



Original Contribution

Managing Distal and Humeral Shaft Fractures

Michael Gill, OTC, OT-SC, Charlotte, NC

Fractures of the humerus have increased in frequency because of our aging population and the growth of participation of sports. Other contributing factors include osteoporosis and medical illnesses that affect a patient's risk of falling.

Humeral fractures are among the most common traumatic injuries that a primary clinician will see in the office or emergency department. When treating them, the goal should be to maintain elbow and shoulder function while achieving prompt fracture union.

I will focus on injuries to the shaft and the distal humerus. The discussion begins with a look at functional anatomy and the causes and presentation. Diagnosis, treatment and complications follow.

Humeral Shaft Fractures: Functional Anatomy

Compared with the non-constrained articulation of the glenohumeral joint, the distal humerus, with its articulation to the sigmoid fossa of the proximal olecranon, has a more organized structural relationship. The end of the humerus is covered on its medial side (the trochlea) with articular cartilage in an arc of almost 270 degrees. The trochlea's medial and lateral ridges and the sigmoid notch's semilunar ridge represent a highly developed articulation, which provides 50% of the intrinsic stability of the elbow¹.

On the anterior surface of the lateral side of the distal humerus, there is a zone of articular cartilage known as the capitellum. It provides proximal articulation with the radius and thereby the articulation to the forearm. These articulations are enclosed in a single synovial capsule and are also held in place by lateral and medial collateral ligament complexes. While the proximal glenohumeral joint enjoys a wide range of motion, the distal humeral articulation represents a modified ginglymus, or hinge joint, which is less tolerant to direct trauma.

Address correspondence to: Michael Gill, OTC, 3510 Conway Ave, Charlotte, NC 28210. Tel: (704) 527-1410; email: abg3510@aol.com.

Causes and Presentation

Shaft fractures are usually the result of a fall on the upper limb, or high-energy trauma as may occur in industrial or motor vehicle accidents or with gunshot injury.

A humeral shaft fracture with a low-energy injury should arouse the suspicion of underlying pathologic bone from osteoporosis or other kinds of osteopenia. Fractures of the diaphysis of the shaft are often more apparent on initial presentation than are proximal humeral fractures. Visible displacement, fracture mobility, and malposition of the distal limb all suggest a shaft fracture².

Displacement of the fracture tends to follow the deforming forces of the surrounding muscles. For example, the deltoid muscle inserting on the proximal third of the humerus will typically deform the proximal shaft and glenohumeral joint into abduction.

Initial Evaluation

The initial history and examination are much like those for the proximal humeral fracture. When evaluating a patient, consider features such as their overall state of health, physiologic and chronologic age, activity level, associated medical conditions and bone quality. Take a brief but thorough history of the nature of the injury, the possibility of loss of consciousness and/or blunt head trauma, current medical conditions and medication status and limb dominance. Social factors, such as the home situation, occupation and recreational activities are also important.

Because humeral shaft fractures have a well recognized association with radial nerve injury, a careful and precise neurological evaluation is mandatory. The physician must establish and clearly document the motor and sensory status of the limb before initiating treatment. Loss of radial nerve integrity following fracture manipulation will influence the choice of management, increasing the likelihood that operative treatment

will be needed. Careful documentation of vascular status is also necessary.

Roentgenographic Examination

The roentgenographic examination must include adequate visualization of the glenohumeral and elbow joints. Failure to do so may miss an associated soft-tissue or skeletal injury, which can prove devastating. In addition to standard anteroposterior and lateral roentgenograms, the oblique view is extremely helpful in defining the fracture pattern and skeletal alignment.

Fracture Management

For the most part, closed fractures of the humeral shaft can be successfully managed by nonoperative means. The shaft of the humerus can heal with 25° to 30° or more of rotary deformity and still enable the person to have excellent upper limb function³.

Deforming forces, such as those of the powerful upper limb muscles, will frequently lessen during the 3 to 4 days following the injury. Therefore, improvement in the fracture alignment will often be seen by allowing the limb to be supported and held dependent in a sling with gravity enhancing the realignment. If manipulation fails to improve the fracture that continues to show displacement on the x-ray film, consider the possibility of soft-tissue interposition and the potential for the fracture not healing.

Traction and Splinting

In the emergency department, support of the shaft fracture is more predictably achieved by the use of well-padded plaster splints. Four-inch plaster will suffice in most cases. Individual splints should be placed on the medial side of the arm posteriorly, anteriorly and laterally, with the latter extending proximally above the shoulder. These are well-padded and wrapped securely, but not tightly, with nonelastic wrap.

If the fracture extends toward the distal third of the shaft and is displaced and unstable, it is best to include the elbow in initial immobilization. A sling and swathe will provide comfort and additional support for the first 7 to 10 days post-injury.

Instruct the patient and family on the need to maintain mobility of the hand and to watch for swelling of the hand and forearm. If swelling should occur, examine the hand expeditiously, since it may have a lasting effect on the hand's function. Swelling usually indicates

that the splints are wrapped too tightly.

Functional Bracing

Most humeral shaft fractures can be managed effectively with functional fracture braces, as advocated by Sarmiento et al⁴. These devices take advantage of the hydraulic effort of circumferential compression of the surrounding soft tissue in stabilizing the bony fragments. Fracture braces are the most useful and predictable method of managing diaphyseal fractures non-operatively⁵.

However, caution is required in applying these devices in the period immediately following the fracture; the snug application of a fracture brace can produce profound swelling of the limb distal to the fracture brace. Generally, they should be applied within 7 to 10 days of the fracture when maximal swelling has diminished and left in place until both roentgenographic and clinical evidence of healing is seen.

These braces are available in a number of different designs and materials. For unstable fractures extending toward the proximal third of the humerus, a fracture brace with an extension above the shoulder will help support the fracture more securely. In most cases, the elbow brace can be allowed to embrace the epicondyles of the distal humerus. This will add to the rotational control of the fracture yet permit elbow mobilization.

Clinically, absence of motion and pain are the most definitive signs of bony union. Roentgenographically, the presence of callus suggests that healing is taking place. Both of these features may vary depending on the nature of the fracture as well as its location. A fracture that is transverse and only partly in contact may heal more slowly than a spiral fracture that presents a large fracture interface and is inherently stable.

Closed humeral shaft fractures will ordinarily begin the healing process by 6 weeks post-fracture and the end result can be expected by 12 to 16 weeks following injury. Failure to visualize callus in the absence of motion and pain would not necessarily suggest that bone healing is not occurring and the patient should be allowed additional time for solid bony union to be demonstrated roentgenographically.

The fracture brace requires a cooperative patient who is knowledgeable about its care. At areas of contact,

such as those near the axilla or above the elbow, skin irritation can develop. Attention to these areas can prevent excoriation and associated complications. In addition, the patient must be instructed to maintain adequate pressure in the brace to prevent swiveling or loosening.

In the past, the most commonly used form of immobilization was a hanging cast, a long arm cast with a loop made of plaster through which a sling could be placed to go around the patient's neck. These casts, however, proved cumbersome, the patient was often required to sleep sitting up, and use of the cast could actually distract the fracture.

Indications For Surgery

There are some specific situations in which surgical intervention is recommended. These include open fractures, fractures associated with vascular injuries, fractures associated with multiple injuries of the limb, particularly those below the elbow (the so-called floating elbow) and certain situations in which the radial nerve appeared functional at the time of the fracture but is not working following fracture manipulation⁶.

With newer developments in intramedullary fixation techniques commonplace in the lower extremity, these applications have been extended to humeral diaphyseal fractures. They permit the fractures to be internally stabilized without surgical exposure of the fracture site. In some instances, however, the fracture will not be amendable to intramedullary fixation, and the surgeon may choose to expose the fracture site and apply plate and screw fixation. In some situations with exposure of these fractures, and autogenous iliac crest bone graft will also be used to ensure fracture healing.

Complications

As with all fractures, there is a possibility of failure to heal or healing with deformity. While failure to heal with closed humeral shaft fractures is uncommon, it may occur in obese patients, infirm patients or those with certain metabolic disorders.

Radial nerve palsy associated with closed humeral shaft fracture has been extremely favorable prognosis for spontaneous recovery⁷. Therefore, if the patient presents with this association, carefully document the nature of the sensory and motor deficit and treat the fracture like other closed fractures.

The patient's hand and wrist, however, should be supported with a low-profile dynamic radial nerve splint. This will allow the hand to maintain a certain degree of function and avoid soft-tissue contracture from the resultant flexed wrist position. Carefully monitor the patient and inform him of the nature of the problem as well as the high likelihood of recovery. The radial nerve is more prone to be contused with transverse fractures at the mid to distal third level⁸. Although uncommon, nerve severance can occur in more distal fractures when there is a short, sharp spike at the fracture end.

Electrophysiologic testing should not be performed before 3 weeks have elapsed, and when it is, the neurophysiologist should be instructed to document the status of the radial wrist extensors and brachioradialis. These are the most proximal muscles innervated by the radial nerve as it passes behind the humerus.

Evidence of reinnervation of these muscles is more likely to be seen initially and, thus, provide support to the presence of the nerve continuity. If there is no evidence of recovery, either clinically or electrophysiologically by 3 months post-injury, consultation is recommended to consider nerve exploration.

A more difficult situation occurs when radial nerve function is intact after careful examination of the patient's initial presentation, but is absent after fracture manipulation or at a follow-up visit. In such a case, it is possible that the nerve is entrapped by the fracture fragments. Some investigators recommend continued observation, since the nerve may have been traumatized rather than severed⁹.

In some cases, additional complications may reflect the results of treatment rather than the fracture itself. These include loss of shoulder or elbow motion because of prolonged immobilization, swelling and residual stiffness of the small joints of the hand or dystrophic problems involving the entire upper limb.

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ABOUT THE AUTHOR

Michael Gill, OTC, OT-SC is a resident of Charlotte, North Carolina. He holds a Associate Degree in Allied Health Science from Piedmont Community College and has thirty-one years of experience in the field of orthopaedics. Gill is Board Certified as an orthopaedic technologist and surgery certified by the National Board of Certification of Orthopaedic Technologists. He is the current President of the National Association of Orthopaedic Technologists.

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