COMPLICATIONS OF INTERLOCKING IN HUMERAL SHAFT FRACTURE MANAGEMENT

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ABSTRACT

Background: The insertion of intramedullary nails inevitably leads to some symptomatology at the insertion site comparable to anterior knee pain following tibial nailing or buttock pain following femoral nailing. Complications of intramedullary nailing includes: Insertion site morbidity, Fracture at the end of the implant, Iatrogenic comminution, Neurovascular Injury and nonunion.

Keywords: Interlocking, Humeral shaft Fractures.

I. COMPLICATIONS OF INTERLOCKING:

Humeral Nails:

1- Insertion site morbidity:
The insertion of intramedullary nails inevitably leads to some symptomatology at the insertion site comparable to anterior knee pain following tibial nailing or buttock pain following femoral nailing. Although this symptomatology is usually mild in nature and temporary in the majority of circumstances, it may cause symptoms sufficient to necessitate another surgical intervention. Unfortunately, although the incidence and severity of this complication appears to be variable, antegrade humeral nailing has been associated with shoulder pain and impingement.(1)

Despite a number of modifications of technique, ranging from "mini" incisions at the edge of the rotator cuff to formal open cuff division and subsequent repair. The insertion of humeral nails through the shoulder can lead to pain and stiffness, which is probably due to the unfavorable local anatomy, where limited subacromial space means that any degree of nail protrusion or soft tissue swelling can lead to impingement, especially in susceptible individuals. A small rotator-cuff incision (1 cm) and meticulous closure with absorbable sutures should avoid this problem.(1)

2- Fracture at the end of the implant:
Well recognized drawbacks of plated diaphyseal fractures are the risk of fracture at the end of the implant because of the stress riser effect of the screws at the end of the plate or refracture after implant removal. This problem was largely eliminated in the lower extremity by the introduction of locking intramedullary nails.(2)

It was postulated that this would also be the case in the humerus following the use of similar intramedullary devices.(2)

3- Iatrogenic comminution:
The introduction of a large diameter intramedullary nail into a fractured humerus can lead to comminution of the existing fracture or insertion site. Comminution of the fracture or insertion site can result in fixation failure and future functional impairment.(3)

4- Narrow canal diameter:
In a series of 40 patients undergoing intramedullary nailing with the Seidel nail, Reimer and colleagues noted a dramatically increased complication rate (58% versus 4%) in patients with a canal diameter of 9 mm or less when...
compared with those with a canal diameter of 10 mm or more. This finding represented 93% reduction in the risk of complications in patients with canal diameters greater than (or equal to) 10 mm.\(^4\)

Although intramedullary reaming of cancellous bone may be relatively innocuous or even beneficial in most circumstances, reaming of cortical bone thins and weakens the cortex. Cortical reaming, in conjunction with the increased heat produced, damages the endosteal blood supply of the bone and, if done excessively, can lead to complete architectural alteration of the endosteum and prevent revascularization. This effect is amplified in the humeral canal, whose architecture, with its distal taper and lack of metaphyseal flair, does not allow dissipation of the pressure or debris created by the reamer.\(^4\)

Failing to ream adequately, however, can increase the risk of comminution or fracture distraction, which is poorly tolerated in the humerus.\(^4\)

Newer systems also have a variety of smaller nails sizes, including 7-, 8- and 9-mm nails that can be used in patients with smaller canal diameters. Thus, it seems prudent to carefully examine preoperative radiographs of the involved humerus, if the canal diameter is such that excessive cortical reaming will be required to accommodate the available intramedullary implant, an alternative method of fixation should be selected. Smaller-diameter implants such as Ender nails can also be effective in such circumstances.\(^4\)

5- Neurovascular Injury:
Potential injury to neurovascular structures during intramedullary nailing of the humerus can be divided into three main areas: (a) risk to the radial nerve from canal preparation and nail insertion, (b) risk to the axillary nerve from proximal locking, and (c) risk to the radial, musculocutaneous, and median nerves and brachial artery from distal locking.\(^5\)

Most nailing systems use a lateral-to-medial proximal locking technique recommended that the anterior-to-posterior approach be avoided because penetration of the posterior cortex with either a screw or a drill places the main trunk of the axillary nerve at risk.\(^5\)

Similarly, extreme internal rotation of the arm may jeopardize the nerve, even with lateral-to-medial locking. The axillary nerve lies approximately five to six centimeters distal to the tip of the acromion. Lateral-to-medial locking screws placed proximal to this level should not injure the nerve, but the more distal of the two proximal locking screws in some nail designs may be in very close proximity to the nerve.\(^5\)

6-Nonunion:
Delayed union or nonunion following intramedullary nailing of humeral shaft fractures has been attributed to instability secondary to implant failure, lack of adequate fracture compression or infection, and has ranged from 0 to 29 percent. Distraction of the fracture is especially deleterious, and many authorities have suggested (and some nail systems have been designed for) distal locking, followed by "back slapping" of the nail prior to proximal locking, to produce compression at the fracture site.\(^5\)

7- Complications related to the locking screws
A-Structures at risk from proximal locking screws:
The axillary nerve
The axillary nerve is at risk by the deltoid splitting incision and by the proximal locking screws. Limiting the deltoid split to less than 5 mm. From its origin will protect the deltoid branches. Antero-posterior directed locking screws put the main trunk of the axillary nerve at great risk. Most series warns against using anteroposterior locking proximal screws.\(^5\)

Transverse lateral to medial screws are inserted through arborized axillary nerve, an incision should be made through the skin and a curved he most at should be placed to the bone to retract any small branches of the nerve. Any protrusion of the lateral to medial screws beyond the medial cortex of the surgical neck, with internal rotation, has the potential for damaging the axillary nerve on the posterior surface of the humerus.\(^2\)

The long head of biceps:
Demonstrated in cadaveric dissection that the long head of biceps was transfixed by anteroposterior locking screws in 25% of the specimens. He advised against the use of these locking screws.\(^6\)
B-Structures at risk from distal locking screws:

Antero-posterior distal locking screws:

Antero-posterior distal locking is performed through an incision into the biceps belly. The median nerve and brachial vessels are lateral to this incision. These structures would be at risk if the fracture is fixed in external rotation and locking performed blindly without exposing the bone. The lower part of the humerus is triangular, distal locking is done on the anterior ridge of this triangle giving a precarious purchase for the drill. Protective sleeves should be used to avoid injury of neurovascular structures by slipping of the drill.(7)

The lateral cutaneous nerve of forearm is the continuation of the musculocutaneous nerve. It crosses from medial to lateral in the lower arm. Cadaveric dissection revealed that the nerve passed within 3 mm from the antero-posterior distal locking screw in more than half of the specimen.(7)

Lateral to medial locking screws:

Distal lateral to medial locking screws can cause injury of the radial nerve and its lateral cutaneous antebrachial branch. This has been demonstrated clinically and in cadaveric dissections, which revealed that 11 out of 12 screws passed within 5 mm from the radial nerve, and in one case the nerve was avulsed by the drill. For this reason it recommended to make 4-6 cm lateral incision and the dissection down to the bone be strictly posterior to the brachioradialis.(7)

External fixator:

Traditionally, external fixation of humeral shaft fractures has been limited to open fractures. The open wound should be treated in an appropriate manner and, for Gustilo grade I or II wounds, followed by ORIF or unreamed intramedullary nailing. For grade III wounds, external fixation is the treatment of choice. Debridement is performed every 48 hours until the wound is clean. Then, at the final debridement, bone grafting may be used if needed. Treatment of humeral shaft fractures with an external fixator carries a high complication rate.(8) (Figure 1)

![Figure (1): High velocity gunshot injury of humeral shaft treated by external fixation.](https://www.turkphysiotherrehabil.org)

Complications of Humeral Shaft Fracture

1. Neural complications:

Radial nerve injury occurs in as many as 16% of humeral shaft fractures. Although the oblique distal third humeral fracture (Holstein-Lewis) is better known for an association with radial nerve palsy than other humeral...
shaft fractures are, such palsy most commonly occurs with middle third humeral fractures. Most of these nerve injuries are neurapraxic or axonotmetic types, 90% of which resolve to at least grade IV strength in 3-4 months.\(^{(10)}\)

Indications for early nerve exploration include a palsy associated with an open wound or penetrating injury. The question of whether it is best to explore a radial nerve when function decreases after closed manipulation is controversial. Some authors recommend waiting to perform exploration if no return of function is observed after 3-4 months, stating that the results of secondary repair of radial nerve injuries are as good as those of primary repair and that the situation has been made easier because the fracture has had time to heal.\(^{(9)}\)

2. Vascular injury:
Fractures of the humeral shaft may be associated with injury or laceration of the brachial artery. Although it is uncommon, it might occur due to gunshot, stab wound, entrapment of vessels between fracture ends and occlusion secondary to hematoma, swelling in a tight fascial compartment or due to spasm of the vessel wall.\(^{(11)}\)

3. Malunion:
It has been shown experimentally that the musculature around the humerus will accommodate 20° of anterior angulation and 30° of varus angulation without compromising function or appearance. The normal mobility in the shoulder and elbow joint will compensate for this degree of displacement. Unless there is severe angulation, malunion of the middle third of the humeral shaft rarely requires correction because shortening, rotational deformity and angulation of this bone rarely impair function.\(^{(12)}\)

4. Delayed union and non-union:
Delayed union is an arbitrary diagnosis, that represents a state in which complete union has not occurred in a reasonable period, and some healing potential remains. The literature has offered 4 months as a reasonable period with which union might be anticipated in the humeral diaphysis.\(^{(13)}\)

Nonunion was defined as absence of bridging callus across the fracture at 6 months and no progress towards union for 3 months. The incidence of non-union in humeral diaphyseal fractures varies from 0% to 5% in patient treated operatively and from 1 to 10% in patients treated conservatively.\(^{(13)}\)

The causes of delayed union and non-union are mechanical and biological, such as excessive motion at the fracture site, gap between fragments and loss of blood supply. Any combination of these factors may come together to cause failure of union. In closed treatment, motion is sometimes difficult to control by external means such as casts, braces, or splint. Gaps are frequently present due to distraction, overriding, soft tissue interposition, and bone loss.\(^{(13)}\)

5. Joint stiffness:
Immobilization of the shoulder and/or the elbow joints usually predispose to stiffness due to adhesive capsulitis, edema of the capsule, fibrosis of the ligaments and the muscles around the joint or adhesions of the soft tissues to each other or to the underlying bone. If the joint has been held in a position where the ligaments are at their shortest length, no exercise will succeed afterwards in stretching these tissues and restore the lost movements completely. This complication as part of conservative treatment of fracture humerus could be prevented by early movement.\(^{(14)}\)

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REFERENCES