Intramedullary Nailing of Proximal Humeral Fractures

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**Introduction**

The treatment of proximal humerus fractures has undergone a large number of different concepts over the last years. Beside conservative measures, a variety of operative techniques have been proposed.

Decision-making is based on the specific fracture pattern, the quality of bone and the individual patient parameters such as biological age and functional needs.

Fractures with minimal or no displacement should usually be treated nonoperatively, as good functional outcome for this group of fractures has been reported [1]. Fortunately, 70–80% of all fractures of the humeral head can be treated conservatively, because they are not dislocated.

On the other hand, there is consensus that in displaced and highly comminuted four-part fractures and head-splitting fractures in the elderly, a primary hemiarthroplasty is recommended [2].

The treatment of displaced three-part and even four-part fractures of the proximal humerus remains controversial. The reported techniques show a wide range of different recommendations, such as percutaneous procedures using wires, pins or screws [3, 4], to open procedures with plate fixation or even joint replacement. The plate fixation of proximal humeral fractures is due to the introduction of angular stable locking plates, and reports show a good outcome [5, 6]. Nevertheless, plate fixation often needs an extended exposure of the fracture elements and can increase the risk of osteonecrosis of the humeral head by disturbing the blood supply. Bulky extramedullary hardware can lead to mechanical complications, as subacromial impingement, and loosening of the plate and screws in poor bone stock have been reported.

Therefore, minimally invasive techniques with closed and indirect reduction have been advocated to preserve the soft tissue envelope and the blood supply to the humeral head and fracture elements.

Intramedullary nailing is a common and usual therapy in the treatment of humeral shaft fractures. In proximal fractures, using intramedullary implants is associated with problems of secure fixation and achieving a rotational stability of the humeral head and its fragments. Therefore, because of the success of angular stable locking plates, angular and sliding stable locking nails have been developed [7–9].

These nails should provide multiplanar locking modes for a rigid fracture fixation, achieving a rotator cuff stability to allow early mobilization without the risk of secondary loss of reduction. Cadaver analyses have shown that the highest bone strength can be found in medial and dorsal aspects of the humeral head and that it decreases from cranial to caudal [10]. Implants should therefore provide secure fixation in this area.

**Indications**

Common classification systems for fracture typing of the proximal humerus are those from Codman, the AO system and the Neer classification [11]. Although limited inter- and intraobserver reliability is reported [12, 13], the Neer classification still represents the most used typing system in clinical practice.

As shown in Fig. 4.10.2.1, Neer describes four major fragments: the humeral head, the lesser tuberosity, the greater tuberosity and the humeral shaft. The classification is based on the presence or absence of significant displacement of one or more of these bone segments. If any of these fragments shows a displacement of more than 1 cm or is angulated more than 45°, the fracture is said to be displaced.

According to Neer: “Displacement defined arbitrarily as a guide for surgeons – 1 cm or 45 degrees, but no guarantee that those with less displacement will do well.”

One-part fractures are nondisplaced fractures or fractures with minimal displacement. A two-
part fracture is one in which only a single segment is displaced in relation to the other three. Three-part fractures occur when two segments are displaced with relation to the other two parts and a four-part fracture exists when all the humeral segments are displaced. Computed tomography scans allow an accurate determination of the Neer fracture pattern, particularly when the humeral fractures are complex.

This classification is not meant as a numerical classification but rather as a concept that makes it possible to describe a fracture or fracture dislocation with standard terminology.

According to this classification, we recommend intramedullary nailing for the following types of fractures:
- Neer type III
- Neer type IV three-part
- Neer type V three-part.

Additional indications are even four-part fractures but only with an intact head fragment. Special features of the T2 proximal humerus nail allow reliable fixation in the often poor cancellous bone, and additional fragments can be augmented by suture, using the locking screws as an anchor.

Proximal humeral fractures with diaphyseal extension can be treated by using special versions of intramedullary nails with a long diaphyseal stem. Furthermore we see an indication in very proximal humeral shaft fractures, where standard locking nails in retro- or antegrade technique do not achieve a secure fixation of the proximal locking screws in the humeral head.

**Implant Features and Instruments**

The following report is based on the use of the T2 proximal humerus nail (Stryker Trauma GmbH, Prof. Küntscher-Strasse 1–5, 24332 Schönkirchen, Germany).

The proximal humerus nail is made from type II anodized titanium alloy (Ti6Al4V) with its known mechanical advantages and biocompatibility. The material allows postoperative CT and MRI scans with minimized appearance of artifacts.

The nail has four proximal locking holes, thus enabling separate locking of fragments of the lesser tuberosity, the greater tuberosity and the humeral head. The proximal holes in the nail are threaded and have a nylon bushing to prevent screw back-out. The proximal 5-mm locking screws are in consequence of this feature axial and sliding stable fixated in the nail. Therefore the combination of the nail and the proximal screws performs mechanically as one firm construction.

The proximal humerus nail is manufactured in different versions. The standard short nail has a length of 150 mm and can be obtained in a left and right version with asymmetric positioning of the proximal locking screws to reduce possible lesions of the axillary nerve. Additionally long nails from 220 to 300 mm can be obtained for the left and right humerus to handle proximal humeral fractures with diaphyseal extension (Fig. 4.10.2.2). All nails have a proximal 6° lateral bend.

In both the short and long nail versions, the positioning of the proximal locking screws is guided by a target device. The distal locking for the short nail is done using the target device, whereas in the long nails a freehand locking is performed. The distal locking hole configuration allows either static or dynamic locking modes.

Proximal locking is always done using 5-mm screws; distal locking is performed with 4-mm