IFSSH Scientific Committee on Sports Injuries in the Hand

Chair: **Loris Pegoli (Italy)**

Committee: **Alejandro Badia (USA)**

Gregory Bain (Australia)

Moroe Beppu (Japan)

Riccardo Luchetti (Italy)

Report submitted December 2012

The sports injuries committee is a new committee with a focus on sports related injuries, etiology, prevention and treatment. This report will cover

A A literature review of publications in the literature

B Review of principles of injuries of the PIP joint.

SPORT RELATED INJURIES TO THE WRIST AND HAND

Sport related injuries to the wrist and hand are often discussed, but from the scientific point of view what it is really known about this subject, and what has been published?

This was the question from which the sport Committee commenced its work. Before starting to describe various conditions, we wanted to provide a review of the literature to see what was published. This helps to identify the sports and their injuries about which more is written and those are not.

The following were the criteria used:

Search engine: Pubmed, Ovid

Key words: Sport trauma, hand trauma, wrist trauma, sport

The keywords were restricted so that the papers identified were specifically localized to "sport" related injuries of the hand From our search we identified 116 papers in 63 journals, describing 46 different sports extending from 1979 till 2012. Figure 1 demonstrates the distribution of papers over this period of time.

The anatomical region described were as shown in table 1, the involved structures as shown in table 2 and the sports as shown in table 3

Table 1:

ANATOMICAL REGION	N. PAPERS
WRIST	80
CARPUS	79

PHALANX	78
METACARPAL	73
ELBOW	37

Table 2:

INVOLVED STRUCTURES	N. PAPERS
BONES	80
TENDONS	76
LIGAMENTS	69
SOFT TISSUES	47
NERVES	39
VESSELS	33

Table 3:

INVOLVED SPORT					
GENERIC	*27*	*RODEO*	*2*	*HORSERIDING*	*1*
SOCCER	*11*	*SWIMMING*	*2*	*KENDO*	*1*
FOOTBALL	*7*	*CHEERLEADING*	*2*	*KICKBOARD*	*1*
GYMNASTIC	*7*	*CYCLING*	*2*	*MARTIAL ARTS*	*1*
ROCK CLIMBING	*7*	*HURLING*	*2*	*RALLY DRIVERS*	*1*
TENNIS	*7*	*HOCKEY*	*2*	*ROWING*	*1*
BOX	*6*	*ALPINE SKATING*	*1*	*RUGBY*	*1*
SOFTBALL	*4*	*ARCHERY*	*1*	*SHOOTING*	*1*
MOTOCROSS	*3*	*BADMINTON*	*1*	*SPORT FISHING*	*1*
GOLF	*3*	*BASEBALL*	*1*	*SQUASH*	*1*
PADDLE SPORTS	*3*	*BASKETBALL*	*1*	*SURF*	*1*

RACQUET SPORTS	*3*	*CRICKET*	*1*	*ORIENTERING*	*1*
WEIGHTLIFTING	*3*	*CROQUET*	*1*	*VOLLEYBALL*	*1*
THROWING SPORTS	*3*	*DANCING*	*1*	*WRESTLING*	*1*
SNOWBOARD	*3*	*ENDURO*	*1*		
SKATING	*2*	*GUNSHOT*	*1*		

As can be seen, there are many papers published on sports injuries of the hand and wrist. They cover many different sports, and many types of injuries of the various anatomic components of the hand and wrist.

Publications were common for the wrist, carpus, phalanges, and metacarpals. Publications of injuries to the bones, tendons and ligaments where all common,

Although the publications where were quite wide and varied, it is unlikely that this represents an indication of the

- The sports with a higher incidence of injuries
- The severity of the injuries in any given sport.
- The distribution of injuries with any given sport.

Many of the papers highlight specific conditions that can occur in various sports (eg ulnar nerve palsy in the hand in cycling; chronic exerional compartment syndrome of the forearm in motorcyclists)

From this review it came out as the digits ligaments lesions are among the ones with a higher incidence. This is the reason why we wanted to start describing in this first report the sport conditions related to the proximal interphalangeal joint.

ATHLETIC INJURIES OF THE

PROXIMAL INTERPHALANGEAL JOINT

Proximal interphalangeal joint (PIP) injuries are common in athletes, frequently overlooked and can greatly impair athletic performance in many disciplines. The clinical and radiological assessment of these injuries will be presented. The principles and options of treatment are outlined. The complications and their possible prevention are discussed.

The PIP joint is the most important joint in the hand because of its ideal location and range of motion. For this exact reason, even mild injuries can greatly impair athletic activity. Injuries to this joint will produce stiffness, pain and occasional instability. Many of these injuries commonly occur in athletes and are initially thought to be trivial and managed by a coach or trainer. The colloquial term "jammed finger" is often heard in playgrounds and the athletic field, unfortunately then similarly used to describe the injury in the emergency room setting. Others may used the term "stoved finger".

The conforming shape of the PIP joint provides stability, which prevents translation and rotation while allowing a generous arc of motion. The stability of the PIP joint is greatly enhanced by the ligamentous support which surrounds the joint. The collateral and accessory collateral ligaments are densely adherent to the lateral margins of the volar plate to produce a three-dimensional ligament-box complex. It is felt that the PIP joint is predisposed to injury because the middle phalanx is an intercalated segment within the finger. When a force is applied to the finger, the distal and middle phalanges act as a lever arm on the PIPJ. Any axial compression or lateral deviation force applied to the finger is likely to produce a PIP joint injury.

The PIP joint is a hinge joint with a range of motion of approximately 110º. The average functional range of motion is 19-71 degrees, 23- 87 and 10-64 for the MCP, PIP and DIP joints. The average functional arc of motion 48%, 59% and 60% of active range of motion for the three joints. Any patient with a PIP joint injury which encroaches on the functional range of motion (23-87 degrees) will have a potential disability (Bain et al 1997,1999). This fact has more obvious bearing on athletes requiring manual dexterity and/or strength, as well as manual occupations. Furthermore, a severely impaired single PIP joint injury can then impair overall hand function compromising the athlete, particularly in sports requiring grip of a small diameter object such as a tennis racquet, cricket paddle or golf club. The implication is even more obvious in athletes who must make a tight fist, such as boxing or sailing.

ASSESSMENT OF THE PATIENT WITH A PIP JOINT INJURY

A thorough history, including an understanding of the requirements of the PIP joint should be obtained, (e.g sport, employment and hand dominance). The mechanism of injury, initial treatment and the delay to presentation should be elicited. Most PIP joint injuries are caused by hyperextension and axial loading resulting in impaction of the volar articular surface of the middle phalanx against the condyles of the proxymal phalanx (Eaton & Malerich 1980). The athlete should also be questioned whether pulling on the digit was performed by teammate or trainer, or an actual reduction was attempted/performed on site. This can provide evidence that even further trauma may have been induced.

On examination the posture and swelling of the finger should be noted and any deformity, including malrotation, noted. The PIP joint can be thought of as having four quadrants: volar, dorsal, radial and ulnar. The exact site of swelling and tenderness should be determined. Swelling and tenderness volarly would indicate a volar plate injury, dorsally a central slip injury, and laterally a collateral ligament injury. Gross appearance will reveal if there is any angulation or joint subluxation/dislocation, whether dorsal or rarely, volar.

Stability of the PIP joint should be assessed. A metacarpal local anaesthetic block will aid in assessment by providing comfort for the patient and preventing flexor spasm which may mask joint instability (Eaton 1971). Stability of the joint is first assessed by having the patient actively flex and extend the finger. If the patient can complete a full range of motion without subluxation or dislocation, it implies that the joint is functionally stable. The assessment of the last 20º of extension is the most critical, because in this portion the joint is most likely to be unstable (Eaton 1971). Passive stability is assessed by applying stress to each collateral ligament in both extension and 30º of flexion (Minamikawa et al 1993). The volar plate is tested by passively hyperextending the PIP joint. The stability is compared to adjacent and contralateral fingers. This portion of the examination is particularly helpful if performed under fluoroscopic control, usually after plain radiographs.

Radiographs of the finger should always be performed in the assessment of PIP joint injuries. It is important that the radiographs be taken of the finger and not just the hand, so that subtle abnormalities can be identified. A true lateral radiograph of the finger is mandatory as it enables assessment of subluxation and the common volar lip fracture (Fig 1). As mentioned, in complicated cases, fluoroscopy to dynamically assess the stability of the joint and can give much better assessment of articular fractures. This exam usually precludes the need for CT evaluation and helps understand the “personality” of the fracture.

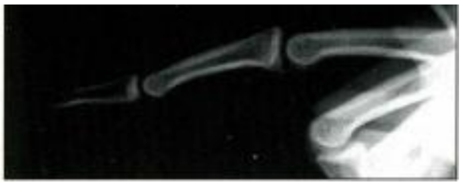

Fig 1. Dorsal PIP joint fracture-subluxation.

VOLAR PLATE INJURIES

The thick, strong fibrocartilaginous volar plate forms the floor of the PIP joint. With the accessory collateral ligaments it provides stability from 15^{o} of flexion to full extension, even if the collateral ligaments have been excised (Bowers 1987). The volar plate becomes tight in extension and prevents hyperextension. Injuries to the volar plate occur following forced hyperextension (e.g. ball sports) in which it is avulsed from the base of the middle phalanx (Eaton 1971; McElfresh et al 1972). With greater hyperextension a split develops between the collateral and accessory collateral ligaments, and the finger will posture in marked hyperextension (Dray & Eaton 1993). With further hyperextension the PIP joint will dislocate, with the middle phalanx dorsal to the proximal phalanx in the 'bayonet' position (Fig 2). For dislocation of the proximal phalanx to occur, at least two sides of the ligament-box complex must be disturbed (Eaton 1971).

Fig 2.Radiograph of dorsal PIP joint dislocation.

The finger will be swollen and tender over the volar quadrant of the PIP joint. Following a metacarpal block, the passive range of hyperextension will be more than the adjacent fingers. Radiographs are often normal, except for the soft tissue swelling.

Treatment of dislocations and volar plate injuries (with or without small bony fragments) consists of mobilization while protecting the finger from hyperextension during the healing phase. If the contralateral PIP joint hyperextends more than 10° the patient will usually regain motion quickly, and is therefore provided with an extension block figure splint for two to four weeks to prevent hyperextension and subsequent swan neck deformity (Fig 3). Patients who do not have laxity of the contralateral PIP joints are mobilized with buddy taping as they are more prone to develop stiffness. It is important that the patients be reviewed at one and two weeks with true lateral radiographs to ensure that they are making satisfactory progress.

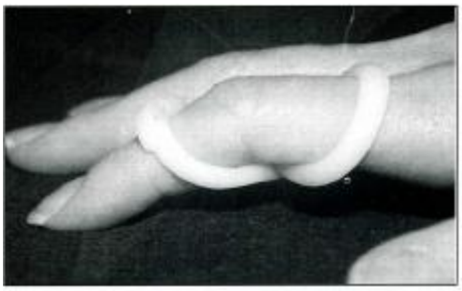

Fig 3. Figure of 8 Extension block sprint

The athlete should not return to ball sports while the finger is still tender. Elite athletes often will return despite the finger remaining swollen and tender. They should wear buddy tape for a further three months, if the finger remains a problem. The patient should be warned that there may be a prolonged recovery and that the finger may be permanently swollen (Fig 4).

Fig. 4. Swollen ring finger PIP joint.

With the addition of an axial load, the volar plate will be avulsed with a fragment of bone, which is often impacted and comminuted (Liss & Green 1992). The stability of the joint following a fracture-dislocation is dependent upon the size of the volar fragment. If the fracture has disrupted greater than 40% of the volar articular surface, the shaft can sublux dorsally because the collateral ligament is attached to only the volar segment (Fig. 5). As these injuries are most stable in flexion, some authors have advocated the use of extension block splints (Dray & Eaton 1993; McElfresh et al 1972). In complicated cases, repair, reconstruction or salvage options will need to be considered.

Fig 5. Dorsal PIP joint fracture-subluxation

Abnormal rotation of the finger indicates a condylar fracture or interposition of soft tissue or bone. The abnormal rotation is best observed clinically (Fig 6) but can be diagnosed with radiographs if a lateral view of the proximal phalanx and an oblique view of the middle phalanx are seen on the same radiograph. The head of the proximal phalanx can button-hole through the rupture in the volar plate and become locked between the two flexor tendons (Bowers 1987). The volar plate, collateral ligament or osteochondral fracture can also block reduction. A widened joint space, seen on the lateral radiograph, may indicate interposition of soft tissue. An open reduction is required if closed reduction is unsuccessful.

Fig 6.Abnormal rotation of finger is best assessed clinically and will often require an open reduction to remove interposed tissue.

Reduction of the dislocated PIP joint is performed with the aid of a metacarpal block. Longitudinal traction is applied to the finger, which is then manipulated. Once the deformity is corrected, the finger is flexed to maintain the reduction. The stability of the joint should be thoroughly assessed as outlined above. Once the dislocation is reduced, the finger should be managed as a volar plate or lip fractures as outlined above. Recurrent and chronic dislocations usually require open treatment.

The therapists have an important part to play in the care of the patient with a PIP joint injury. They conduct and supervise rehabilitation programs to increase the range of motion and strength of the hand. They can provide off-the-shelf or custom-made splints for controlled motion or immobilization of the joint. Edema control with coban wrap and gloves are important and aid in maximizing mobilization. Once functional range of motion is obtained, sports specific rehab is critical to getting the athlete back in the game. They also provide valuable advice, encouragement and reassurance to the athlete.

COLLATERAL LIGAMENT INJURIES

Collateral ligament injuries are produced by a lateral force applied to the finger, with the radial collateral ligament injured six times more often than the ulnar (Eaton 1971). Failure of the collateral ligament almost always occurs at its proximal attachment and is followed by separation from the accessory collateral ligament (Kiefhaber et al 1986). If the lateral force continues, the volar plate will be avulsed from the middle phalanx (Kiefhaber et al 1986). The patient who has had a collateral ligament injury will be tender and swollen over the ligament. The collateral ligaments should be tested in extension and 30^{o} of flexion and compared to adjacent and contralateral fingers (Minamikawa et al 1993). If the extended PIP joint can be deviated more than 20^{o}, the collateral ligament can be assumed to be ruptured (Fig.7 & 8) (Kiefhaber et al 1986).

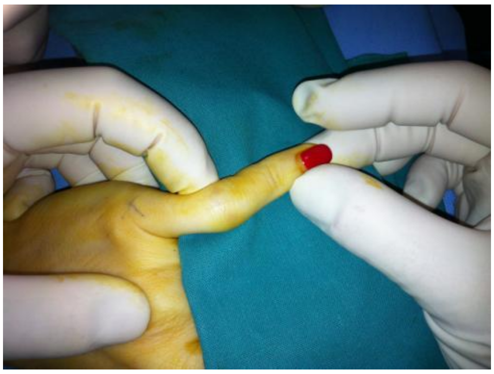

Fig 7. Clinical examination of lateral dislocation

Fig 8. Radiograph of a lateral dislocation.

The majority of these injuries can be managed non-operatively; however, interposition of the collateral ligament may necessitate open reduction. When the finger is reduced the ligaments usually return to their anatomical position, therefore late instability is uncommon. Once reduced, the finger can be mobilized with buddy taping for four to six weeks, with the injured ligament abutting the adjacent normal finger. It is not uncommon for the collateral ligament to avulse a small bone fragment, which does not change the management. Occasionally a large fragment with articular cartilage is avulsed, and requires open reduction to maintain alignment and joint congruity.

CENTRAL SLIP INJURIES

The central slip of the extensor mechanism is the prime extensor and the most important dorsal stabilizer of the joint. The dorsal capsule provides minimal stability because there is no formal capsular structure dorsal to the collateral ligaments (Eaton 1971). Injury to the central slip occurs following hyperflexion, resisted extension or laceration. The central slip should be tested by asking the patient to extend the PIP joint against resistance while the MCP joint is extended. Treatment consists of maintaining PIP joint extension with a splint, finger cast or a transarticular K-wire for six weeks. Fractures with a large fragment may require open reduction. A Capener dynamic extension splint can be worn for an additional four weeks (Fig 9) (Eaton & Malerich 1980).

Fig 9. Capener dynamic extension splint .

Volar dislocations are rare and usually result from a hyperflexion or rotatory force on the finger. The condyles of the proximal phalanx either rupture the central slip or perforate the extensor mechanism between the central slip and the lateral band (Dray & Eaton 1993; Weiss & Hastings 1993). Closed reduction is often unsuccessful. Following open reduction, the extensor mechanism is repaired and the joint immobilized in full extension for six weeks with a splint or transarticular wire (Dray & Eaton 1993).

FRACTURES INVOLVING THE PIP JOINT

The volar lip fracture is the most common fracture that occurs following injuries to the PIP joint (Jupiter & Belsky 1992). Fortunately, while ubiquitous, they require minimal treatment and maintaining mobility is the priority, particularly in the athlete. Therefore, protective buddy splinting in crucial. Fractures which involve dorsal, volar and lateral lips have been discussed previously (Fig 10).

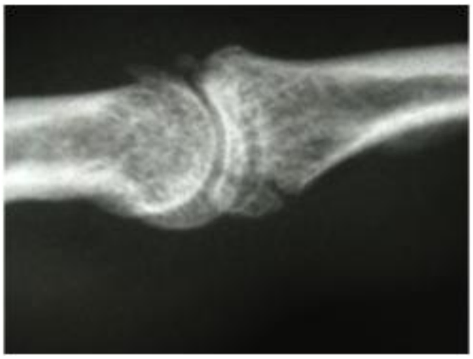

Fig 10. Comminuted fracture of the base of the middle phalanx .

The unicondylar fracture is common in the athlete and results from a shearing force at the PIP joint. Undisplaced unicondylar fractures have a tendency to displace (Weiss & Hastings 1993), so require close, radiological review until fracture union. In the displaced fracture the finger is often deviated, with the collateral ligament acting as a deforming force on the free fragment. An open reduction is often required to obtain an anatomical reduction of these fractures to prevent joint incongruity and deformity of the finger.

Bicondylar fractures result from an axial force applied to the finger. These fractures are often comminuted and difficult to manage. They often require open reduction or dynamic skeletal traction. Fractures of the lateral plateau of the base of the middle phalanx are produced by a lateral compressive force and are similar in mechanism and configuration to the lateral tibial plateau fracture (Hastings St Carroll 1988).

The articular cartilage of the plateau is depressed by the condyle. Oblique radiographs, fluoroscopy or even tomograms may be of value in the assessment of these complex fractures. Open reduction followed by occasional bone grafting may be required if joint congruency is to be achieved (Hastings & Carroll 1988). However the vast majority of articular comminuted fractures require relative anatomic reduction coupled with early motion in order to avoid significant limitations in range of motion compromising athletic function. Therefore, dynamic external fixation is usually the mainstay of treatment.

Distraction is achieved via external fixation and utilises Vidal's principle of ligamentaxis to provide a reduction, and has been reported to provide good results by a number of authors (Schenck 1986; Robertson et al 1946; Stern et al 1991; Gutow & Slade 1997; Morgan et al 1995; Patel & Joshi 1994; Vidal et al 1979; Schenck 1994; Badia 2006). Distraction maintains the length of the capsuloligamentous structures of the joint, which aids in prevention of joint contractures. In addition, distraction unloads the joint to prevent collapse of the fragmented articular surface (Schenck 1994).

Most authors have utilised skeletal traction (Schenck 1986; Morgan et al 1995; Robertson et al 1946) although skin traction has also been proposed (Fig 10) (Hawk 1922). Schenck reported a unidirectional longitudinal skeletal traction attached onto a forearm-based arcuate splint via a rubber band (Schenck 1986; Schenck 1994). Passive mobilisation can be performed by sliding the traction mechanism around the arcuate splint.

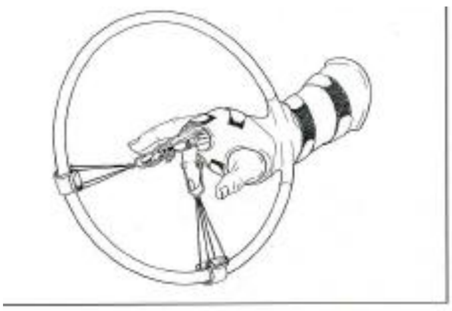

Fig 10. Arcuate splint provides distraction and allows passive mobilisation.) Reproduced with permission from Schenck, R.R. (1994), The dynamic traction method. Hand Clinics 10:187-197.).

However, these forearm-based "Banjo-style" splints are difficult to construct and cumbersome for the patient, especially when dressing and sleeping. A number of low profile distraction techniques have recently been published which avoid many of the compliance problems observed with the forearm-based splints (Gutow & Slade 1997; Dennys et al 1992; Allison 1996; Fahmy 1990). Dennys modified Schenck's arcuate splint to produce a lower profile lateral hinge traction splint (Dennys et al 1992).

Gutow and Slade utilised phalangeal K- wires constructed so that rubber bands provided distraction across the joint (Gutow & Slade 1997). The S-quattro method utilises serpentine springs to provide distraction between phalange K-wires (Fahmy 1990), while Allison's technique utilises stainless steel wire attached to ferrules mounted on phalangeal K-wires (Allison 1996). Patel and Joshi reported on the mini phalangeal distractor which utilises the llizarov principle of gradual fractional distraction for chronic lesions with soft tissue contractures (Patel & Joshi 1994).

Distraction and stabilisation are provided with bidirectional (Morgan et al 1995) and tridirectional (Robertson et al 1946) traction techniques. They have the advantage of providing longitudinal traction and a vector of traction to maintain reduction (Morgan et al 1995; Robertson et al 1946). However, these devices suffer from the same compliance problems as the arcuate splint described above (Schenck 1986; Schenck 1994).

Agee developed the "force couple splint", which utilises phalangeal K-wires to provide a volar reduction force on the base of the middle phalanx (Agee 1987). This technique is clever but does not provide traction, and therefore cannot be used for comminuted fractures with loss of the dorsal buttress.

The rhomboid bilateral spring loaded external fixateur developed by Inanami et al provides distraction and places a volar directed force on the base of the middle phalanx to maintain reduction of the PIPJ (Inanami et al 1993). Transverse K-wires are inserted across the head of the proximal phalanx, base and distal aspects of the middle phalanx and a spring wire rhomboid apparatus is applied to each side of the finger and secured to the K-wires with pulleys (Inanami et al 1993).

Hastings and Carroll reported on a modification of the Kessler lengthening device (Hastings & Carroll 1988; Hastings & Ernst 1993). This is a bilateral fixator that has a pin at the anatomical axis of the proximal phalanx and two pins in the middle phalanx. The proximal component consists of a block with a number of holes to allow dorsal and volar translation to correct the dorsal instability. Distraction is obtained by a threaded pin which connects the proximal and distal components. The joint rotates around the axis pin in the proximal phalanx. Therefore this fixator provides distraction and allows some correction of the instability while allowing isometric mobilisation.

Badia described a simpler dynamic external fixator that did not rely upon rubber bands to obtain traction since these can break, be lost and lose tension via gradual plastic deformation (Badia 2006). The initial pin, placed through the P1 condylar central axis of rotation, is distally bent in order to engage the 2nd pin, placed in the P2 central axis. The tension of distraction can be modified by the degree of bend placed in the first pins distal engaging construct. Dorsal/volar translation can be achieved via transfixing pins placed perpendicular to the phalangeal axis but being careful to not interfere with the extensor tendon mechanism which would work against the desired principle of early active mobilization. (Fig.11)

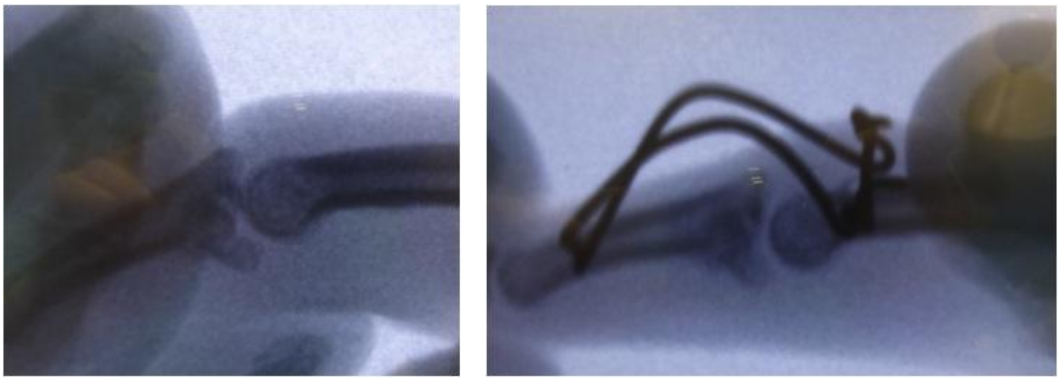

Fig.11 Badia's simple dynamic external fixator provides longitudinal distraction via ligamentataxis achieved using only two simple .045 K-wires, but requiring precise bends in the first, proximal placed pin and allows alteration of this traction via changing the angle of bend.

When desiring more controlled, gradual passive mobilization, with the aid of a worm gear. (Compass Proximal Interphalangeal (PIP) Joint Hinge. Smith & Nephew Richards, Memphis TN USA) is a radiolucent unilateral hinged external fixateur which allows active and/or passive mobilization whilst maintaining joint stability (Hotchkiss 1996; Bain et al 1998). A K-wire is advanced across the anatomical axis of the head of the proximal phalanx and becomes the mechanical axis of the compass hinge. Fluoroscopy is used to confirm the position of the wire. Other devices have provided distraction, stabilization and mobilization but not in a controlled manner (Hastings & Carroll 1988; Hastings & Ernst 1993; Inanami et al 1993). The worm gear is a unique device that, when engaged, allows the finger to be passively mobilized in a controlled fashion but, which can be disengaged to allow active mobilization (Fig 12). The worm gear is patient controlled and mobilizes the joint with a mechanical advantage similar to that obtained with a turnbuckle as used in the elbow. The angular markings on the hinge allows the patients to monitor their recovery and to set goals with the hand therapist. There is the capability to provide distraction across the joint.

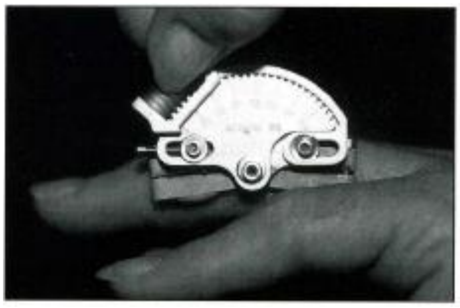

Fig 12. Patient controlled passive mobilisation with the compass dynamic PIPJ hinge fixateur. (Reproduced with permission from Bain, G.I., Mehta, f.A., Heptinstall, R.f. and Bria, M. (1998), Dynamic External Fixation for Injuries of the Proximal Interphalangeal Joint of the Finger. J Bone.Joint.Surg (Br).80-B:1014-9.).

SEQUELAE OF PIP JOINT INJURIES

The common sequelae of injured PIP joints is not instability or redisplacement but persistent restricted range of motion and swelling (Eaton 1971). Factors associated with a poor prognosis include fractures which are intra-articular, comminuted or open. Severe soft tissue injury, especially involving skin loss or flexor tendon injury, predisposes to a poor outcome (Strickland et al 1982). Post-traumatic stiffness can be minimised by early joint motion. Rarely should immobilization be continued for more than three weeks (Bowers 1987). Flexion contractures can be treated initially by dynamic extension splints, resting extension splints and serial casts (Bowers 1987). Resistant cases may require surgical release of the PIP joint.

Post-traumatic swelling is universal following injury to the PIP joint. It is common for this swelling to persist for at least six months. Following a severe injury such as a dislocation, the swelling may be permanent. The use of coban wrap, pressure garments, massage and mobilisation will help to minimise the swelling.

Degenerative arthritis is inevitable if there is joint incongruity or irregularity. Swan-neck deformity (Fig 13) may develop following volar plate injury, and boutonniere deformity following central slip injury. Angular deformities of the finger are usually due to displaced fractures which have not been anatomically reduced. The majority of complications can be prevented by early diagnosis and appropriate treatment.

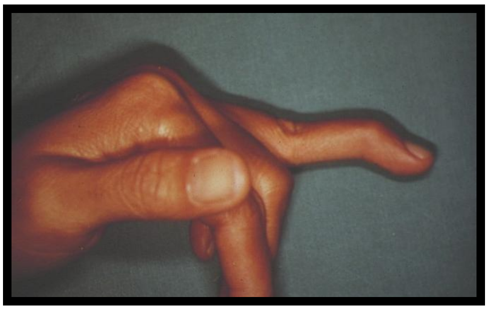

Fig 13. Late swan-neck deformity from untreated PIP joint volar plate injury

CONCLUSION

Athletic injuries to the PIP joint are relatively common yet are often undertreated and can have profound impact on sports performance. An early complete assessment of the finger is an important initial step in the management of PIP joint injuries. Radiographs of the finger are critical to assess fractures and subtle instabilities of the joint. Most patients are managed with bubby taping or extension block splinting while instabilities or marked disruption of the bony or soft tissue anatomy may require surgical intervention. Swelling and stiffness are common complications which can be managed with dedicated hand therapy. A sports specific rehabilitation program will be necessary to allow the athlete to return to premorbid level of play. Therefore, early involvement of the hand specialist is crucial to maximize clinical outcome in managing these daunting injuries in the sportsman.

REFERENCES

Badia A, Riano F, Ravikoff J, Orbay J, Gonzalez E, Khouri R. “Dynamic intra-digital external fixation for proximal interphalangeal joint fracture dislocations". J Hand Surg Am , vol. 30A, no.1 pp.154-160, Jan.05.

Bain GI, Hunt, J and Mehta J A.(1997): Operative fluoroscopy in hand and upper limb surgery: First 100 cases. JHS(B) 22B(5):656-658.

Bain, G.I., Mehta, J.S.: Proximal Interphalangeal Joint: Surgical and Mobilisation Options. British Journal of Hand Therapy. 1999, 3(4): 13-18.

Bain GI, Polites N, Higgs B and Hepinstall R (1999): Functional motion of the joints of the hand. Presented to The American Academy of Orthopaedic Surgeons.

Bain, G.I., Roth, J.H., Mehta, J.S.: Injuries of the Proximal Interphalangeal Joint. British Journal of Hand Therapy. 1999, 3(4): 9-12.

Bowers WH (1987): Anatomy of the interphalangeal joints.In: The interphalangeal joints, edited by Bowers WH.New York: Churchill Livingstone.

Bowers WH (1987): Injuries and complications of injuries to the capsular structures of the interphalangeal joints. In: The interphalangeal joints, Vol 3 No 4 edited by Bowers WH. New York: Churchill Livingstone.

Dray CJ and Eaton RC (1993): Dislocations and ligament injuries in the digits. In: Operative Hand Surgery, edited by Green DP. New York: Churchill Livingstone.

Eaton JW (1971): Joint injuries of the hand, Springfield:Charles C Thomas.

Eaton RC and Malerich MM (1980): Volar plate arthroplasty for the proximal interphalangeal joint ten year review, journal of Hand Surgery 5:260-268.

Hastings H II and Carroll C (1988): Treatment of closed articular fractures of the metacarpophalangeal and proximal interphalangeal joints. Hand Clinics 4(3):503-527.

Jupiter JB and Belsky MD (1992): Fractures and dislocations of the hand. In: Skeletal trauma: Fractures, dislocations and ligamentous injuries, edited by Browner BD, Jupiter JB, Levine AM and Trafton PC Philadelphia: W B Saunders.

Kiefhaber TR, Stern PJ and Crood ES (1986): Lateral stability of the proximal interphalangeal joint. Journal of Hand Surgery 11 A:661 -669.

Leddy JP (1993): Flexor tendon-Acute Injuries. In: Operative Hand Surgery, edited by Green DP.New York: Churchill Livingstone.

Liss FE and Green SM (1992): Capsular injuries of the proximal interphalangeal joint. Hand Clinics Nov; 8(4):75S-768.

McCue FC III, Andrews JR and Cieck JH (1974): The coach's finger. Sports Med 2:270-276.

McElfresh EC, Dobyns JH and O'Brien ET (1972): Management of fracture-dislocation of the proximal interphalangeal joint by extension block splinting, Journal of Bone and joint Surgery American 54A:1 705-1 711.

Minamikawa Y, Horii E, Amadio PC, Cooney WP, Linscheid RL and An KN (1993): Stability and constraint of the proximal interphalangeal joint, Journal of Hand Surgery 18A:198-204.

Strickland JW, Steichen JB and Kleinman WB (1982): Phalangeal fractures, factors influencing digital performance. Orthop Review 11:39-50.

Weiss AC and Hastings C II (1993): Distal unicondylar fractures of the proximal phalanx, journal of Hand Surgery 18A:594-59.