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TREATMENT OF FRACTURES TO THE HAND

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SUMMARY

The aim of this article is to discuss the treatment of fractures to the hand given the importance of this organ in terms of functional anatomy. After classifying the various types of fractures, surgery and rehabilitation options for all types are discussed. Particular emphasis is placed on therapy for the most frequently seen lesions such as fractures to the scaphoid, the fifth metacarpal and the base of the first metacarpal. The importance of the use of prophylaxis against stiffness and treatment for oedema, which are commonly seen in fractures to the hand, is also highlighted.

Introduction

Automation and continuing industrial development have brought an increase in industrial accidents and, in this regard, the hand is one of the regions most at risk of trauma. Therefore, there should be a considered commitment to therapy which allows for the complete restoration of the injured hand, or where this is not achievable, the return of as much functionality as is feasible, in the shortest possible time. Fractures of the hand are very common and the associated lack of functionality can have a huge impact on daily and work life. When fractures are stable, they may be treated conservatively; however, if fractures are displaced, comminuted or associated with lesions of the soft tissue, the injury may call for open or closed reduction treatment and synthesis [1]. Choosing a treatment which allows for an optimum setting of the fracture and at the same time permits mobilisation as quickly as possible is essential. The older the patient, the more important this becomes. The role of rehabilitation is essential for these types of lesions, whether treatment has been conservative or has involved surgery. The hand is made up of three groups of bones, namely: the carpus (8 short bones), the metacarpus (5 long bones) and the phalanges (3 long bones in each finger and two in the thumb), over 30 tendinous insertions and numerous complex structures [2]. Fractures of the hand may be divided into fractures of the bones of the carpus, metacarpus and of the phalanges.

Fractures of the carpus

Fractures of the carpal bones are very common and are typically caused by falling on to the palm of the hand; the most frequently involved bones are the scaphoid (83%) and pyramidal bones (13.8%). These bones may be subject to disorders of consolidation and also to post-traumatic necrosis due to their anatomic position and also to the nature of vascularisation involved. Fractures which involve only the carpal bones are rare and are usually treated conservatively with an antebrachial-metacarpal plaster brace until bone consolidation is complete [3]. However, this is not the case for fractures of the *scaphoid*. These are very frequent in young men and rarely seen in children or the elderly, this is

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because in these age groups, the radius is the principal point of weakness. Fractures to the scaphoid usually follow a fall on the palm of an outstretched hand or occur through a knock to a closed fist. 20% of fractures to the scaphoid involve the proximal pole, 60% the waist of the bone and 20% the distal pole. These fractures are complicated by a high percentage occurrence of pseudarthrosis and vascular necrosis. This is due to the vascularisation of the scaphoid; blood supply comes from vessels which penetrate the bone at the distal third of the dorsal ridge and it reaches the proximal pole via a retrograde course. Therefore, the scaphoid is at severe risk of vascular necrosis [4]. The symptoms of these fractures consist of pain in the wrist with associated loss of function; clinically one might also find oedema of the anatomical snuff box, with pain on palpitation or axia l pressure to the thumb. The primary diagnostic instrument is radiography which allow s for four projections: the dorsal palm (AP), lateral, oblique at 45˚ and ulnar deviation of the wrist. If the first x-rays are negative, but the suspicion of a fracture remains, it is important to repeat the x-rays 15 days later. Over this time, an undiagnosed fracture may be revealed through a radiolucent line due to progressive reabsorption of bone at the edges of the fragments. The most commonly used table for the classification of these fractures is that of Herbert (Table 1). Treatment of type A fractures involves immobilisation, first through a brachial-metacarpal plaster brace and then an antebrachial-metacarpal brace with thumb included for a period of between 45 – 60 days, followed by a thin section CT scan to evaluate the amount of bone consolidation obtained and the need for further immobilisation. Treatment of type B fractures involves instead open reduction through a palmar approach to the waist and osteosynthesis obtained with a titanium Herbert screw (Figure 1) or Kirschner wire (Figure 2) followed by immobilisation in antebrachial- metacarpal plaster for 30 days.

Therapy for pseudarthrosis consists of surgery to increase blood flow to the pseudoarthrotic areas together with an autoplastic bone graft and synthesis with Herbert screws. Finally, an antebrachial-metacarpal plaster is applied [5].

For those fractures that receive a closed treatment (non-surgical), active ROM (range of motion) exercises for the shoulder, MCF (metacarpophalangeal joints), PIP (proximal interphalangeal joints) and DIP distal interphalangeal joints are performed from the index finger to the little finger. Over the following six weeks once the brachial-metacarpal plaster has been replaced with the antebrachial-metacarpal plaster the shoulder and finger exercises are maintained and active flexion, extension, supination and pronation exercises of the elbow start. At the 12th week, if x-ray shows that consolidation is not sufficient,

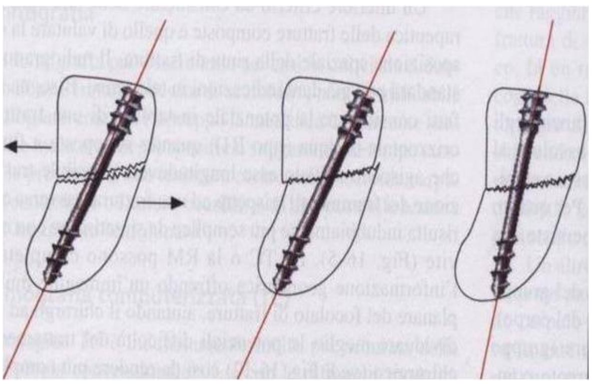

Figure 1: Fracture of the scaphoid treated with Herbert screws.

A1. tubercle fracture	B1. distal oblique fracture	D1. fibrous union
A2. Incomplete fracture through the waist	B2. displaced fractures of the waist	D2. pseudarthrosis with initial deformity
	B3. fractures of the proximal pole	D3. pseudarthrosis sclerosis with advanced deformity
	B4. dislocated fractures	D4. vascular necrosis of the proximal fragment

Table 1: Herbert classification of lesions of the scaphoid. Since the 1996 revision type C lesions of delayed union are no longer included.

Figure 2: Fracture of the scaphoid treated with Kirschner wire.

the antebrachial-metacarpal plaster is maintained; if, however, sufficient consolidation has occurred, the split is removed and an exercise programme begins. This consists of: ROM exercises both active and assisted flexion and extension of the thumb, together with ulnar and radial inclination of the wrist, MCF and IP joint of the thumb. Between the 14th and 18th week all the splints are removed and occupational therapy begins. From the 18th week strengthening exercises are initiated and aggressive ROM exercises continue until full functionality is restored [6 - 7].

Regarding surgically treated fractures of the scaphoid, ROM exercises for the shoulder and active ROM exercises for the MCF, PIP and DIP begin in the first 10 days after surgery. In the first four weeks, after the removal of the suture, exercises continue for the ROM of the shoulder. Between the 4th and the 18th week, the antebrachial-metacarpal plaster is replaced with a brachial-metacarpal one, in order that active and assisted extension and flexion exercises of the elbow and pronation and supination may be performed. Active ROM exercises are maintained from the forefinger to the little finger as are exercises for the ROM of the shoulder. At 8 weeks, provided that the CT scan shows the required consolidation, the plaster is replaced with a removable splint, and ROM exercises of flexion, extension, active and assisted radial and ulnar inclination of the wrist, as well as active and assisted exercises for the ROM of the MCF and IP joint of the thumb begin. Between the 10th and 14th week use of the split is suspended and occupational therapy exercises start. From the 14th week and thereafter the aim is to strengthen grip, aggressive ROM exercises begin and the patient may begin unlimited activity [7].

Fractures of the metacarpus

Fractures of the metacarpal bones are very common and generally due to direct trauma. Among modern work accidents, the most common are multiple fractures involving the skin and the soft tissue to varying extents (lesions of the tendons, capsule and ligaments). They can involve the shaft with a transverse (direct trauma) or oblique (indirect trauma) fissure, the epiphysis or the distal region of the metaphsis (subcapital fracture) or proximal region of the metaphsis (base fracture). There is often displacement which given the shortness of the section of fractured skeleton presents problems for reduction and contention.

However, this may be achieved by placing the fingers in a position of semiflexion (metacarpophalangeal joints and interphalangeal joints) to avoid early onset stiffness caused by a non-functional position. Shaft fractures are treated conservatively with an antebrachial-metacarpal plaster, as long as they are stable fractures of the third and forth metacarpal bones. In other cases, and if more metacarpal bones are involved, open reduction is necessary together with synthesis with mini-plates and free screws. For fractures at the neck of the metacarpal bones, closed reduction treatment is preferred together with stabilisation with metal wires, to avoid secondary displacement while in plaster. Fractures to the head necessitate open reduction and osteosynthesis with mini screws.

The duration of both open and closed reduction, is the time it takes to correct every minor rotatory movement, because if they were to persist, they would cause, after consolidation, a lateral deviation in flexion of the radius involved with consequent overlapping of the fingers and functional deficit. X-ray projections of the hand are always AP , lateral and oblique [4-5].

Non-displaced metacarpal fractures are stable lesions and are treated with the application of a splint to the wrist at 30˚ extension, the MCF at 60-80 ˚ of flexion and the IP in complete extension. In this position, the important ligaments of the wrist and the hand are held at maximum tension to avoid retraction. It is essential that early movement of the PIP and DIP is possible, as this helps to prevent tendon adhesions and controls oedema. The splint must extend from under the elbow to the distal edge of the first phalange in order that the patient may continue with active exercises of flexion and extension of the PIP and DIP immediately [6-8].

Fractures to the first metacarpal bone generally involve the base. Particular lesions are the *Bennett* fracture, an oblique fracture to the base of the first metacarpal which allows for carpo-metacarpal articulation and the *Rolando* fracture, an intra-articular fracture in the shape of a Y at the base of the first metacarpal bone. The Bennett fracture, which is much more common than that of Rolando, is made of two fragments; a small triangular fragment that remains attached to the trapezium and a larger one which dislocates dorsally and consequently forms Bennett's dislocation fracture. A radio-dorsal dislocation is seen which is principally caused by traction from the abductor muscle of the thumb (Figure 3).

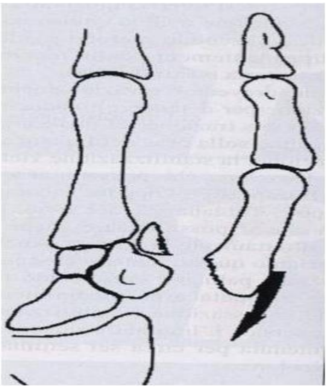

Figure 3: Bennett fracture.

Figure 4: Bennett fracture treated with mini fixatives.

Clinically, swelling is evident at the base of the first metacarpal and pressure to that point produces pain. AP and lateral projection x-rays of the thumb show the fracture. The treatment is almost always exclusively surgical with closed reduction and osteosynthesis with Kirschner wire to fix the base of the metacarpal bone to the trapezium or open reduction and synthesis with mini-fixatives (Figure 4).

For impacted fractures at the base of the first metacarpal, immediate reduction is necessary. This is achieved through axial traction on the finger and pressure at the base of the metacarpal bone. Then an antebrachial-metacarpal plaster brace is applied, incorporating the first finger (first finger in semiflexion, first metacarpal in modest abduction and the wrist lightly extended) for about 30 days [6]. The fifth metacarpal fracture, or *boxer's fracture*, is the most common fracture of the hand. It is a lesion of the distal metaphsis of the fifth metacarpal and it occurs as the result of hitting an object with a closed fist. Treatment depends on the amount of displacement which is assessed though a true lateral x-ray of the hand. Fractures to the neck of the metacarpal bones are usually engaged and angulated, with the distal fragment displaced towards the palm as a result of traction from the intrinsic muscles. An excessive angulation can cause the knuckle of the metacarpophalangeal joint to disappear and permit the head of the metacarpal to stick out of the palm during functional activities. For fractures of the second and third metacarpal only a 10° of angulation is acceptable; however, it is possible to accept 30° for the forth metacarpal and 40° for the fifth, this is due to the increased mobility of the fourth and fifth CMC. If the amount of displacement is not acceptable, a closed reduction with anaesthetic block to the wrist using the Jahss manoeuvre might be attempted. In which case, the first phalange is flexed at 90° in order that dorsal pressure is applied directly to the head of the metacarpal bone. Afterwards, an ulnar gutter splint is worn for about 3 weeks, with the metacarpophalangeal joint at 80° of flexion, the proximal interphalangeal joint at 0° and leaving the distal interphalangeal joint free. In order to avoid excessive scarring, adhesions and rigidity not linked to the fracture itself, but due to the tendency of an immobilised hand to become rigid, it is important that the fingers are mobilised quickly. Surgical treatment of the boxer's fracture is indicted if the alignment of the fracture is not acceptable (> 40° of displacement), if a new displacement occurs in a fracture that has already been reduced, or if malrotation of the finger is presented. Surgical fixation usually consists of pinning with percutaneous Kirschner wire; however, open reduction and synthesis might be necessary. Surgically treated fractures need approximately 3 weeks of immobilisation. After non-surgical treatment, active movements of the non-immobilised thumb, index finger, middle and ring fingers are performed during the subsequent two weeks. After 3 weeks the ulnar gutter splint is removed and an antebrachial-metacarpal plaster is applied for a further 3 weeks. This allows for the active movement of the fourth and fifth PIP and DIP and of the MCF. Between the 3rd an d 5th weeks active and assisted exercises for the ROM of the ring and little fingers are performed during passive extension. After the 5th week active, assisted and passive exercises for the ROM of the ring and little finger are continued until full functionality is restored. After surgical treatment a splint is applied leaving the PIP and DIP free and active ROM exercises for the ROM of the PIP and DIP and the fingers that are not involved begin in the first week. Between the 10th and 14th day the suture is removed and active exercises continue. The splint is removed at 3 weeks. Between the 3rd and 5th week stabilisation is effected through buddy taping with the adjacent fingers, active, assisted and passive exercises for the ROM of the ring finger and little finger are performed with passive extension of all the articulations. From the 7th week activity without limitation may begin [6-8].

Fractures of the phalanges

In the adult, fractures of the distal phalange are most common, followed by fractures of the proximal and intermediate phalange; approximately 20% of the fractures are intra-articular. Fractures of the phalanges are most frequently seen in children, the most common involves the shaft of the fifth finger. X-rays must be performed with an AP and true lateral projection of the finger [3].

Fractures of the phalanges can involve the shaft and the epiphysis and as such they can be articular. In particular, it should be noted that in fractures of the shaft of the first phalange (Figure 5), the action of the intrinsic muscles causes the proximal fragment to flex while the distal fragment extends; often this is accompanied by an axial rotation.

Figure 5: Fracture of the first phalange of the V finger.

However, in fractures of the second phalange, when the fracture is proximal to the insertion of the superficial flexor, the central extensor tendon extends the proximal fragment while the distal fragment is flexed by the superficial flexor. If, instead, the fracture is distal to the insertion of the superficial flexor, it is the proximal fragment that is flexed and the distal extended [5].

The treatment of compound fractures involves the use of an antebrachial-metacarpal plaster brace with a metal stake which incorporates the fractured finger. Displaced fractures instead necessitate a closed reduction and stabilisation with percutaneous Kirschner wire (Figure 6) or open reduction followed by synthesis with miniscrews or plates. In particular articular fractures need anatomical reduction and early mobilisation in order to prevent secondary articular rigidity due to long periods of immobilisation [4].

Active exercises for the ROM are recommended while the therapist supports the fractured area, as early as 4 weeks after surgery. In the following 2 weeks, active and active assisted exercises which work the intrinsic muscles are recommended, those being extension of the MCF and flexion of the IP combined. Once the fracture appears sound upon x-ray, dynamic splinting may begin. The dynamic splints may be worn from 6 hours per day and increasing by one hour each time until the threshold of 12 hours per day is reached. The dynamic splints may be alternated with dynamic bandages maintaining flexion. Therapy may continue for between 3 – 6 months after injury [6-8].

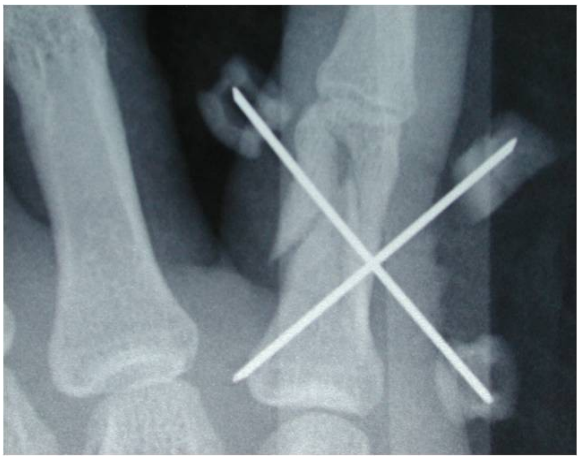

Figure 6: Fracture of the first phalange of the V finger.

Stiffness of the hand

Stiffness is the most common complication which affects a fractured hand, the result of a combination of three factors: oedema, pain and immobilisation (prolonged and/or in a bad position). Stiffness of only one finger can negatively affect the normal functioning of the entire hand. It is universally acknowledged that the prevention of stiffness after a trauma to the hand is achieved through early mobilisation. The best treatment prioritises functional re-education, while surgical intervention is only necessary in the more complex cases. Any pathology that causes limited articular excursion, insufficient stimulus of connective structures, and is aggravated by scarring of the tissue, can cause stiffness. The risk of stiffness is particularly high in cases of fracture combined with pain, oedema and inappropriate immobilisation which is either too long or in a non-physiological position. This can be prevented in its initial stages by early mobilisation; this limits retraction and maintains the intra-articular space. Moreover, 'controlled' mobilisation of lesioned tissue can speed up the scarring process, improving architectural organisation and mechanical properties [9]. An important role is routinely given to the prevention of psychosomatic syndromes; the patient's mood is decisive in the setting in and advancement of post-traumatic stiffness. Careful observation of the patient is important, with the aim of preventing psychosomatic syndromes destined to cause stiffness. This involves the evaluation of both intellectual and emotive aspects and the consideration of pharmacological therapy where appropriate. Combating fear and any psychogenic resistance from the patient is helpful in improving their predisposition to the therapy itself, and promoting a collaborative attitude [10].

Medical therapy for oedema

Oedema is almost always present during the clinical course of a trauma to the bones of the hand. It is caused both by local vasomotor alterations and variations in the hydrophilic state of the tissues.

Such oedema, which should be only local and transitory, can cause damage to the articular and periarticular tissues if it persists. As such, it can be the precursor to chronic stiffness.

As far as medical therapy is concerned, enzyme complexes, anti-inflammatory and vasoprotective drugs, diuretics, cortisones and in some cases tranquilizers are used.
The enzymes some of which have fibrinolytic (hyaluronidase) agents contribute to the prevention of adhesions causing permeability, while the other drugs help the reabsorption of interstitial liquid.
The anti-inflammatory drugs act on almost the entire range of phlogistic phenomena due to overlapping of both past and proliferative vascular phenomena. This class of drug causes a reduction in vascular phenomena and an improvement in tissue trophism, thereby favouring the repair and scarring processes.
The vascular-protectors that include vitamins C, K, P and flavonoids act predominantly on the vessel walls at the level of the endothelium, increasing their resistance to chemical-physical agents and reducing their permeability.
Diuretics are used because of their depletive action on liquids at a cellular level which aids their elimination through urination. The use of such substances must be carefully evaluated before administration and monitored after as they can cause, depending on the drug given, either hyponatremia or hypokalemia with all their attendant effects.
Cortisones are sometimes used because of their anti-phlogistic and anti-proliferative actions and for their marked protective action on vessel permeability.
Tranquilizers are used to reduce the psychological resistance of the patient and ensure a positive attitude towards the physiokinetic therapy [11].
In conclusion, we can confirm that in the treatment of a fracture to the hand it is essential for clinical orthopaedics and often, surgery and rehabilitation to work together. A perfect reduction and correct immobilisation are necessary but not sufficient for full recovery, if they are not followed up with adequate rehabilitation. Through various stages and using a combination of different methods which depend on the fracture type, the aim is to allow the patient to return to work with the minimum possible functional deficit.

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