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Bucholz, Robert W., Heckman, James D.
Rockwood & Green's Fractures in Adults, 5th Edition

BIOMECHANICS

Part of "24 - FRACTURES OF THE SHAFT OF THE HUMERUS"

Klenerman divided the mechanisms by which humeral fractures occur into three separate groups based on laboratory investigations (50). He recognized that violence is imparted to the bone directly, indirectly, and through muscular forces. Direct force implies an impact between the arm and an object, creating a three-point bending moment. This occurs when the patient falls against or is thrown against a fixed object or when a blunt object strikes the arm. Experimentally, this type of mechanism produced a transverse type fracture line, occasionally with a nondisplaced butterfly fragment (50). Klenerman theorized that higher-energy injuries of this type probably would produce complete separation of the butterfly fragment (50). Indirect violence in which the energy absorbed by the humerus is applied through the distal portion of the limb occurs in situations such as a violent twisting of the arm behind the back or during arm wrestling. These rotational injuries create a spiral fracture pattern (50). Spiral fractures can also occur through muscular violence in activities such as throwing a baseball or a hand grenade (29,46). Klenerman (50) concluded that all fractures of the shaft arise from tensile forces. Experimentally, axially applied compressive loads created only compression fractures in the cancellous bone of the proximal or distal humerus (50). Gunshot injuries represent yet another mechanism in which a high-energy direct blow from a small projectile causes a highly comminuted fracture (66,95).

Certain predictable deformities result from muscle forces acting

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on fracture fragments. These deformities vary depending on the level at which the fracture occurs. With injuries above the insertion of the pectoralis major, the proximal fragment is abducted and externally rotated by the rotator cuff muscles. Between the pectoralis and deltoid insertions, the proximal fragment displaces medially through the pull of the pectoralis muscle. In fractures below the level of the deltoid insertion, the strong deltoid muscle becomes the dominating force abducting the proximal fragment and causing a varus deformity at the fracture site.