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Multiple Complications from a Finger Fracture in a Basketball Player:
A Case Study with Implications for the Sports Medicine Practitioner

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ABSTRACT: Minor finger and hand problems resulting from NCAA Division-1 Basketball competition are fairly common. True injuries— those requiring removal from participation— are rare, as suggested by injury surveillance and epidemiological data. The objective of this study is to present the case of multiple complications resulting from an original finger dislocation and fracture. Improper fracture healing led to tendon imbalances, causing finger angulation. The extended period of time the finger was deformed further resulted in osteoarthritis (progressive wearing down of the cartilage and bones that comprise a joint). Severe complications stemming from the original injury occur infrequently in the general population and are virtually unheard of in the athletic population. Seemingly routine or inconsequential finger injuries may produce serious, permanent, and uncorrectable damage. Sports medicine practitioners should be familiar with the effects of injury on surrounding small and large tissue structures to provide optimal intervention and patient understanding. This knowledge will increase treatment compliance, preventing severe complications or permanent dysfunction.

INTRODUCTION

Although seemingly insignificant, finger fractures present enormous potential for fine motor dysfunction and chronic problems (Prentice, 2006). Injury may not only limit the function of a finger in sport, especially those requiring tremendous control, but also the finger's usefulness in activities of daily living. Less than optimal intervention, either conservative by means of rest and rehabilitation or more aggressive operative methods, can lead to additional disability and complications, such as malunion, nonunion, and posttraumatic osteoarthritis (Ring, 2005).

A fairly common occurrence in finger fractures is malunion. Malunion fractures are those that heal with a deformity, and are caused by bone regeneration with fragments in an imperfect, or malaligned position (Freeland, 2006; Delforge, 2002). Common causes of malunion are the inability to effect position of fracture reduction and inadequate maintenance of immobilization. Most malunions involve joint surface incongruency, angular deformity, or rotational deformity. Bony union does occur; however, an angular or rotary deformity is the common result (the individual finger appears turned downward in relation to the others or looks crooked/ deviated from the center) (Ring, 2005; Delforge, 2002). These deformities may present individually or all together. Bony shortening is also a possible deformity (Freeland, 2006).

Major complications of malunion finger fractures are the sticking together of flexor or extensor tendons. Malunion increases the likelihood of tendon adhesions, permanent shortening (contracture), and limitation of joint motion (Skinner, 2003). Extensor tendons inserting on the middle bone of the finger transmit extensor forces to the bone, leading to tendon imbalance and permanent bending of the second joint on the finger (Ring, 2005; Skinner, 2003). Flexor tendons inserting on the bottom side cause dorsal angulation, and the segment moves toward the back of the hand if the fracture is closer to the tendon insertion. Fractures farther away from the insertion angulate with the apex toward the palm side of the hand. All finger fractures closer to the hand angulate with the apex facing the hand's palm because of the sideways force from bands passing palmarly toward the axis of the second joint (Skinner, 2003). This angulation is further contributed by the greater distance the extensor tendons have from the axis of rotation of the fracture site compared to that of the flexor tendons (Freeland, 2006). Secondary correction may be required if these tendon forces begin to produce a serious deformity (Skinner, 2003).

Malunion of a finger generates aesthetic and functional problems, such as trouble gripping and picking up due to associated pain or diminished motion. The functional impact depends on the location, type, and severity of the malunion. Time since injury, joint involvement, and joint adhesions also play a role in determining functional impact. Neither chronic finger flexion nor a substantial angular deformity is functional (Ring, 2005; Freeland, 2006).

A less frequent complication of finger fractures is a prolonged amount of healing time. Normal healing time for bones is four to six weeks. Smaller bones may even heal in as little as three weeks. Delayed union occurs after the normal amount of time has passed and the fracture is not a single complete union. If more time passes and still no union exists, the term nonunion is used, and a nonunion fracture has occurred. Delayed healing may or may not lead to nonunion (Scudder, 1915).

Nonunion is not to be confused with no union. Rather than complete separation, nonunion concerns only a particular area that is not fully healed. In many cases, fibrous union is present and the fracture is almost totally healed, except in a certain area. There are localized and general causes of nonunion. Local causes are the impedance or interference of surrounding soft tissue between fracture fragments, such as periosteum strips, fascia, or muscle. Distance between pieces or substandard immobilization also may cause nonunion. General systemic causes can be syphilis, pregnancy, prolonged lactation, and acute febrile diseases (Scudder, 1915).

Although persistent hand pain is multifactorial, nonunion suspicion should increase if a fracture is involved. The majority of nonunions are post-surgical and result from either poor bone fixation or a combination of that and decreased blood supply. An overwhelming number of nonunions in the hand are atrophic, meaning the fractured bone decreases in size and wastes away. Like malunion fractures, nonunions in the hand are also associated with tendon adhesions or contracture, which will require operation (Ring, 2005). Delaying operation can cause degenerative bone and joint disease, such as osteoarthritis. Osteoarthritis is a progressing loss of joint cartilage accompanied by attempted repair and hardening of underlying bone (Buckwalter, 2003). Development of the posttraumatic form secondary to a fracture has several contributing factors. These include involvement of surfaces within the joint, joint incongruency, resulting angular deformity, quantity and quality of nearby blood vessels, and degree of immobilization. Upper extremity joints are less likely to develop arthritis due to their reduced role in load carrying (Maeurer, 2004; Wright, 1990).

The in vivo canine studies by Vener et al. have shown development of posttraumatic (occurring after an injury) osteoarthritis in response to a fracture within the joint. Damage is first seen as cracks in the zone of calcified cartilage and bone beneath the cartilage, which extends to surface cracks on the cartilage. Actual failure of cartilage begins in the zone of calcified cartilage and sub-cartilage bone, spreading deeper to this area and the overlying cartilage. Such damage is expected to respond the same in humans, leading to degeneration of cartilage. Geometry of certain joints may predispose one surface to damage (Vener, 1992).

Similar to canine studies, human research has shown joint cartilage damage associated with fractures inside the joint, as well as abnormal loading (Court-Brown, 2006). As in the canine studies, human research has shown a link between substantial single, repetitive, or torsional loading forces, and damage in the calcified cartilage and bone regions beneath the cartilage without damaging the joint surface or surrounding soft tissue. Progression causes these surface irregularities to become clefts, penetrating the entire cartilage until reaching the bone (Buckwalter, 2003).

Members of the medical community debate the adverse effects of malunion on surrounding joints. Scant evidence suggests that malunion in the upper extremity contributes to posttraumatic osteoarthritis. A number of authors have shown posttraumatic osteoarthritis in the knee from a malunion of the tibia. In theory, these principles could be applied to other joints. Even with this debate put aside, posttraumatic osteoarthritis can be a complication of any fracture (Court-Brown, et al., 2006).

CASE REPORT

This case report was generated following all accepted protocols related to the Health Insurance Portability and Accountability Act (HIPAA), consent, and patient privacy laws. Any specific information related to the patient's identity has been changed to protect his privacy.

This athlete was a 28 year old male and NCAA Division 1 basketball player. The subject stood 6' 11", weighed 225 lbs., was a student and former member of the U.S. Marine Corps. The athlete suffered a fracture to the proximal (closest) bone of his left index finger and a second joint dislocation while playing at a junior college in February 2005. (The second joint is anatomically known as proximal interphalangeal joint [PIP].) The cause of injury was a force applied directly to the tip of the athlete's finger from a basketball. Surgical repair with screws was performed in March 2005. The athlete reported no change in alignment post surgically.

The athlete transferred from his junior college in May 2006, a little more than a year after the initial injury and repair. His finger was noticed at his pre-participation examination. Questioning revealed persistent pain at the left PIP joint of his index finger that increased with activity. Despite stating that the joint remained chronically stiff and had never really improved since surgery, the athlete maintained that he was able to compete effectively. The resting position of the PIP was in 60 degrees of flexion. The finger segment distal (away from) to the injury site had a lateral angular deformity of 30 degrees. Active range of motion (AROM) showed slight second joint extension, but no active or passive flexion. The screw head from the previous surgery was visible under the skin along with breakdown of the tissue at the site. Stability and ROM were unaffected in the other fingers and wrist.

An initial differential diagnosis of a boutonniere deformity or pseudo-boutonniere deformity was ruled out due to the length of time of the injury and angulation of the joint. Referral for diagnostic imaging revealed a single screw across the proximal bone of the left index finger, a marked angular deformity, a hyperextension deformity, and arthritis within the joint (Figure 1). The final diagnosis was a malunion fracture to the PIP joint of the left index finger, post traumatic arthritis, and PIP joint contracture.

Figure 1. X-ray of the affected finger at initial evaluation.

Despite expressing desire for operative correction, the athlete initially chose to attempt to play through the basketball season since he was able to function during the previous one. The athlete later injured the first joint of the finger (anatomically known as the metacarpalphalangeal joint [MCP]) of the same finger and was diagnosed with a radial collateral ligament sprain. Findings were instability, pain with full flexion, and AROM limited to 60 degrees out of a normal range of 90-100 degrees. Conservative care was given. The athlete performed rehabilitation in the athletic training room accompanied by buddy taping—taping two fingers together—until fully healed. Improvements were achieved.

The athlete returned again mid season complaining of a substantial increase in pain and stiffness at both the PIP and MCP joints. The team physician decided to perform a two-stage corrective reconstructive surgery after the season ended. A closing wedge osteotomy and screw removal was performed first to straighten the finger. A piece of bone was cut out on the inner side, and the segment was realigned. Pins were inserted on both sides of the finger to better maintain alignment (Figure 2). Kirshner wires were also used. A splint was applied and instructions were given to wear it at all times. Follow-up x-rays exhibited a still open fragment, but good evidence of a healing callus. Pins were removed and the second stage was planned.

Figure 2. X-ray of the affected finger post closing wedge osteotomy.

A joint contracture release to restore motion was performed ten weeks later on the PIP and MCP joints. The MCP release was uneventful. The PIP release revealed no cartilage whatsoever on either joint side and difficulty finding any joint space. The extensive osteoarthritis completely destroyed the joint. Resulting lack of cartilage required the finger to be fixated with pins and Kirshner wires in MCP and PIP flexion. These procedures were performed to provide a better functional position and less pain. The PIP joint was further pinned in a position to attempt fusion (Figure 3). Protective splinting was applied three weeks post surgery with accompanying pin removal. Aggressive rehabilitation increased MCP flexion to 80 degrees; however, patient noncompliance reversed these effects.

Figure 3. X-ray of the affected finger post MCP and PIP joint contracture release.

Further postoperative evaluation showed no further healing at the osteotomy site. The athlete was diagnosed with a stable nonunion fracture. A crossroads was reached, in which the athlete could have attempted further intervention or leave the finger as it was. Operation was eventually chosen due to the faster return to competition provided. A PIP joint fusion using a bone graft from his wrist was performed. Surgeons would attempt to have the bones join together. Hardware was again inserted to maintain alignment (Figure 4). Follow-up showed progressive signs of healing, but the final outcome is still undetermined. Athlete was allowed to return to competition, as this would not affect healing. He continues reevaluation as scheduled.

Figure 4. X-ray of the affected finger post PIP fusion using a bone graft from the radius

DISCUSSION

In some cases of malunion, the patient may be left with a disability (Delforge, 2002). For these reasons, malunion should be avoided whenever possible and treated so that angular or rotational deformity does not exceed five degrees (Court-Brown, 2006). Prior to transferring from his junior college, the patient did not seek treatment for slight finger malalignment and function. This injury progressed into gross deformity and loss of function. Compliance with rehabilitation and physician visits is unknown, but there is a high likelihood that multiple complications from the patient's initial finger injury would not have occurred if he had been totally compliant.

Surgery is not always necessary; however, it may be proper for a disfigurement, and obligatory when disabling (Binnie, 1913). Although the fingers have an outstanding ability for functional adaptation and tolerance of great deformities from fractures, surgery was still required (Freeland, 2006). This further demonstrates the severity and rarity of this athlete's injury.

Nonunion and malunion surgery in the hand and fingers must be based on a detailed analysis of risks and benefits. The probability of achieving a functional outcome with surgery should be heavily weighed (Ring, 2005). Discretion and full consideration of risks and benefits should be given prior to selection of a corrective procedure. The team physicians weighed the individual patient risks and ultimately chose operation even though possibility of massive improvement was diminished due to the length of time since the initial injury. Nevertheless, any amount of straightening and movement would produce more functionality, and make the finger more aesthetically pleasing.

Malunions requiring operation are infrequent; however, an angulation of 15 degrees inward in the proximal or middle finger should have surgery (Freeland, 2006). This fact is consistent with this case. Even if the fracture heals, it is unlikely the joint will be returned to useful motion, which was one result of this case. Surgeons have debated the site preference for malunion correction, either at the site of injury or a separate site (Ring, 2005). More recent literature states that surgery must be done at the site of the malunion when accompanied by a significant angular deformity or adhesion, which this case involved (Freeland, 2006). A closing wedge osteotomy is easier than an opening osteotomy and avoids the need for a bone graft. Kirschner wire fixation is more easily adjustable than plate fixation (Ring, 2005). A closing wedge osteotomy was used along with the suggested Kirschner wire fixation; however, a bone graft was needed later on. Such bone grafting is extremely rare because it is not mentioned in the literature. While it cannot be assumed that the need for bone grafting is completely unheard of, its infrequency relegates it to an issue of small importance.

Surgery of a malunion fracture should be performed within ten weeks due to the possibility of recreating the original fracture line by mobilizing the callus (Ring, 2005). Early operation may allow removal of an immature callus and thus promote more optimal reduction of the original fracture. Risk of tendon or joint adhesion increases with a longer lasting deformity (Freeland, 2006). If enough malunion is present to cause a functional loss, correction should not be delayed (Ring, 2005). The patient in this case waited more than two years for correction, more than eleven times the recommendation. A delay in healing is also unusual. Buchler et al. (1996) reviewed the results of 59 osteotomies for malunion correction. Union was obtained in 100% of patients, with satisfactory correction in 76%. 89% achieved net gains in motion (Buchler, 1996). This patient did not achieve union or any gain in motion, nor did he achieve successful union. Contrasting research states that corrective osteotomies almost always heal with improved finger motion, but still have remaining stiffness (Freeland, 2006). Looking at either study, this patient's finger did not heal as it should have, and a radial bone graft was ultimately necessary.

While malunion fractures are somewhat common in the phalanges, the need for operative correction is minimal. Tubiana showed that of 10,000 hand injuries, only 30 malunion fractures (.003%) required operative intervention (Tubiana, 1985). It is noteworthy that much of the early research had somewhat small patient populations, which demonstrated a surgeon's unwillingness to operate on a finger malunion. More recent studies are beginning to show a change in treatment, with osteotomies being largely, if not entirely, successful (Freeland, 2006).

It is extremely unusual to achieve nonunion in the metacarpals and phalanges. Occurrence is only present when accompanied by some complex scenario or complication, such as tendon adhesion, contracture, or joint stiffness (Ring, 2005). Such a complication was part of this case. Various studies show between 0-25% of malunion correction surgeries result in nonunion. While rare for malunion correction to result in nonunion healing, the factors of this case actually made it more likely to occur due to the aggravating circumstances.

A detailed radiographic study by Smith and Rider (1935) observed that delays in union occur as long as fourteen months. Evidence of complete healing is usually present around five months. Based on this lengthy healing time, bony union should not be completely suspected until at least one year has passed (Smith, 1935). Surgery is performed when nonunion is present clinically and radiographically (Ring, 2005). Treatment of nonunion fractures requires absolute immobilization (Scudder, 1915). Only a single bone juncture must heal with a closing wedge osteotomy; therefore, a bone graft is usually unnecessary (Freeland, 2006). Outcomes of the case presented here are inconsistent with the above statements.

Elderly people are immediately at risk for posttraumatic osteoarthritis due to the presence of generalized osteoarthritis. Younger individuals are less likely to develop posttraumatic osteoarthritis, the exception being involvement at the end of a bone or residual angular deformity (Wright, 1990). Posttraumatic osteoarthritis progresses over years eventually leaving bone-on-bone touching, causing severe pain, loss of mobility, and deformity (Buckwalter, 2003). Even when degeneration begins immediately after injury, these complications take two to five years in the most severe cases, such as joint line fractures and dislocations. Other cases will take ten years (Wright, 1990). The time of diagnosis for the patient's posttraumatic osteoarthritis was 1.5 years after the original injury, indicating the aggressiveness and severity of the condition.

Accelerated damage can come from partial dislocation of a joint or malalignment by disrupting the normal force distribution of contact stresses within a joint. Peak stresses are increased in some regions, allowing normal physical activities to produce damaging levels of this focal stress. These increased levels of focal stress will lead to cartilage damage and joint degeneration. Sport participation further accelerates these changes. Predisposition is given to those with a previous significant joint injury, abnormal anatomy, or alignment. Disruption of normal joint function from malalignment accelerates degenerative changes with participation sports (Buckwalter, 2003).

CONCLUSION

Nonunion and malunion fractures in the finger are some of the most complex areas to manage. Nonunions and malunions present a different set of challenges from similar injuries at different sites in the body. Poor finger function may compromise overall hand function (Ring, 2005). Even though the complication rates of corrective phalange osteotomies are relatively low, potential hazards of each case must never be discounted (Freeland, 2006). Even with successful union and alignment, the majority of fingers will remain with limited function and mobility. The complexity of hand and finger nonunion is so great that it cannot be expected the part will function well, even if the optimal treatment is provided (Ring, 2005). The most recent NCAA Men's Basketball Epidemiology fails to list finger injuries statistics in practices or games at any divisional level, further suggesting the rarity of serious injury and time loss due to finger trauma (Dick, 2007). Prevention of serious complications is the best treatment for limit time loss.

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