiring, screw fixation or Kirschner wire (K-wire) fixation to stabilize the fracture and allow earlier motion. However, McNemar *et al.*[3] suggest a period of immobilization for 10–14 days post K-wire fixation.

Neck of metacarpal fracture

Metacarpal neck fractures are the most common fractures of the hand, with fractures of the fifth metacarpal accounting for 51–68% of all metacarpal fractures.[4] Recent studies have accepted that up to 70° of volar angulation will not lead to an associated functional loss;[5] therefore, the majority of these fractures are treated non-surgically. A rotational deformity is not tolerated functionally as the injured finger will become fixed under the adjacent fingers when a functional grip is required. This is a clear indication for surgical management; however, literature regarding hand therapy management following surgery is lacking.

A systematic review of fifth metacarpal fractures was unable to determine the optimal therapy treatment for these fractures. The studies reviewed were of poor quality and did not present optimum therapy management of these fractures.[6] Management varied from immobilization, protected mobilization to no protection at all.

Braakman *et al.*[5] compared two protocols for the management of neck of metacarpal fractures. The first protocol included the provision of an immobilizing ulna gutter plaster of Paris (POP) cast that positioned the wrist in 45° of extension, the MCPJ in 90° of flexion and the IPJ at 0–10° of extension. The second protocol applied tape to the little and ring fingers. Patients were reviewed at one week. The POP group presented with significant MCPJ extension lag (up to 30°) and a flexion deficit in comparison to the tape group. The extension deficit remained significantly different between the two groups at four weeks follow-up. The flexion restriction remained in the POP group in 44% of patients at the four-week follow-up and in 8% at three months. This highlights the detrimental effects of immobilizing finger joints even for a short period of time. At four weeks follow-up all the tape patients had regained full motion.

Hansen and Hansen[7] conducted a study in which they compared POP, elastic bandaging and a functional splint. As expected, at follow-up the POP patients had reduced range of motion (ROM) compared with the other two groups. At a four-week follow-up the patients wearing the elastic bandage complained of significantly more pain than the splinted or POP patients. This study may indicate that no protection deters a return to function due to pain. This view is supported by a study that compared a hand-based volar and dorsal thermoplastic splint that allowed full motion of the MCPJ and wrist to buddy strapping.[8] The dorsal component of the splint extended across the MCPJ protecting the fracture site. At a three-week follow-up, patients treated with the brace complained of less pain and had a greater ROM than the buddy strapping. Those that had a brace had returned to work sooner than those with the buddy strapping.[8]

Hofmeister *et al.*[9] randomized neck of fifth metacarpal fractures into forearm-based POP with either the MCPJ flexed or extended for a four-week period. They found no statistically significant difference in motion or grip strength on review at three months following treatment. Tavassoli *et al.*[10] randomized extra-articular metacarpal fractures into three groups. The fractures were managed for five weeks with either (i) MCPJ flexion with IPJ motion or (ii) MCPJ extension with IPJ motion or (iii) MCPJ flexion with IPJ extension and no mobilization. On removal of the cast there were no significant differences in motion between the groups. At nine weeks following treatment there was no significant difference in ROM or grip strength. These two studies challenge conventional practice regarding the positioning of MCPJ with splinting.

Three studies have shown the benefits of no support or splinting in the management of these fractures. Ford *et al.*[5] purely advised patients as to which exercises to perform, at a three-week follow-up appointment all patients had regained full flexion and this was also the average time that employed patients had returned to work. At a four-week follow-up 50% of patients continued to have an extensor lag (between 5° and 30°). Arafa *et al.*[11] instructed patients to 'use their hands as normally as possible'. At four months follow-up 82% of patients were totally satisfied with their outcome. The remaining patients continued to have mild discomfort, or were conscious of the deformity. Five ($N = 101$) patients had a clinically obvious deformity and 14% of patients continued to have an extensor lag of less than 15° with no functional impairment. The complications discussed in these two studies can be addressed with therapy but require a follow-up review. This highlights that the contribution of hand therapy is important within the first stages of the patient pathway.

The comparison of immobilization of patients within a POP for three weeks and buddy strapping of the little finger to the ring finger has also been compared.[12] The buddy strapping group was given advice through an information sheet and no follow-up appointments. This group returned to work significantly earlier than those in POP and only one patient ($N = 38$) returned to the clinic complaining of pain and swelling. No patients within this group felt a follow-up visit was necessary.[12] At 12 weeks following injury there was no significant difference between the group's motion (flexion or extension) or functional outcome (Disabilities of the Arm, Shoulder and Hand Questionnaire). This study indicates that minimal intervention with this patient population can aid a rapid return to function and limited clinical follow-up is required; however, some form of education and information (such as a leaflet) is required.

Shaft of metacarpal fracture

The classification for shaft metacarpal fractures includes transverse, oblique (spiral) and comminuted.[2] The possible mal rotation of oblique fractures or shortening of comminuted fractures is poorly tolerated in function and these may require surgical stabilization; however, for the majority of stable fractures closed reduction and non-surgical management is appropriate.[2] McMahon *et al.*[13] randomized the treatment of stable shaft metacarpal fractures with either a compression glove or three weeks immobilization in POP. Those who were placed in a glove had lost significantly less flexion than the POP group at the two- and three-week follow-up appointments. At the four-week follow-up appointment there was no significant difference between the two treatment groups. This may indicate that three weeks of immobilization is an appropriate period without a significant loss in function. Burkhalter[14] advocates a forearm-based POP with the wrist in 30–40° of extension and a dorsal extension block with the MCPJ in 80–90° of flexion and IPJ extension. Patients were able to perform a composite fist within the POP. McNemar *et al.*[3] discuss a 'three point fixation splint' in which stable fractures can be treated. Two counter pressure points are proximal and distal to the volar fracture site, and one pressure point is over the dorsal fracture apex. Burkhalter[14] and McNemar *et al.*[3] do not review specific outcomes for their management.

Surgical fixation may use percutaneous wiring, intramedullary wiring or open reduction. A study of long oblique mid shaft metacarpal fractures with cerclage wire fixation allowed 17 patients to mobilize with no protection or restriction post surgery. They reported no complications and full motion was achieved in all patients at eight weeks following surgery.[15] There is no further available evidence to guide our management of these surgically fixated fractures.

Base of metacarpal fracture

Metacarpal base fractures are classified as intra- or extra-articular. Stability of these fractures is determined by the volar and dorsal carpometacarpal and interosseous ligaments,[16] with the stability reducing as mobility of the carpometacarpal joint increases in a radial to ulna direction. The potential deforming forces are due to the insertions of Extensor Carpi Radialis Longus, Brevis and Flexor Carpi Radialis into the second and third metacarpal bases; and of Extensor Carpi Ulnaris and Flexor Carpi Ulnaris into the fourth and fifth metacarpal bases. There are conflicting opinions in the literature as to the optimal treatment of these fractures and limited indications regarding therapy management.

Bora and Didizian[17] treated intra-articular fractures with no or minimal displacement within a forearm-based wrist immobilization splint or POP for four weeks. On review these patients all had 'satisfactory outcomes' with no compromise in grip strength. Patients with disruption of the joint surface were reduced and K-wired with wrist immobilization in a POP for 4–6 weeks. Three quarters of these patients required further open reduction and internal fixation (ORIF) to restore the CMCJ articulation and grip strength. Hsu and Curtis[18] described a case series of five patients of whom two had fractures associated with a dorsal dislocation at the base of the fifth metacarpal. One patient had a closed reduction and wrist immobilization in a POP for four weeks and one patient had a fracture at the base of the third and fourth metacarpal, which was initially reduced but could not be maintained and therefore required K-wiring and an above elbow POP for four weeks. Both patients at four weeks follow-up had regained full ROM. Although Hsu and Curtis[18] only discuss two fracture-dislocation case studies, it indicates that wrist immobilization of four weeks does not result in significant wrist joint stiffness. Kjaer-Petersen *et al.*[19]

reviewed intra-articular base of fifth metacarpal fractures managed surgically and non-surgically. All patients were immobilized in an 'ulnar plaster cast' for three or four weeks. Thirty-eight percent of patients followed up at a median of 4.3 years complained of 'symptoms' regardless of the method of treatment (closed reduction, percutaneous K-wiring or ORIF).[19] These studies suggest that immobilization of the wrist for four weeks is adequate for fracture stability and does not impede the return of wrist motion.

Lundeen and Shin[20] retrospectively reviewed intra-articular base of the fifth metacarpal fractures. All patients were treated with a POP to immobilize the wrist. The ring and little finger MCPJ were placed in 70° of flexion. They report that the average time for the cast immobilization and clinical healing was five weeks. The average time for return to work was six weeks. At an average of 43 months follow-up the average grip strength was 98% of the contralateral hand. Only one patient out of 22 reported a 'poor' result from their injury. They do not discuss return of motion or the rationale for inclusion of the ring and little fingers.

Petrie and Lamb[21] reviewed 14 cases following base of fifth metacarpal fractures treated non-surgically with early motion and found minimal loss of grip strength (tested at greater than 2 years following injury) and an average return to work of three weeks. They reported complications such as metacarpal shortening, incongruity in the articular surface and widening of the joint; however, only one patient had pain significant enough to affect work. The complications they reported were not discussed in previous papers that immobilized the wrist perhaps suggesting that a period of immobilization is required.

Review of existing pathway

At our department all patients with a metacarpal fracture of the head, neck, shaft or base were provided with a forearm-based wrist splint that positioned the wrist in 20° of extension with a dorsal hood that maintained the MCP joints in 70–90° of flexion. The splint was worn for a period of four weeks before full active ROM commenced. At six weeks patients were permitted to remove the splint and return to full function. All patients received an X-ray at one week following their fracture or surgery to evaluate the fracture position and identify any potential complications such as the development of an unstable fracture.

The pathway did not provide clear guidelines as to when patients could return to low, medium or heavy duty work or full contact sport. Patients were not provided with written information on the management of metacarpal fracture injuries. The majority of patients were reviewed on a weekly basis until eight weeks following injury irrespective of their injury classification.

This pathway provided fracture stability but it did not make allowances for fractures that were stable or fixated, which would permit mobilization of the unaffected joints and earlier return to light functional use. This resulted in the development of complications and loss of long-term functional use of the hand. We observed that patients who were less compliant with their treatment protocol tended to have better functional outcomes and fewer complications. As complications developed in those who were compliant, more hand therapy appointments were needed, which increased the costs to the patient and the hospital.

It was agreed that the existing patient pathway was inadequate and that an evidence-based, cost-effective pathway should be developed. In addition, it was agreed that a patient information leaflet should be developed that would provide the patient with information and advice following a metacarpal fracture. (Copies of the patient information leaflet can be obtained by emailing the corresponding author.)

Rationale for a new patient pathway

A new evidence-based pathway was developed for the management of all metacarpal fractures (see Figure 2). The pathway was approved by the referring Plastic and Orthopaedic Surgery Consultants following presentation of the available evidence and incorporated their recommendations for splint positioning and return to function. In addition, a patient information leaflet was developed and approved by the Trust's patient publication group. Patients were to be provided with this at their first appointment.

Following is a summary of the rationale for the new pathway. All fractures were seen in hand therapy at the time of initial diagnosis and were reviewed again at one week for clinical assessment and radiographic review to ensure fracture stability had been maintained.

Thermoplastic splinting was advocated over the use of POP in this patient population in the four fracture classifications as precise positioning of specific joints is required of the involved fingers only. POP, although cheaper than thermoplastic material, may prevent full motion of unaffected joints and therefore generate further therapy input to regain ROM.

Head of metacarpal fracture

A hand-based splint with a dorsal hood that positioned the MCP joints at 70° of flexion protecting the affected and neighbouring finger was advocated. There is no evidence to suggest that the wrist joint should be immobilized. The extensor digitorum communis is a potential deforming force to this fracture pattern (pulling the fracture fragments dorsally) however maintained flexion at the MCPJ joint will reduce this risk. The position of MCPJ flexion will preserve length of the collateral ligaments, prevent the 'claw' like position of an oedematous hand and provide extensor tendon tension around the head of the metacarpal.[22] Avascular necrosis is a complication of these fractures if the head of the MCPJ is placed in greater than 70° of flexion.[23] Clinical union has been shown to occur between two and three weeks after fracture;[24] therefore, therapists encouraged light function and full active motion at two weeks if the fracture was stable and at four weeks if unstable or fixated with K-wires. All patients were advised to mobilize the IPJ freely within the splint. Remodelling of the bone from the initial soft callous formed in the reparative healing phase to a harder callous

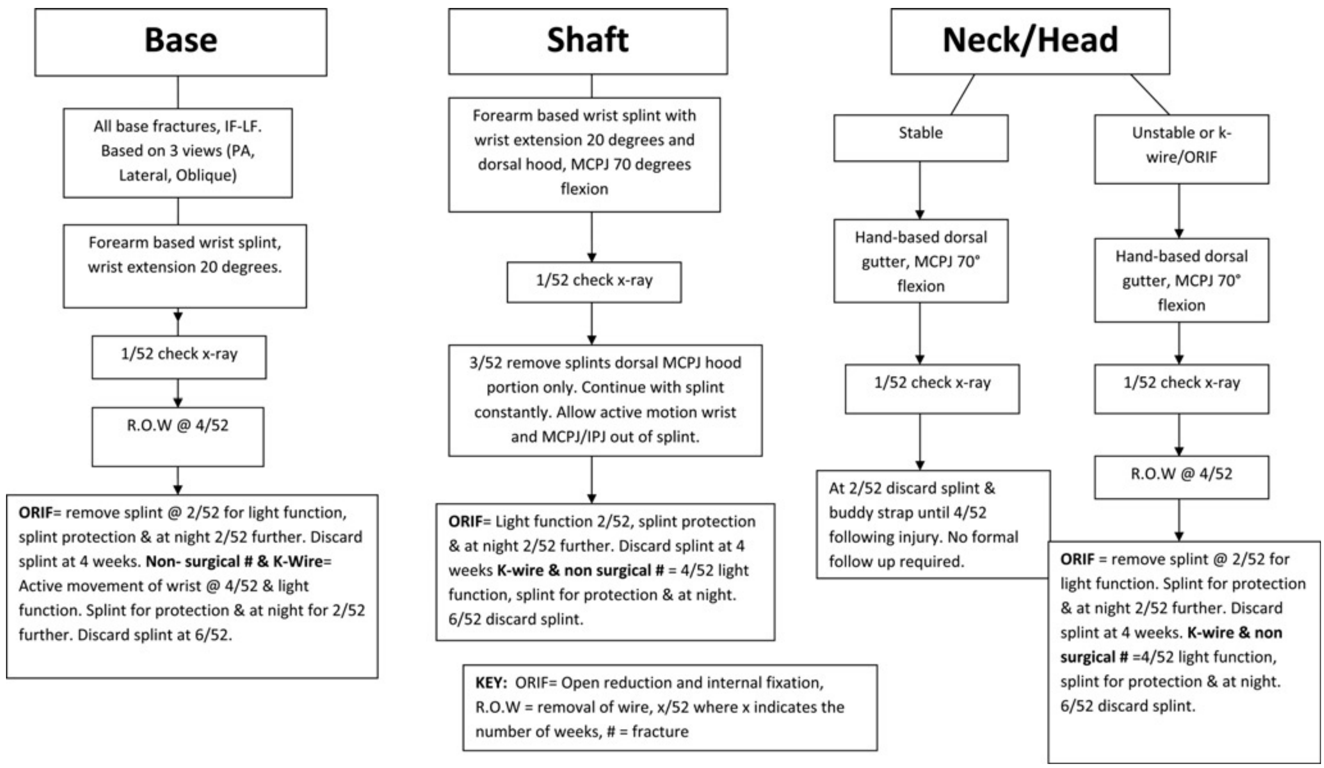

Figure 2 Evidence-based pathway. MCPJ, metacarpophalangeal joint; ORIF, open reduction and internal fixation

occurs around six weeks.[24] Therefore patients did not require any further protection at this stage and were advised to return to everyday tasks.

Neck of metacarpal fracture

A dorsal hand-based splint positioning the affected and neighbouring finger MCP joints in 70° of flexion was provided for the initial 2–4 weeks (dependent on stability and surgical fixation) following the fracture. This offers initial protection of any direct force to the fracture site which has been shown to be beneficial in pain reduction, ROM and return to work.[7] The splint position encourages the MCPJ to rest in a degree of flexion enabling the base of the proximal phalanx to glide upwards on the volar angulated head of the metacarpal.[25] This position may reduce further volar angulation with function. Placing the MCPJ in flexion tightens the dorsal capsule and extensor mechanism allowing the soft tissues to further stabilize the fracture. A position of 90° of flexion is often found by patients to be uncomfortable and unreasonable to obtain in an oedematous hand; therefore, we chose to place the MCPJ in a comfortable 70° of flexion.

If the fracture was diagnosed as stable, the splint was removed at two weeks following injury and patients were placed into buddy straps for a further two weeks to reduce any risk of angulation (scissoring) or rotation, and discourage full use of the hand until clinical healing occurred. This patient group was advised accordingly on return to function and work and given no formal follow-up appointment at this point. If the patient had an ORIF, they were advised to remove their splint at two weeks to begin full active motion and light function, and to continue with the splint for protection until they were four weeks following surgery. Unstable, reduced or K-wired fractures maintained the position in their splints until four weeks following injury or surgery. This time frame is to ensure fracture stability occurs in the initial healing phase.[24] K-wires were removed at four weeks following surgery. These patients gradually returned to light functional tasks between four and six weeks in accordance with fracture healing times.[24] Passive stress and strengthening was delayed until six weeks enabling clinical union.[3]

Shaft of metacarpal fracture

A forearm-based wrist splint that positioned the wrist in 20° of extension with a dorsal hood over the affected and neighbouring fingers that maintained the MCP joints in 70° of flexion (allowing IPJ flexion and extension) was advocated for the initial period of two weeks for all metacarpal shaft fractures. This errs on the side of caution for these fractures can be potentially unstable, and may result in complications with a significant functional impact. It has been shown by Wright[26] that after three weeks of immobilization joint and soft tissue stiffness can lead to a significant loss of hand function. Following three weeks of protected mobilization the dorsal hood component was removed, the remaining portion of the splint (forearm-based wrist splint with the wrist in extension) was to be worn at all times unless exercising. Patients were encouraged to achieve full active motion of the MCPJ and wrist. This will address any extensor tendon adhesions, MCPJ lag or flexion deficit complications. At 2–3 weeks a soft bone callous would have stabilized the fracture site and pain and oedema would be resolving[24] allowing for the reduced splinting restriction. The splint was then removed (except for protection and at night) at four weeks to begin light function and completely discarded at six weeks following injury.

If a patient had an ORIF, they were permitted to perform light functional activities at two weeks due to the increased fracture stability with this rigid fixation. Non-surgically managed fractures and those with K-wires began light function at four weeks following injury and discarded their splints at six weeks as clinical fracture union progressed.

Base of metacarpal fracture

Intra- and extra-articular base of metacarpal fractures that were treated non-surgically or with K-wires were provided with a forearm-based wrist splint, positioning the wrist in 20° of extension for a period of four weeks. This parameter was decided based on the possible deforming forces of the extrinsic wrist extensors and flexors discussed previously. Base fractures will heal quickly due to their composition of cancellous bone.[20] Numerous authors have advocated immobilization of the wrist for four weeks without detriment to wrist motion.[17–19] At four weeks following injury or surgery, patients were advised to begin light function and wrist motion. The splint was to be worn for a further two weeks for protection and completely discarded at six weeks following surgery or injury.

Patients who had their fractures fixated with an ORIF were permitted to perform light functional activities at two weeks due to the enhanced stability of their fracture sites. The splint was worn for protection for a further two weeks and discarded at four weeks following surgery.

Discussion

The risk of malunion, non-union, angular displacement and fracture rotation following a metacarpal fracture is well documented.[3] However, there are no clear guidelines for the therapeutic management of metacarpal fractures that would minimize these risks, prevent secondary complications and ensure optimal return to function.

The discussed literature has been applied during the development of a new evidence-based pathway. The pathway accounted for the location and stability of a fracture and aimed to minimize the risks associated with metacarpal fractures and prevent secondary complications from developing. The pathway aims to ensure effective treatment for patients which should result in improved departmental efficiency and therefore reduce the number of appointments required. A key priority was not to overtreat the patients (reducing appointment costs and time) and prevent unnecessary immobilization of unaffected joints.

The aim of the new pathway is to improve patient compliance and increase cost-effectiveness by reducing the number of follow-up appointments needed if fewer secondary complications present.

Conclusions

Surgical and non-surgical complications following metacarpal fractures can compromise both the appearance and the function of the hand. This paper presents an evidence-based patient pathway that aims to limit the risks associated with these fractures and prevent secondary complications from occurring. It is recommended that the patient pathway be evaluated against functional outcome measures to assess the efficacy of the pathway and determine the effect on improving patient compliance and enhancing cost-effectiveness.

Acknowledgement: We would like to acknowledge Matthew James, Catina Bernardis, Sameer Gidwani, Dr Jamil Ahmed and Joanna Hickling for their contributions to the development of the pathway.

Competing interest: None declared.

Accepted: 1 June 2010

References

1 Radiopaedia.org. Metacarpal fractures. See http://radiopaedia.org/articles/metacarpal-fractures (last checked 7 March 2010)
2 Green DP, Pederson WC, Hotchkiss RN, Wolfe SW. *Greens Operative Hand Surgery.* 5th edn. Churchill Livingstone, London, UK: Elsevier Health Sciences, 2005
3 McNemar TB, Howell JW, Chang E. Management of metacarpal fractures. *J Hand Ther* 2003;**16**:143–51
4 Braakman M, Oderwald EE, Haentjens MH. Functional taping of fractures of the 5th metacarpal results in a quicker recovery. *Injury* 1998;**29**:5–9
5 Ford DJ, Ali MS, Steel WM. Fractures of the fifth metacarpal neck: is reduction or immobilisation necessary? *J Hand Surg* 1989;**14B**:165–7
6 Poolman RW, Goslings JC, Lee JB, Muller MS, Steller EP, Struijs PA. Conservative treatment for closed fifth (small finger) metacarpal neck fractures. *Cochrane Database Syst Rev* 2005;**20**:pCD003210
7 Hansen PB, Hansen TB. The treatment of fractures of the ring and little metacarpal necks. A prospective randomised study of three different types of treatment. *J Hand Surg* 1998;**23B**:245–7
8 Harding IJ, Parry D, Barrington RL. The use of a moulded metacarpal brace versus neighbour strapping for fractures of the little finger metacarpal neck. *J Hand Surg* 2001;**26B**:261–3
9 Hofmeister EP, Kim J, Shin AY. Comparison of 2 methods of immobilisation of fifth metacarpal neck fractures: a prospective randomized study. *J Hand Surg* 2008;**33A**:1362–8
10 Tavassoli J, Ruland RT, Hogan CJ, Cannon DL. Three cast techniques for the treatment of extra-articular metacarpal fractures. Comparison of short-term outcomes and final fracture alignments. *J Bone Jt Surg* 2005;**87A**:2196–201
11 Arafa M, Haines J, Noble J, Carden D. Immediate mobilization of fractures of the neck of the fifth metacarpal. *Injury* 1986;**17**:277–8
12 Bansal R, Craigen MAC. Fifth metacarpal neck fractures: is follow-up required? *J Hand Surg (Eur vol)* 2007;**32E**:69–73
13 McMahon PJ, Woods DA, Burge PD. Initial treatment of closed metacarpal fractures. *J Hand Surg* 1994;**19B**:597–600
14 Burkhalter WE. Closed treatment of hand fractures. *J Hand Surg* 1989;**14A**:390–3
15 Al-Qattan MM, Al-Lazzam A. Long oblique/spiral mid-shaft metacarpal fractures of the fingers: treatment with cerclage wire fixation and immediate post-operative finger mobilisation in a wrist splint. *J Hand Surg* 2007;**32**:637–40
16 Bushnell BD, Draeger RW, Crosby CG, Bynum DK. Management of intra-articular metacarpal base fractures of the second through fifth metacarpals. *J Hand Surg* 2008;**33A**:573–83
17 Bora FW, Didizian NH. The treatment of injuries to the carpometacarpal joint of the little finger. *Journal of Bone and Joint Surgery* 1974;**56**:1459–63
18 Hsu JD, Curtis RM. Carpometacarpal dislocations on the ulnar side of the hand. *Journal of Bone and Joint Surgery* 1970;**52**:927–30

19 Kjaer-Petersen K, Jurik AG, Petersen LK. Intra articular fractures at the base of the fifth metacarpal. *J Hand Surg* 1992;**17B**:144–7
20 Lundeen JM, Shin AY. Clinical results of intra articular fractures of the base of the fifth metacarpal treated by closed reduction and cast immobilisation. *J Hand Surg* 2000;**25B**:258–61
21 Petrie PWR, Lamb DW. Fracture-subluxation of the base of the fifth metacarpal. *Hand* 1974;**6**:82–6
22 Ebinger T, Erhard N, Kinzl L, Mentzel M. Dynamic treatment of displaced proximal phalangeal fractures. *J Hand Surg* 1999;**24**:1254–62
23 Freeland AE. *Hand Fractures: Repair, Reconstruction and Rehabilitation*. New York, NY: Churchill Livingstone, 2000
24 La Stayo PC, Winters KM, Hardy M. Fracture healing: bone healing, fracture management and current concepts related to the hand. *J Hand Ther* 2003;**16**:81–93
25 Jahss SA. Fractures of the metacarpals: a new method of reduction and immobilisation. *J Bone Jt Surg* 1936;**20**:178–86
26 Wright TA. Early mobilisation of fractures of the metacarpals and phalanges. *Can J Surg* 1968;**11**:491–8