**INTRODUCTION**

Physical therapy for the hand must embrace an understanding of the hand as an ‘organ’ that interfaces the person with their world by bringing in sensory information, and allowing the person to engage in activity that determines function and quality of life. The hand has intricate anatomical structures in close proximity that contract, glide, and heal following injury. Maintaining joint mobility and stability while the structures in the proximity remain free to glide and resist contractile forces are critical to hand motor performance. Issues of motor control and sensory motor integration are critical to the functionality of the hand. Exquisitely innervated, the hand can serve as a sensory organ or contribute painful stimuli that alter the cortex and produce chronic pain. Manual therapy techniques can contribute to normalizing the neurosensorimotor function of the hand, in combination with other techniques. In the current chapter we highlight the most prevalent conditions affecting the digits.

**DIGITAL FrACTURES**

**Epidemiology: incidence, prevalence, economic impact**

Hand fractures are a common traumatic injury usually arising during work place, sporting or recreational activities. Fractures of the metacarpals and phalanges are most
common (Hove 1993, Van Onselen et al 2003, Aitken & Court-Brown 2008, Feehan & Sheps 2008a). Border digits are the most commonly affected (thumb/small finger). The majority are treated conservatively (Feehan & Sheps 2008b). Metacarpal fractures represent 35% of hand fractures.

**Anatomy**

To better understand hand fractures one must first understand the relationship between both soft tissue and bony factors that contribute to both soft tissue and skeletal stability. We suggest that readers consult a standard anatomy text or The Electronic Textbook of Hand Surgery (http://www.eatonhand.com/hom/hom033.htm) website for details of hand/wrist anatomy as we only will highlight key elements. The latter website has primal pictures used with permission, some radiographic images of anatomy and pathology and information on various bony and soft tissues providing accessible and clearly visualize aspects of key anatomical features. More detailed descriptions of anatomical features are available in classic anatomic textbooks.

**Pathology**

Bone fractures result from excessive force, in comparison to bone strength. Fracture angulation is determined by the forces exerted by the soft tissues on both the proximal and distal fragment. Movement recovery following fracture can be affected by the nature and severity of the original fracture, associated soft tissue injuries and the extent of malalignment in bony structure that occurs following bony healing.

The mechanism of injury plays a role in the type of fractures that should be anticipated. A direct blow will result in a transverse fracture, a twisting injury will cause a spiral fracture and combination of torque and axial force will result in a short oblique fracture. Fractures are further classified based on the location (head, neck, shaft or base of a specific hand bone) and any associated soft tissue injury.

All fractures are associated with soft tissue injury. The nature of these injuries can be difficult to determine even with imaging and clinical examination. Muscle and ligament injuries can be important aspects of the fracture and may become more evident as the fracture heals and swelling subsides, or when movement is initiated. Scar healing of injured soft tissue can be a substantial component of active movement limitation.

**Metacarpal fractures**

The metacarpal bones have intrinsic stability provided by strong interosseous ligaments binding them to the carpal bones and proximally by the transverse metacarpal liga-

ment which links all metacarpal heads. Ligaments tend to prevent excessive displacement with injury. The fifth metacarpal is commonly fractured during a ‘punch’ mechanism (the majority of these injuries occur in males) and are treated conservatively since full motion/function is often obtained despite malrotation. There is generally a good blood supply which supports high rates of healing, usually within 4–6 weeks. The most important soft tissue concerns are preserving MP joint flexion and maintaining EDC glide.

Fractures of the base of metacarpals are intra-articular fractures that result usually from high forces that disrupt the rigid carpal ligaments of the index and middle finger or overwhelm the normal flexibility of the ulnar metacarpals. Shaft fractures are extra-articular fractures that usually arise during a fall or blow and usually angulating dorsally (with components of shortening or rotation). They are described as transverse, oblique or spiral. Intrinsic muscle tension will cause both ends of the metacarpal bone to flex into an apex dorsal presentation. This causes a shortening which compromises the extensor mechanism by altering the muscle length relationship. Metacarpal neck fractures are the most common metacarpal fracture (‘boxers fracture’). The impact of a closed fist causes a break at the extra-articular neck. If associated with a bite, infection is a potential complication which can substantially increase tissue damage. Metacarpal head fractures are intra-articular fractures caused by high axial loading that may involve collateral ligaments and substantial comminution. These fractures can lead to chronic pain and joint instability.

**Phalangeal fractures**

Phalangeal fractures have greater tendency towards instability as the phalanges lack intrinsic muscle support and are adversely affected by the mechanical forces of the extrinsic flexors and extensors. However these fractures are also more likely to become stiff with immobilization (Shehadi 1991) (predicted motion return of 84%). If immobilization is longer than 4 weeks, predicted motion is 66%.

Intra-articular fractures of the base of the proximal phalanx (PP) usually occur following an abduction force most commonly seen in sports injuries or a fall. Displaced fractures may not be reducible conservatively because of collateral ligament avulsion which worsens the fracture displacement with MP flexion. This can lead to higher rates of non-union with conservative management (Shewring & Thomas 2006). PP shaft fractures have the poorest prognosis for regaining full ability as they occur in the flexor zone two. Since 90% of the proximal phalanx surface is covered by gliding structures these can easily become adherent to the fracture callus. PP condyle fractures usually occur with the lateral deviation force and may be associated with collateral ligament injury. This is a common sports injury, and a common missed diagnosis.
The interossei and lumbricals muscles are the prime MCP flexors. The lumbricals originate from the tendons of the flexor digitorum profundus tendon and the three palmar and four dorsal interossei muscles originate from the volar and dorsal surface of the metacarpal respectively (Smith 1975). The interossei insert onto the antero-lateral base of the proximal phalanx and on the extensor mechanism forming part of the lateral band with the lumbricals, which also inserts dorsally into the extensor apparatus. These intrinsic muscles, along with the extrinsic flexor tendons create deforming forces on the fractured metacarpal shaft resulting in apex dorsal angulation (Flatt 1996). A proximal phalanx fracture will typically angulate with an apex volar deformity because the interossei will flex the proximal fragment due to their insertion at the proximal phalangeal base while the distal fragment is pulled into hyperextension by the central slip which inserts at the base of the middle phalanx and acts to extend the distal fragment. Fractures of the shaft of the MP occur less commonly, and may displace dorsally or volarly. Intra-articular fractures at the base of the middle phalanx (MP) occur commonly from a fall or direct force. These may be associated with PIP joint dislocation and damage to the volar plate and/or central slip. If the compression trauma is severe, a comminuted fracture of the articular surface, with depression of the fragments into the bone shaft or ‘pilon’ fracture occurs. MP fractures of the distal third tend to angulate with an apex volar deformity as the flexor digitorum superficialis (FDS) acts to flex the proximal fragment. A proximal third fracture usually angulates with an apex dorsal deformity as the FDS will flex the distal fragment while the central slip extends the proximal fragment.

DP fractures are common during crush injuries and may not displace significantly because the presence of a rigid nail plate dorsally helps to preserve alignment. However, due to the space restrictions inherent in the fingertip anatomic structures and their dense innervations, these injuries can be particularly painful. The distal phalanx (DP) accounts 50% of hand fractures, which may be attributed to its vulnerability as the fingertip. Tendons avulsion alone or with a variable amount of the articular surface ‘chip fracture’ can occur. This commonly occurs in sports and hence there are sport-related names for these injuries (‘jersey’ = FDP avulsed from the volar base of the DP or ‘baseball’ = avulsion of the terminal extensor tendon from the DP). PP shaft fractures are proximal to the nail bed and usually result from direct trauma. PP tuft fractures are the most distal fracture and can be quite painful and difficult to manage since union may be slow.

**Thumbs fractures**

The first CMC joint is a double saddle-joint, which allows movement in both the flexion/extension plane and in abduction/adduction. Because of the wide range of motion present at the thumb CMC joint, angulation of up to 30° is well tolerated allowing rehabilitation to achieve full function even when re-morbid joint mobility is not attained. In extra-articular fractures dorsal angulation occurs because the abductor pollicus brevis, adductor pollicis and flexor pollicis brevis muscles attaching at the base of the proximal phalanx and act to flex the distal fragment while the abductor pollicus longus muscle (which attaches to the metacarpal base) extends the proximal fragment. A Bennett fracture is an intra-articular fracture involving the metacarpal base. The fracture fragment involves the volar ulnar portion of the metacarpal base. This fragment is held undisplaced by the anterior oblique ligament. The remainder of the thumb metacarpal usually subluxes radially, proximally and dorsally by the forces exerted by the abductor pollicus longus.

**Diagnosis of digital fractures**

The focus of assessment depends on the stage of healing. Clinical and radiographic assessment of fracture union should be performed until union is established. Clinical signs of non-union include exquisite local pain at the fracture site and movement of the fractured components. Computed tomography can be a useful adjunct to radiographs as they help to accurately delineate the degree of articular displacement and can identify other associated injuries. Radiographs are routinely used to identify fractures and to determine the degree of displacement; however X-ray cannot be used to rule out a rotational deformity. Patients can be asked to actively flex their digits to determine if there is any scissoring of the digits (i.e. overlap). If pain from the acute injury precludes an active flexion effort, passive wrist flexion and extension will place a flexion moment across the fingers with the tenodesis effect allowing an assessment of rotation to be made. A thorough clinical assessment should determine whether there is any associated soft tissue or neurovascular injury and identify any rotational deformity. Assessment should include evaluation of impairments and disabilities arising from fracture complications or treatment sequelae. A summary of these and potential treatment approaches are described in Table 31.1.

**Prognosis for digital fractures**

Prognosis varies according to the outcome of interest. Successful union of the fracture, restoration of normal anatomy, pre-injury movement/grip strength and function are typical goals and outcomes evaluated. Union is dependent on the person’s individual capacity for bone healing and thus affected by prognostic factors that affect bone healing in a generic sense, including individual physical factors (nutrition, comorbidity, age, bone...
<table>
<thead>
<tr>
<th>Problem</th>
<th>Physiotherapeutic treatment strategies</th>
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<tr>
<td>Fracture protection (Fess et al 2004)</td>
<td>• Custom-made or off-the-shelf orthoses</td>
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<td>Pain</td>
<td>• Frequent, low intensity active exercise of unaffected joints and affected joints when stable</td>
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<td></td>
<td>• Adequate fracture protection and oedema management</td>
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<td></td>
<td>• Desensitization programme</td>
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<td></td>
<td>• Electro-thermal agents</td>
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<td>• Co-ordinate pharmacological management and therapy</td>
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<td>Nerve irritation/ neuroma</td>
<td>• Desensitization programme (Robinson &amp; McPhee 1986, Waylett-Rendall 1988)</td>
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<td></td>
<td>• Mirror box therapy (Altschuler &amp; Hu 2008, Ezendam et al 2009) – limited evidence</td>
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<td></td>
<td>• Visualization exercises – limited evidence</td>
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<td></td>
<td>• Nerve gliding/neurodynamic techniques focused on at-risk or symptomatic nerve bias</td>
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<td>Oedema</td>
<td>• Exercise in elevation</td>
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<td></td>
<td>• Compression (compressive gloves, retrograde massage, Coban wrap, string wrapping (Flowers 1988) (especially for digits)</td>
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<td></td>
<td>• Thermal agents (cold in acute stages for those who can tolerate; heat should be used only in elevation with monitoring of volume)</td>
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<td>• Physical agents (high voltage stimulation) (Stralka et al 1998)</td>
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<td>Loss of joint motion (Michlovitz et al 2004)</td>
<td>• Active exercise of affected joints (stable fixation or healed)</td>
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<td>• Physiological and accessory joint mobilization</td>
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<td></td>
<td>• Static progressive splinting</td>
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<td></td>
<td>• Dynamic splinting</td>
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<td></td>
<td>• Continuous passive motion (Soffer &amp; Yahiro 1990) (low evidence in other upper extremity joints)</td>
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<tr>
<td></td>
<td>• Constrained movement therapy (blocking or casting of adjacent mobile digits to enforce movement of stiff joints)</td>
</tr>
<tr>
<td>Loss of power</td>
<td>• Progressive resisted exercise (Hostler et al 2001, Bautmans et al 2009)</td>
</tr>
<tr>
<td>Loss of endurance</td>
<td>• Progressive resisted exercise</td>
</tr>
<tr>
<td></td>
<td>• Progressive functional activity</td>
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<tr>
<td>Scissoring</td>
<td>• Buddy tape to adjacent digit</td>
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<td></td>
<td>• May require osteotomy</td>
</tr>
<tr>
<td>Joint Instability</td>
<td>• Buddy taping, taping, custom or premade orthoses</td>
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<tr>
<td></td>
<td>• Activity modification to avoid lateral stress</td>
</tr>
<tr>
<td>Non-union</td>
<td>• Low dose ultrasound (Busse et al 2002, Griffin et al 2008)</td>
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<tr>
<td>Abnormal sensorimotor integration or motor control</td>
<td>• Sensorimotor retraining (focused, progressive retraining of normal sensory responses)</td>
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<td>• Motor control exercises</td>
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<td></td>
<td>• Dexterity training/functional activity</td>
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<tr>
<td>Prevention of future fractures</td>
<td>• Assess risk for future fracture (based on age mechanism of injury and comorbid status)</td>
</tr>
<tr>
<td></td>
<td>• Manage modifiable risk factors (safety training, activity modification, protective devices, fall prevention, balance training as needed)</td>
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quality), the bone affected (composition, blood supply, biomechanics), behavioural (compliance with fixation, immobilization, rehabilitation; activity levels), injury (type of fracture, size of defect, soft tissue components, associated injuries) and complications (nerve compression, infection, loss of reduction).

Optimal anatomic outcomes and functional outcomes are moderately related, in that malunion can lead to decreased pain, grip strength, scissoring, or loss of joint motion (Synn et al 2009). However, poor functional outcomes can occur in the presence of good anatomic restoration, particularly where pronounced joint stiffness, chronic pain, or chronic regional pain syndrome exist (Field et al 1992, Field & Atkins 1997). Conversely, adequate functional outcomes are attained in older sedentary individuals despite lack of restoration of normal anatomy (Grewal & MacDermid 2007). When fracture malunion results in scissoring, a corrective rotational osteotomy may be required.

Table 31.1  Summary of treatment problems and associated treatment techniques for hand fractures*—cont’d

<table>
<thead>
<tr>
<th>Problem</th>
<th>Physiotherapeutic treatment strategies</th>
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<tr>
<td>General</td>
<td>• In simple, closed metacarpal fractures, early motion has the potential to result in earlier recovery of mobility and strength, facilitate an earlier return to work, and not affect fracture alignment (Feehan &amp; Bassett 2004)</td>
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</tbody>
</table>
| Dorsal skin scar contracture    | • Silicone gel/topical agents to superficial scars  
• Scar massage/mobilization for adherence  
• Simultaneous heat, stretch and tendon gliding exercises (Wehbe 1987)  
• Scar mobilization with hand-held suction device  
• Ultrasound  
• Laser |
| MP joint contracted an extension| • Early positioning MP joint at 70°  
• Later dynamic or static progressive splinting of MPs |
| Intrinsic muscle contracture    | • Early active intrinsic minus exercises; blocking exercise  
• Later – dynamic splinting; muscle stimulation |
| Absence of MP head              | • Educate patient about shortening of metacarpal; assess whether any functional implications (may not affect functional outcome)  
• Assess functionality of extensors; if redundancy is apparent splinting extension at night and strengthen intrinsic  
• Assess alignment – volar prominence = volar angulation and may require adaptive padding/gloves/positioning or osteotomy  
• Communicate with health care team |
| Loss of IP extension            | • Blocking exercises  
• MP block extension splint during the day  
• PIP extension splint thing at night  
• Neuromuscular stimulation to EDC and interrosei  
• Joint mobilizations |
| Loss of IP flexion              | • FDP/FDS tendon glide exercises  
• Daytime MP flexion blocks blunting  
• Dynamic or static progressive night’s splinting  
• Heat and composite stretching  
• Joint mobilizations  
• Stretch of oblique retinacular ligament |
| Boutonniere deformity           | • Early DIP active flexion to maintain length of lateral bands  
• Later splinting |
| Swan neck deformity             | • Orthotic to hold MP joint in flexion |

Evidence on prognosis and fractures is generally sparse and poor quality (level IV studies). Functional (DASH), aesthetic and fracture union outcomes in metacarpal shaft and neck fractures were not affected by palmar angular deformity, but functional and aesthetic outcomes were better in non-operatively managed patients (Westbrook et al 2008). Spiral/long oblique fractures of the shaft of the metacarpal are at risk of shortening and resultant extension lag and reduced grip strength. However, there may be progressive recovery of the extension lag by 1 year and a mean of 94% of the contralateral hand motion by 1 year after injury (Al-Qattan 2008). In 51 unstable metaphyseal MP and PP fractures where fixation was maintained with miniature titanium plates union, the final range of total active motion (% TAM) was excellent (> 85%) for 26, good (70–84%) for 17, fair (50–69%) for 5, and poor (< 49%) for 3 (Omokawa et al 2008). Postoperative complications included loss of reduction (2 cases), condylar head collapses (2 cases), and one superficial infection. Plates were removed in 30 cases, and additional surgery was required in 20 cases. Postoperative grip strength averaged 87% of the contralateral side. Older age, intra-articular fracture, phalangeal bone involvement, and soft tissue injury were associated with poorer range of finger motion following fracture (Omokawa et al 2008). A level IIb study of 120 MC and PP emergency room fractures indicated that infection, increased bony defect and associated soft tissue injury increased the risk of nonunion (Ali et al 2007). In another study, 36% of MC or PP fractures showed different complications, PP and open fractures were at higher risk for stiffness, non-union, plate prominence, infection, and tendon rupture (Page & Stern 1998).

### Conservative treatment of digital fractures

The general principles of fracture management is to reduce the fracture (open or closed) in a manner that will restore normal anatomy and maintain the reduced position through an immobilization/fixation technique that is sufficient to withstand the potential for loss of reduction through deforming or external forces. Since immobilization leads to comorbid stiffness/weakness, early mobilization is preferable where it does not compromise reduction. In keeping with these goals (Fig 31.1), the general principles of rehabilitation of fractures are divided into two stages (MacDermid 2004):

- **Stage 1 – Early rehabilitation**, which includes protect the healing fracture, minimize pain and oedema, restore normal motion and tissue extensibility, monitor patients for associated injuries or complications, prevent therapy-induced complications, to assist patients in dealing with their injury using appropriate coping mechanisms and avoidance of patterns that increase the risk of developing chronic pain/disability syndromes and to help patients to understand their injury, the role of healthcare providers, and how to take an active role in their rehabilitation.

- **Stage 2 – Later rehabilitation**, which includes amelioration of joint contracture, restoration of hand and arm strength, adaptation to residual physical impairments, transitioning into normal work or activity and to teach the prevention strategies to reduce risk of a second fracture.

There is a lack of clinical trials comparing different treatment approaches for digital fractures. A single small low-quality trial suggested the use of a compression glove avoided the loss of function imposed by splintage and was associated with a greater range of movement during the second and third weeks following a metacarpal fracture (McMahon et al 1994). Management is based on the stage of bone healing and presenting fracture sequelae (see treatments based on presenting problems in Table 31.1). Poor quality studies support the use of metacarpal bracing for early mobilization.

### Ulnar Collateral Ligament (UCL) Injury of the Thumb

#### Epidemiology

UCL injuries can be acute or chronic. Acute injuries are much more common and are the result of an acute valgus stress rupturing the ligament. Chronic injuries are referred to as gamekeeper’s thumb. This is also an injury of the UCL; however, it is the result of attenuation of the ligament due to a chronic, repetitive radially directed force on the ulnar side of the thumb. This was traditionally noticed in Scottish gamekeepers who fractured the necks of the rabbits between their thumbs and index fingers.

#### Anatomy

The thumb MP joint has both static and dynamic stabilizers. The static restraints include the volar plate, proper and accessory collateral ligaments. The proper collateral ligament acts as the primary stabilizer of the MP joint in flexion, and in extension, the accessory collateral ligament and the volar plate are the primary joint stabilizers (Minami et al 1984, Heyman et al 1993). The dynamic stabilizers include both the thumb extrinsic (EPL, EPB and FPL) and intrinsic (APB, FPB, and adductor pollicis muscles) structures. The adductor pollicis is the most important dynamic stabilizer of the thumb MP joint. It inserts into the extensor hood (through its aponeurosis) and lies superficial to the joint and the UCL.
Pathology

When a valgus stress is applied to the thumb (i.e. a fall onto the abducted thumb) the dynamic and static stabilizers fail sequentially depending on the magnitude of the force. When the injury is limited to the dynamic stabilizers, the thumb will be stable on valgus stress testing. When the proper collateral ligament ruptures valgus instability will be present in MP flexion. When the accessory collateral is also torn, there will be valgus instability in both flexion and extension, indicating a complete tear (Heyman et al 1993). At times, the ruptured distal end of the ligament can become displaced such that it lies superficial and proximal to the adductor aponeurosis. This entity was first described by Stener in 1962 and the lesion bears his name (Stener 1962). Due to interposition of the adductor aponeurosis this injury will not heal without operative intervention.

Diagnosis

Patients will report a history of a valgus injury and complain of pain and swelling over the ulnar aspect of the MP joint. Pain will be exacerbated by forceful pinch and activities such as unscrewing jar tops and holding large objects because of a lack of power from the thumb’s inability to generate counter-pressure on the object. Occasionally a Stener lesion may be evident as a palpable mass on the ulnar aspect of the joint; however, lack of such a mass does not rule out a Stener lesion. Radiographs should be obtained and viewed prior to stress testing of the ligament to rule out an avulsion fracture thereby avoiding potential displacement of the fracture fragment. Stress testing of the UCL is performed by placing a valgus stress across the MP joint 30° of flexion and then extension. If there is more than 30° of laxity (or 15° more than the contralateral side) in flexion (30° of MP flexion)

Week 1
- Immobilization
- Early (safe) mobilization

Weeks 2–6
- Manage pain and edema
- ROM unaffected joints
- Safe active motion if fracture stable (closed undisplaced or rigid fixation)

Weeks 4–6+ (graduated mobilization – with clinical union)
- Progressive active, gentle passive techniques
- Assess and treat specific emerging impairments within safety margins (table 1)

Weeks 8–12+ (remodeling and functional restoration)
- Passive techniques and joint mobilization
- Progressive strength and function program
- Dynamic or progressive static orthotics
- Manage residual disability and future fracture risk

Fig 31.1 Progression in the rehabilitation process.
rupture of the proper collateral ligament is likely. The valgus stress is then applied in extension. If there is less than 30° of valgus laxity in extension, the accessory collateral is intact, precluding a Stener lesion. If there is greater than 30° of laxity in both flexion and extension, the accessory collateral ligament is also ruptured and the probability of an underlying Stener lesion is approximately 80% (Stener 1962). Radiographs demonstrate radial deviation at the MP joint and possible volar subluxation.

**Prognosis**

There are no specific prognostic studies on this topic. Inadequate mobilization or failure to detect a Stener lesion can lead to chronic instability and pain.

**Conservative treatment of UCL injury**

Management consists primarily of immobilization sufficient to permit ligament reattachment/healing. Although biomechanical evidence suggests early control of mobilization might be feasible (Harley et al 2004), it has not been tested in clinical trials. Casting or customized splinting can be used for mobilization but removable splints are best reserved for compliant patients. A Stener lesion or failures to achieve a stable thumb with minimal pain during pinch are indications for surgery (Dinowitz et al 1997): early repair or late ligament reconstruction. Progressive strengthening and protection from lateral stress (functional splinting/taping) will allow remodeling of collagen fibres to ligament orientations that provide tensile strength. Stretching the UCL prematurely can lead to chronic instability.

**OTHER DIGITAL TENDON INJURIES**

Other tendon injuries that affect the digits can occur through lacerations, avulsion injuries (e.g. mallet/jersey finger), acute boutonniere, pulley ruptures. Lacerations of the flexor tendons that rupture in zones one or two require surgical repair and specific tendon rehabilitation protocols (Groth 2005, Newport & Tucker 2005, Libberecht et al 2006, Koul et al 2008, Soni et al 2009). These may involve active (protected) early mobilization in specially selected cases where repair strength is sufficient. Early passive mobilization protocols remain more common. Consultation with the referring surgeon and awareness of hand therapy rehabilitation protocols are required (Klein 2003, Chai & Wong 2005, Sueoka & Las- tayo 2008, Yen et al 2008). Extensor tendon rupture or lacerations in the digits require extension splinting (4–6 weeks), and in some cases surgical repair. Gradually progressed protected active range of motion protocols instituted within the safety margins allowable by the specific repair are required to ensure tendons glide is restored without compromising repair (tendon rupture or gapping). Active motion with differential gliding is emphasized during rehabilitation. When tendons scarred limits differential gliding, tenolysis may be required.

**OSTEOARTHRITIS OF THE DIGITS**

**Epidemiology**

Digital osteoarthritis (OA) is the most prevalent form of degenerative arthritis, although functional consequences vary (Doherty et al 2000, Hunter et al 2004). The DIP is the most affected, although functional consequences tend to be more severe in the carpometacarpal (CMC) joint of the thumb, which affects 1 in 4 women and 1 in 12 men. In patients older than 75 the prevalence of radiographic CMC degeneration increases to 40% in women and 25% in men (Armstrong et al 1994, Doherty et al 2000, Caspi et al 2001).

**Anatomy**

The CMC joint acts as a universal joint, allowing motion in extension, flexion, adduction and abduction. Together, these movements allow the complex movements of the thumb such as opposition, retro-pulsion, palmar and radial abduction, and adduction. The CMC joint has little intrinsic stability and relies on static ligamentous restraints to limit translation of the metacarpal base during these movements. There are three ligaments that help to stabilize this joint. The primary stabilizer of the CMC joint is the anterior oblique ligament, or volar beak ligament. It is an intra-capsular structure which originates from the palmar tubercle of the trapezium and inserts on the ulnar side of the metacarpal base, along the articular margin. It resists abduction, extension and pronation forces. The secondary stabilizers include the dorso-radial and inter-metacarpal ligaments. The dorso-radial ligament resists dorsal and radial translation of the CMC joint and is the most robust of the CMC joint ligaments. The inter-metacarpal ligament lies between the base of the first and second metacarpals and prevents radial translation of the base of the first metacarpal (Bettinger et al 1999). The thenar muscles also play a role as dynamic stabilizers of the CMC joint. These muscles work in concert, stabilizing the thumb in position to allow activities such as pinching.

**Pathology**

OA is a degenerative condition characterized by pain, intermittent inflammation and cartilage degeneration. The pathological processes that underlie this degeneration are multifactorial and not fully defined but include
part morning pain, CMC joint. is when the first CMC joint is involved in the scaphotrapezium joint combination with OA at other sites. Thumb base OA is ankylosis. Generalized OA is when hand arthritis exists subsequently reparative change and may include bony erosion, cortical destruction and the absence of nodes. Erosive OA is defined radiographically. Non-nodal OA is defined by IP joint OA in the absence of nodes, plus the thumb metacarpal while distally the adductor pollicis pulls the thumb into an adducted position (Blank & Feldon 1997). This adducted posturing of the thumb leads to difficulty spreading the hand around objects for grasping and leads to compensatory, progressive hyperextension of the MP joint. The aetiology of CMC joint laxity has been attributed to hormonal influences (i.e. prolactin, relaxin and oestrogen), thus potentially explaining the increased incidence of CMC OA seen in women.

Diagnosis

Hand OA is diagnosed using clinical features with radiographic substantiation (Zhang et al 2009). Heberden and Bouchard nodes are clinically defined postero-lateral firm/hard swellings of the IP in PIP joints respectively. Nodal OA exists in the presence of these nodes plus underlying IP joint arthritis defined clinically and/or radiologically. Non-nodal OA is defined by IP joint OA in the absence of nodes. Erosive OA is defined radiographically by sub-cortical erosion, cortical destruction and subsequent reparative change and may include bony ankylosis. Generalized OA is when hand arthritis exists in combination with OA at other sites. Thumb base OA is when the first CMC joint is involved in the scaphotrapezial joint.

Typical hand OA symptoms are pain on usage, mild morning pain, inactivity stiffness particularly when affecting only single or a few consistent joints. Lateral deviation of IPs, subluxation or adduction of the thumb base are the common deformities.

The diagnosis of CMC OA is based on history and clinical exam. The typical presentation is a woman in her 50s to 70s with radial sided hand or thumb pain. Clinical examination will reveal tenderness localized to the CMC joint, with a positive grind test (axial compression of the thumb) reproducing pain and crepitus. Radiographs are used to confirm the diagnosis. Various stages of joint involvement can be seen, ranging from a widened joint space (joint effusion or synovitis) to joint space narrowing, subluxation, sclerosis and osteophyte formation. Differential diagnosis includes psoriatic arthritis, rheumatoid arthritis, gout and haemochromatosis, each tends to have different target sites of involvement that can be used to assist with differential (Zhang et al 2009).

Prognosis

Genetic factors, female sex, age over 40, menopausal status, obesity, higher bone density, greater for muscle strength, joint laxity, prior hand injury, higher occupational recreational use are all associated with increased risk of hand OA and its severity and progression (Zhang et al 2009).

Conservative treatment of digital arthritis

Hand OA is a multi-joint problem and treatment approach. EULAR evidence-based recommendations for management suggest a combination of pharmacological and non-pharmacological treatment be individualized to the patient (Klein 2003, Chai & Wong 2005, Sueoka & LaStayo 2008, Yen et al 2008). Education about joint protection and exercise are recommended for all patients. Local application of heat, especially prior to exercise, splints for thumb OA and orthotics to prevent or correct lateral angulation flexion deformities are recommended. Local treatments are preferred over systemic for mild to moderate pain and when only a few joints are affected. Topical NSAIDs and capsaicin are effective and safe treatments. Pharmacological and surgical interventions should be considered in patients with marked pain or disability or when conservative treatments have failed. There is insufficient evidence to choose between different orthotics options (off-the-shelf/custom fit, long/short opponens, dorsal/volar, thermoplastic/neoprene/other materials). Orthotics should be customized according to the joint deformity/damage, functional requirements and patient preferences. It is common for patients with hand arthritis to have multiple orthoses that suit different activities or levels of disease activity. Exercise and education have been shown to be more efficacious than OA information alone (Moe et al 2009).

RHEUMATOID ARTHRITIS AFFECTING THE DIGITS

Rheumatoid arthritis is an inflammatory arthritis that has diffuse digital and other involvement. In the past severe hand deformities were common, but are now uncommon because of pharmacological advances in management of the disease. Older patients may continue to present with severe deformity and for surgical reconstruction.
Rheumatoid arthritis hand deformity can include boutonniere, swan neck, ulnar drift, caput ulna, tendon rupture and sagittal band/tendon subluxation.

**CONCLUSION**

Injuries to the joints, tendons, ligaments and nerves in the digits are common and require attention to detail during rehabilitation to restore fine precision movement is necessary that essential that function. Principles suggest that protected motion during healing/joint irritability, progressive active movement and strengthening that incorporates functional activities and selected use of joint mobilization techniques to enhance joint kinematics is required. Oedema management and integration of sensory and motor assessment/retraining are particularly important. Reliance on principles is essential given the dearth of physical therapy evidence for digital disorders and the specific lack of attention to this area within manual therapy literature.

**REFERENCES**


