Non-Contact Femoral Fracture in a Collegiate Football Player

Terri-Anne Moore, Michelle Cleary, Thalia Diaz and Israel Mitchell
Florida International University, USA

Abstract: We present a unique athletic injury witnessed by the primary investigator who was compelled to convey the details of the incident to other Certified Athletic Trainers. This case is presented to increase awareness and ensure proper recognition, evaluation, and treatment of this potentially life-threatening injury.

Femoral fractures are usually caused by tremendous forces as a result of direct contact. The femur is one of the largest and most dense bones in the body and requires a great amount of force to overcome the mechanical strength of the bone and cause breakage or fracture. Accidents that may cause a femur fracture usually involve falling from a height, high-speed collisions in sports such as skiing or snowmobiling, or car accidents (DePalma, 1970).

Various types of femur fractures encompass simple, spiral, comminuted, transverse, closed, open, pathological and stress fractures (Shultz, 1972). These fracture types can be further classified into femoral neck, intertrochanteric, subtrochanteric, supracondylar, and femoral shaft fracture categories (Derian, 1970). A review of the current medical literature revealed that the types of femoral pathology observed in sports can range from avulsion fractures involving anterior cruciate ligament injury, femoral neck stress fracture, stress fracture from excessive exercise, and fractures associated with decreased bone density (Clement, Ammann, & Taunton, 2002; Manketelow, Haddad, & Goddard, 2000). Gender specific fractures occurring in athletics include stress fractures in female athletes associated with nutritional factors and epiphyseal fractures typically observed in males ages 12 to 15 (Anderson, Hall, & Martin, 2000). The purpose of this case study is to report an unusual instance of a non-contact displaced transverse mid-shaft femoral fracture witnessed by the primary investigator during a football practice session.

Background and Case Presentation

The athlete (AG, to protect anonymity) was an 18 year-old male American football linebacker (height = 183 cm, weight = 89.4 kg) with no personal or family medical history of cancerous tumors or other bone disorders. The injury was witnessed by the athletic training staff early in the practice season of a new National Collegiate Athletic Association Division IAA football program. During examination, AG reported that after receiving and running the football, his foot established contact with the ground but became trapped under a fallen cornerback. AG attempted to free his foot from under his fallen teammate, and as he twisted his leg, he heard a loud snap. Athletic trainers on the sideline also heard the snap, which resembled a sound of a gunshot or a blown electrical transformer. Minimal contact was involved with this injury, inconsistent with the typical mechanisms of injury (Surgical Notes, 2001)

As the certified athletic trainer and student intern approached the patient on the field, he was lying on his left side. During the initial assessment, obvious visual deformity and swelling were evident at the fracture site. No evidence of discoloration, impaired circulation, or diminished sensation was observed at this time. The displaced bone fragments appeared to protrude posterior-laterally without breaking the skin. AG remained on the field for approximately 15 minutes; during this time he appeared to become calmer and was likely experiencing symptoms of psychogenic shock. The athlete confirmed that he felt tingly in his entire body and was uncertain about the specifics of his injury. Appropriate medical personnel (emergency medical services) were immediately contacted following University protocol. The emergency medical technicians arrived on the scene and re-evaluated the athlete's vital signs. The injury was immobilized using a traction splint and the athlete transported by ambulance to the nearest medical facility (Surgical Notes, 2001)

Two anterior-posterior and lateral views of diagnostic radiographs revealed a displaced transverse fracture through the mid-shaft of the right femur (Figures 1 and 2). Overriding with foreshortening of the femoral length and posterior displacement of the distal femur were disclosed from the radiograph. The pre-operative diagnosis was therefore a transverse displaced femur fracture, right femur. The operating physicians performed the pre-operative evaluations, and all neurovascular examinations were normal. The operation physician discussed the risks and benefits of surgery with AG and his family. Once AG was admitted to the hospital, his leg was placed in traction and appropriate pain medication was administered (Surgical Notes, 2001).

Methods

The participant involved in this case study was a National Collegiate Athletic Association Division IAA student-athlete who was injured while participating in a University sanctioned athletic practice. A signed medical information release and informed consent form was obtained from the participant in accordance with Florida International University Institutional Review Board policies. The participant's medical records were obtained and the information was synthesized and reported. Radiographic, magnetic resonance imaging, and computer aided tomography studies were collected and critically analyzed. Histology and oncology reports were reviewed and surgical notes were examined and summarized. Relevant literature was reviewed and incorporated when appropriate.

Results

Surgical Repair of the Femoral Fracture

Intramedullary nailing of the right femur was performed with a Synthase® 440 x 11 mm nail and static locking screws (Surgical Notes, 2001). General anesthesia was administered and all bony prominences were padded. The right lower extremity was placed in a traction boot and a C-arm fluoroscopy assisted closed reduction was performed using longitudinal traction and adduction. An incision was made from the tip of the greater trochanter extending approximately 6 cm proximally and a dissection was carried deep to the gluteus maximus fascia. The drill site was identified, a guide pin was placed in the fossa, and a guide wire was drilled into the proximal femur using a large 12mm drill bit. With the fracture maintained in position, a guide wire was passed across the fracture site and verified fluoroscopically in the anterior-posterior and lateral planes.

The fracture site was maintained while internal fixation was performed. A 12mm nail was obtained, a guide wire was measured to a 440mm nail, and an exchange tube was placed in the medullary canal. The guide wire was removed and replaced by smooth tip guide wire. Ten cm into the femoral shaft, a Synthase® 440 x 11mm nail was placed over the guide wire in the intramedullary canal and mounted in position extending distal to the fracture site. The nail was inserted without difficulty and was noted to be in excellent position with the fracture in anatomic reduction. A drill was utilized to insert static locking screws at the proximal end of the femur and the nail was impacted to facilitate better stabilization of the treatment site. Distal locking was performed using a free hand technique. This technique is usually completed when locking the two transverse distal holes in the universal tibial and femoral nails (Browner & Edwards, 1987). During intramedullary reaming a tissue specimen from the intramedullary canal was reserved for histological and oncological analysis (Surgical Notes, 2001).

Surgical Risks and Potential Complications

Surgical procedures have an inherent risk primarily associated with the administration of general anesthesia. The extent of this particular injury created a great deal of concern associated with potential complications of the surgical procedure, such as excessive bleeding, infection, hematoma, neurovascular injury, chronic pain, stiffness, loss of range of motion, additional surgery, nonunion, malunion, migration of the pin, improper selection of the pin, and splitting of femur at time of surgery (Browner & Edwards, 1987; Derian, 1970). Fortunately, AG did not encounter any of the above mentioned complications and the surgery was considered a success. The post-operative diagnosis was concluded as a transverse displaced fracture, right femur (Surgical Notes, 2001).

Rehabilitation Program and Return to Play Decision

The primary goals for phase one of a rehabilitation program for a femur fracture are reestablishing pain-free range of motion, reducing or preventing muscle atrophy, regaining joint movement, and decreasing pain. While hospitalized, AG initiated his rehabilitation program on post-operative day 3. Ambulation was facilitated by using a walker and progressing to crutches. Quadriceps muscle group atrophy was reduced by performing isometric quadriceps sets and straight leg raises. During bed rest, continuous passive motion was utilized to maintain and increase range of motion. The athlete was discharged on post-operative day 7 and he continued his rehabilitation program at the university athletic training room (Surgical Notes, 2001).

Rehabilitative activities were continued and the goals of phase two focused on regaining and improving muscular strength and attempting weight bearing. The atrophied quadriceps muscles were re-educated using neuromuscular electrical stimulation modalities. Therapeutic exercises included wall slides, leg lifts in flexion and extension, knee extensions, and active assisted hip abduction. A stationary bike with gradual seat progression was utilized to increase range of motion (Prentice & Voight, 2001).

The goals of phase three were to regain balance and neuromuscular control and to implement functional activities leading to the return athletic activity. To achieve these goals, proprioceptive neuromuscular facilitation (co-contraction) exercises were incorporated into the rehabilitation program. Muscles strengthening continued and progressive weight bearing activities were performed as the athlete completed intervals of walking and then jogging during practice sessions. In the final phase of rehabilitation, sport-specific and functional progressive activities were implemented and AG gradually increased his level of confidence. The athlete successfully completed his rehabilitation program and returned to full athletic activity within 6 months (Dugowson, Drinkwater & Clark, 1991; Prentice & Voight, 2001; Surgical Notes, 2001).

Discussion

Non-contact femoral fractures have been increasingly occurring in athletic populations (Mbubaegbu & Percy, 1994), perhaps due to the increasing numbers of physically active individuals and sport participants. Athletic trainers and other allied health care professionals must understand that femur fractures are significant injuries that are usually the result of tremendous forces that overcome the mechanical strength of bone. Our case of a displaced transverse mid-shaft femur fracture in a collegiate football player is unique in that it deviates from the normal mechanism of injury.

The strength of the femur is determined by the composition of bone tissue. Bone mass is a major determinant of bone strength and bone tissue is composed of a biphasic composite material, mineral as one phase and collagen with ground substance as the other. The combination of these two composite materials makes bone stronger for its weight than either substance by itself, and this feature is what gives bone tissue its density (Wheeless, 1996). In our case, it is difficult to comprehend the relationship between the magnitude of the injury and the biomechanical forces required to overcome the strength of a normal femur.

The etiology of injuries in the femoral shaft fracture category and the transverse fracture type typically involves either direct contact or the presence of torsion, neither of which were present in our case. However, this fracture type is also usually accompanied by shock, pain, and angulation, all of which were present in our case. Blood loss may be up to 3000 cc and anterior-posterior and lateral radiological views are used to confirm the diagnosis (Derian, 1970). Incidence of this type of fracture is reported to be about 40% of all femur fractures (Browner & Edwards, 1987). Transverse fractures are often located in the shaft of the bone and this type of fracture includes short spiral fractures, what is referred to as the reverse fracture in the Evan's classifications, and many pathological fractures. These fractures reveal a varus deformity because of the pull of the iliopsoas muscle still attached to the lesser trochanter, not present in our case (Browner & Edwards, 1987). The prognosis of this injury is to return full activity in 4 to 6 months (Derian, 1970).

Because minimal physical contact was involved in this injury, other biomechanical factors must to be considered for better understanding of the pathomechanics of the injury. Bone loading is the amount and type of force applied to a bone and can be affected by a number of forces that cause breakage or fractures. Tension, compression, torsion, and shear forces are all stresses that act on the three axes of bone. When equal and opposite external distracting loads are placed on a joint, a pull is created and tension forces arise. External crushing loads equally applied on opposite surfaces of a structure produce compression, shortening, and widening on the structure resulting in compressive stress or strain. Torsion occurs when a load is placed on a structure creating twisting about an axis and producing torque forces within the structure. Shear stresses occur when equal but not directly opposite loads are applied to opposing surfaces or structures. Tension force usually produces a transverse fracture, torsion force produces a spiral fracture, and the combination of tension and compression creates bending (Wheeless, 1996).

An analysis of the mechanism of injury makes our case even more peculiar because the athlete's foot was planted as he attempted to free it from the fallen teammate. From this mechanism, one would conclude that a form of torsion (twisting) was placed upon the bone and should have produced a spiral fracture. However, this was not the case. The athlete suffered a transverse fracture which would be consistent with a form of tension that should have caused this injury. In addition, the ground surface used for football practice could have contributed to this injury. The practice field was natural grass and it was unevenly distributed; therefore the athlete's cleats could have become struck in the earth and added to the biomechanical stress placed on the femur.

Further, the distinctive nature of this injury leads us to scrutinize the nutritional status of the athlete. The tissue specimen reserved during surgery was analyzed to rule out possible pathological bone disorders, particularly in the absence of radiographic evidence. All pathological tests were negative (Surgical Notes, 2001). However, the athlete's medical file does not disclose any nutritional assessment or bone density test. AG acknowledged that his eating habits prior to the injury were poor and infrequent and that he was physically unfit. Relationships between nonalcoholic carbonated beverage consumption and bone fractures have been reported in the medical literature (Wyshak et al., 1989). However, AG stated that he has refrained from drinking carbonated beverages since he was in middle school and his normal daily beverage consumption included water, juice, and milk. Therefore, it seems unlikely that nutritional concerns contributed to the injury.

The surgical technique performed, intramedullary nailing, is one of the greatest advances of this century in the treatment of fractures. This technique has been developed over the past 40 years. Prior to the use of metal nails, intramedullary fixation was sporadic. The first instance was reported by the Conquistadores in the 16th century. Kuntscher, a forefather of intramedullary nailing, recognized the great advantages of this method for the repair of femoral fractures. The benefits of intramedullary nailing, particularly by the closed method, are to provide superior bone stability with limited soft tissue exposure and dissection. Soft tissue envelopes around the fracture and the extraosseous blood supply to the bone are preserved. Soft tissue preservation enhances revascularization of the injured bone, promotes periosteal callus formation, and decreases the risk of infection and non-union. Absence of concomitant musculotendinous damage improves the potential for early joint and muscle rehabilitation. Reamed intramedullary nailing is preferred because it provides better stability due to the increased contact between the rod and the medullary canal. Since larger rods are often used, the rods are generally stronger and less likely to fatigue the fracture. Non-reamed nails are usually quicker and simpler to use, but this smaller apparatus provides less fixation. Once stabilized with an intramedullary nail or rod, femoral fractures are more likely to heal completely and rehabilitation is facilitated (Browner & Edwards, 1987).

Conclusions

A femoral fracture is a medical emergency that provides a challenge for allied health care professionals requiring accurate and early recognition and appropriate on-the-field care. Athletic trainers should be aware that an injury of this extent can result from biomechanical factors alone and does not require direct contact or extreme forces. Exercising clinical knowledge and utilizing appropriate skills may reduce the risk of a life threatening situation, especially where the typical mechanism of injury deviates from the norm, as in our case.

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Figure 1. Anterior-Posterior radiograph of right femur mid-shaft fracture.

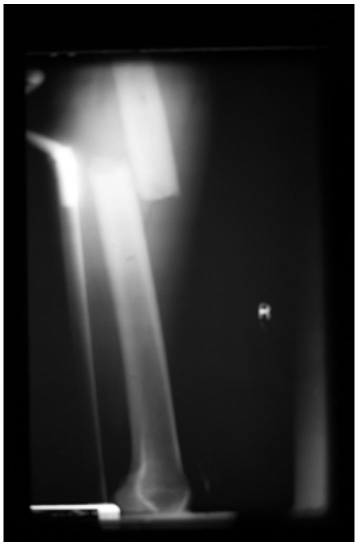

Figure 2. Proximal static locking screws with intramedullary nail.