(i) Fractures of the proximal humerus: general considerations and nonoperative management

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Abstract

Fractures of the proximal humerus are common, accounting for 6% of all fractures, and tend to affect elderly patients after a fall from standing height. Patterns of fracture are predictable from the anatomy of the proximal humerus, the insertions of the rotator cuff on the tuberosities causing displacements of these segments and impacting on functional outcome. Fractures also impair blood supply to the head segment, particularly if the anatomical neck is involved and especially if the head is dislocated. Overall, nonoperative management gives results that are sufficiently good that it is exceptionally difficult to set up a trial that has sufficient power to prove any method of treatment better than rehabilitation alone.

Keywords classification; fracture; nonoperative treatment; rehabilitation; shoulder

Introduction

The large majority of fractures involving the proximal humerus are minimally displaced and are suitable for nonoperative management. Nonoperative management is an active process that requires regular monitoring and appropriate rehabilitation interventions to optimize the clinical outcome. Although there is a strong tendency to look at radiographs showing shoulder fractures and recommend operative intervention, the evidence that such interventions are beneficial is weak and studies to determine the desirable thresholds for surgical care are ongoing. This paper reviews the anatomy of the proximal humerus relevant to fracture management and discusses the nonoperative care of shoulder fractures. Subsequent papers in this mini-symposium will consider the alternatives to be considered when a patient and their surgeon decide that internal fixation of the fracture will be desirable.

Epidemiology

Most fractures of the proximal humerus occur in the elderly, osteoporotic population[1] who are least well equipped to cope with the loss of function that a fracture entails and the prolonged rehabilitation that may involve following complex instructions and carrying out physically demanding and uncomfortable exercises for several months. About half of the patients are older than 70 at the time of fracture and women suffer these injuries 2—3 times more commonly than men.[2] Furthermore, this is the population whose bone quality is least suitable for secure internal fixation if this is contemplated as a potential route to faster functional recovery. They account for approximately 6% of all adult fractures and the age-specific incidence rises most rapidly in female patients[3] therefore, as with most fractures related to osteoporosis, it is likely that the burden of these fractures on healthcare systems will rise inexorably over the coming decades.

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Anatomy

Fractures of the proximal humerus are the most common shoulder fractures. There are several reasons why fractures of the proximal humerus can result in impaired function which are interlinked, and range from straightforward mechanical reasons in which deformity or tissue quality impair excursion, through to biological reasons whereby the patterns of injury and blood supply can bring about avascular necrosis in segments of the injured bone.

Range of movement

The proximal humerus articulates with the glenoid fossa to form the glenohumeral joint, which is the major contributor to movement of the shoulder girdle (the scapulothoracic joint being the second major contributor). The glenohumeral joint has an enormous range of motion, which can only be achieved by a trade off with stability. Thus there is a large, approximately spherical articular surface on the humerus, which articulates with a small glenoid fossa. This enables tendons attached close to the articular surface (the rotator cuff) to maintain their efficiency even after significant rotations of the humeral head, which bring the tuberosities adjacent to the glenoid margins. Any enlargement of the glenoid fossa would correspondingly reduce the potential excursion of the cuff tendons and limit range of humeral head rotation. Likewise any alteration of the position of the tuberosities due to fracture displacement will bring about earlier limitation of range due to contact of the tuberosity with the glenoid margins and its soft tissue attachments, limiting movement.

The capsule of the shoulder is normally thinner and has a higher elastic content than the capsule of other large joints. After trauma, changes in the capsule occur (either due to scar tissue formation in tears caused by injury or possible local and systemic effects akin to the development of frozen shoulder) which make it much thicker and stiffer. The capsule shortens and its confluence with the overlying rotator cuff tendons mean that they can no longer pay out to allow the full range of humeral head rotation.

Thus it can be seen that with both operative and nonoperative treatment, restoring or maintaining the anatomy of the proximal humerus simply makes the restoration of normal movement a possibility. However restoration of the tissue quality of periarticular capsule, tendon and other soft tissues is just as vital, and may be facilitated (but not guaranteed) by appropriate rehabilitation.

Structure of the proximal humerus

The humeral head is approximately two thirds of a sphere and is covered in articular cartilage, being connected to the humeral metaphysis at the anatomical neck (Figure 1). The anatomical neck is therefore the only route of entry for blood supply to the humeral head and displaced fractures involving the anatomical neck, as part of any fracture pattern, carry a significant risk of avascular necrosis of the head segment.

Between the shaft of the humerus and the humeral head the metaphyseal region of the proximal humerus is expanded anteriorly, laterally and posteriorly where the rotator cuff tendons attach to form the tuberosities — the lesser tuberosity being anterior and the greater tuberosity lateral and posterior. The two are separated by the groove for the long head of the biceps tendon, which has a plate of bone in its base that is denser than the cortical bone over the tuberosities. There is a fibrous band bridging across the groove from lesser to greater tuberosity, which therefore forms a tunnel through which the tendon of the long head of biceps can enter the shoulder joint to reach its attachment at the supraglenoid tubercle of the scapula. This arrangement has implications on the pattern of fractures that occur in the proximal humerus, as will be discussed later. Note that medially the shaft effectively runs into the head with no intervening tuberosity.

It has long been observed that when fractures of the proximal humerus occur the fracture lines pass between segments that have their own integral strength, therefore there is a strong tendency for fracture lines to occur in predictable zones, and this will form the basis of classification systems as we will see. Although fracture lines can occur anywhere, they are most likely to separate segments as follows.

Segments of the proximal humerus: Codman observed that fractures of the proximal humerus tended to follow lines of epiphyseal fusion and, more than a century later, this forms the basis of the most commonly used classification systems. These epiphyseal segments help us to visualize and understand the fracture patterns and displacements that we see. The 'parts' described below begin in infancy as separate ossification centres.

The humeral head is a discrete structure with a dense plate of subchondral bone supporting articular cartilage, the trabecular architecture beneath this supporting the subchondral plate on cross-linked columns. Around the margin of the articular surface the subchondral plate becomes thinner at the attachment of the joint capsule — the anatomical neck. Thus there is a transition of mechanical properties at the anatomical neck and fracture lines tend to propagate here, making the humeral head itself a potential separate 'part' in the fracture process. The capsule is thin where it lines the rotator cuff tendons and much thicker medially where the shaft directly abuts the head with no intervening cuff attachment and this thick medial capsule can be the only remaining soft tissue attachment to the head segment in some fracture patterns.

The shaft is the second element with structural integrity, being a tube of thick cortical bone. As it thins to expand and form the metaphyseal region the mechanical properties correspondingly change — this transition in properties occurs most quickly at the junction of the shaft with the humeral head medially and the rotator cuff insertions elsewhere. This is therefore a further site liable to fracture and indeed the most common site of fracture — the so-called surgical neck of the humerus.

Between the shaft and the humeral head is the expanded metaphysis where the rotator cuff tendons insert. It has already been noted above that this area is divided into two 'tuberosities' by the groove for the long head of the biceps tendon (Figure 2). Anterior and medial to the groove is the lesser tuberosity to which subscapularis attaches whilst the greater tuberosity gives attachment to supraspinatus laterally and the infraspinatus and teres minor posteriorly. The bone of the tuberosities is thin if examined by CT, for example, but is permeated by the Sharpey's fibres of the cuff insertions, which gives it tremendous integrity if the cuff tendons are intact. Thus the greater and lesser tuberosity fragments form two more 'parts' that can be separated from the

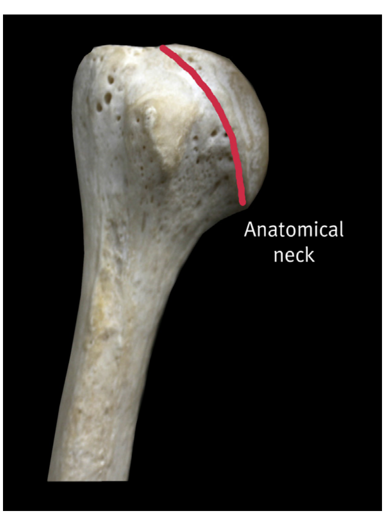

Figure 1 The proximal humerus has an articular surface that is approximately 2/3 of a sphere and joint the metaphysis at the anatomical neck, where the capsule attaches.

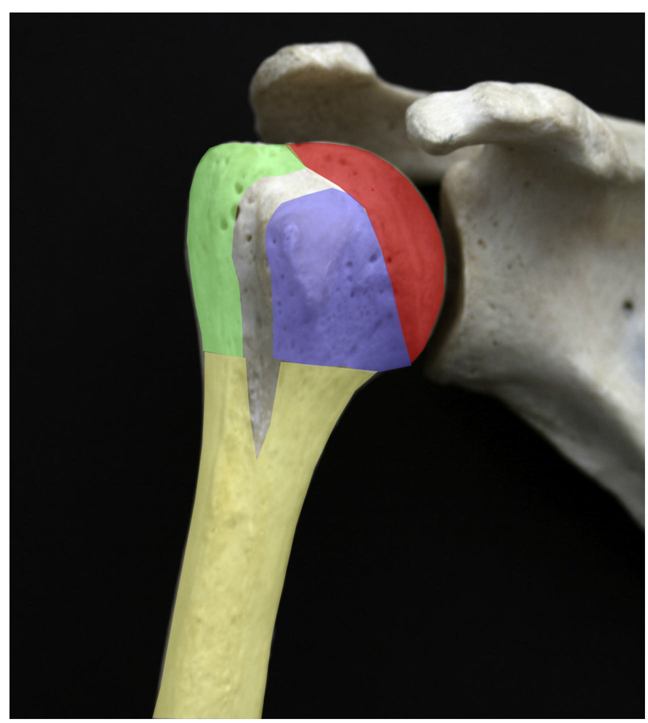

Figure 2 The proximal humerus coloured to identify the shaft (yellow), head (red), greater tuberosity (green) and lesser tuberosity (blue), with the groove for the long head of biceps between the greater and lesser tuberosities.

