Technical Note

Obere Extremität 2019 · 14:136–138
https://doi.org/10.1007/s11678-019-0521-5
Received: 8 December 2018
Accepted: 17 April 2019
Published online: 6 May 2019

Marvin Minkus[1] · Markus Scheibel[1,2]

[1] Department of Shoulder and Elbow Surgery, Center for Musculoskeletal Surgery, Charité-Universitätsmedizin Berlin, Berlin, Germany

[2] Department of Shoulder and Elbow Surgery, Schulthess Clinic, Zürich, Switzerland

Open reduction, retention, and fixation of proximal humeral fractures using a locking plate osteosynthesis

Video online

The online version of this article (https://doi.org/10.1007/s11678-019-0521-5) contains the video: "A standardized approach for open reduction, retention and fixation of proximal humeral fractures using a locking plate osteosynthesis." You will find the video at the end of the article as "Supplementary material." Video by courtesy of Dr. M. Minkus, Charitè – Universitaetsmedizin Berlin, Germany and Prof. Dr. M. Scheibel, Charitè – Universitaetsmedizin Berlin and Schulthess Clinic Zuerich, Switzerland, all rights reserved 2019.

Background

Owing to demographic changes, the number of proximal humerus fractures is continuously rising and surgical treatment can be challenging [1]. Nonoperative treatment with short-term immobilization and early functional exercises represents a well-established treatment option especially for minimally displaced fractures [2, 3]. However, complex proximal humeral fractures are common, especially in the aging population [2]. Primary arthroplasty must be considered in fractures where vascularity of the humeral head is impaired or an anatomical reduction and stable fixation cannot be achieved. However, in most remaining cases, especially in three- and four-part fractures when displacement of the tuberosities is present, locking plate osteosynthesis has been reported to be the gold standard [4]. While intramedullary nailing might be an option for two-part fractures or more distal fractures with diaphyseal involvement, it often fails for complex fractures and has the potential disadvantage of affecting the rotator cuff [4]. Angular stable plating has been introduced to specifically address displaced, unstable, and/or comminuted fractures of the proximal humerus. An anatomical reduction before plate fixation is crucial. Secondary displacement, implant malpositioning, or primary screw perforation are primary complications that might occur and should be avoided.

The following technique illustrates a standardized approach for an anatomical reduction, retention, and fixation using a locking plate osteosynthesis. This reproducible technique improves fixation with regard to primary stability, allowing for an early passive and active rehabilitation process.

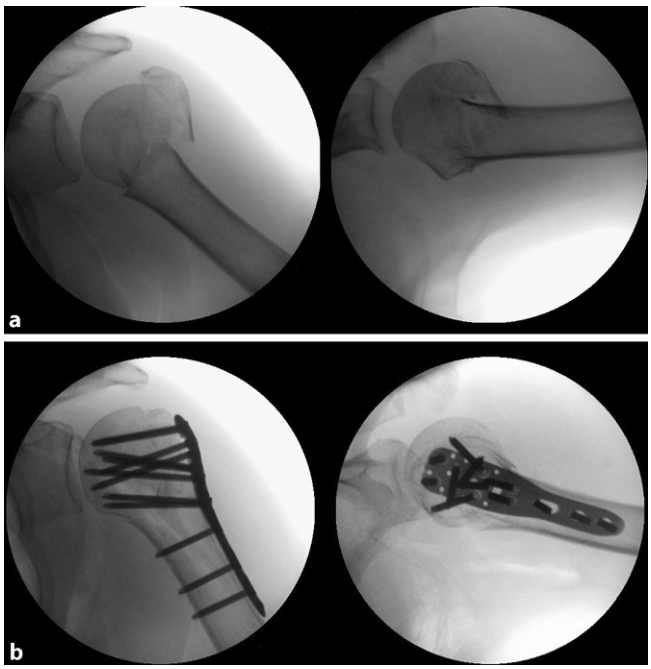

Fig. 1 ◄ Image-intensifier preoperative (**a**) and postoperative (**b**) evaluation in true anteroposterior and axillary view

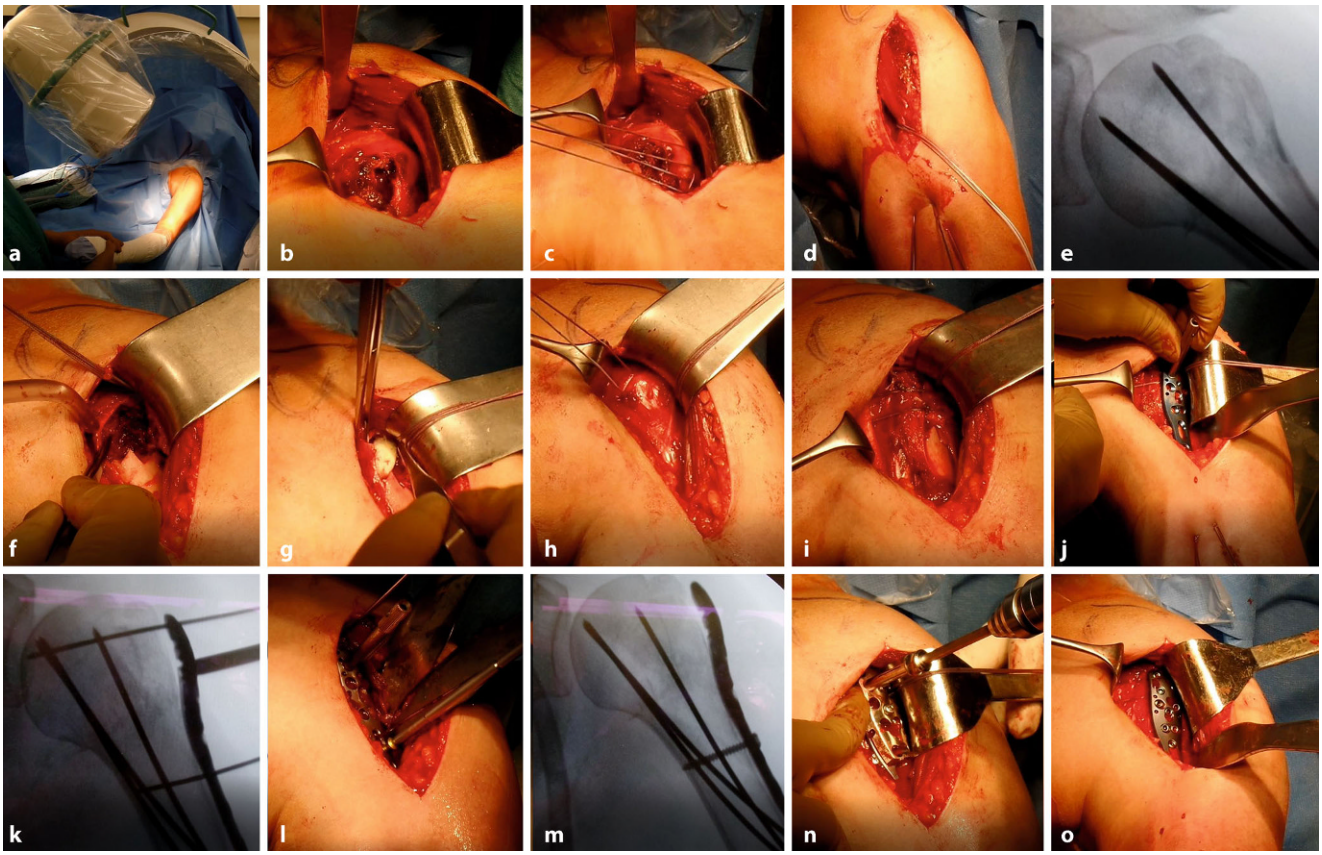

Fig. 2 ▲ Step-by-step illustration of locking plate osteosynthesis with allograft augmentation and suture cerclage for proximal humeral fractures. For more detailed information on the subfigures please see the text

Technical note

Set-up

Under general anesthesia, intrascalene block, and perioperative intravenous antibiotics, the patient is placed in a beach-chair position with the affected arm prepped and draped in a sterile fashion and placed on a side table. Before starting the procedure, the fracture should be re-evaluated with the help of an image intensifier, which is inserted from proximal offering a good visualization in the true anteroposterior (AP) and axillary plane (**Fig. 1a and 2a**).

Anatomical reduction and suture cerclage

A standard deltopectoral approach is used for this surgical technique. Once the fracture side is exposed, the hematoma is evacuated, the bursa is partially removed, and a deltoid retraction hook (Innomed, Savannah, GA, USA) is inserted underneath the deltoid muscle allowing for excellent exposure of the fracture line between the shaft and the head and also at the greater tuberosity (**Fig. 2b**). Since the tuberosities are usually attached to the rotator cuff, this can be utilized for later reduction. Full exposure is best achieved with the arm in abduction in order to decrease the tension of the deltoid muscle. FiberWire No. 5 (Arthrex, Naples, FL, USA) can be used as a suture cerclage and is inserted at the tendinous-osseous junction of the posterior rotator cuff (**Fig. 2c**). Usually one suture is inserted in the infraspinatus and a second one is inserted more distally in the teres minor tendon. Both sutures are used primarily to help in the reduction process of the fracture and secondarily to neutralize the posteromedial pull of the posterior rotator cuff.

To secure the anatomical reduction, K-wires are inserted percutaneously from distal to proximal into the humeral shaft and are advanced under image-intensifier guidance until the tip of the K-wire reaches the fracture line between the head and the shaft (**Fig. 2d**). In valgus displaced fractures, a tappet is inserted into the humeral head via the fracture line between the greater tuberosity and the intertubercular groove. Under image-intensifier guidance, the humeral head is elevated out of the valgus position, thereby restoring the medial integrity of the calcar. Once an anatomical reduction is achieved, the K-wires are advanced until they reach the subchondral bone plate, therefore retaining the humeral head in position (**Fig. 2e**).

The next step includes the anatomical reduction and fixation of the greater tuberosity. In cases of impacted fractures, there is usually a loss of bone substance at the lateral aspect of the humeral head, making an anatomical reduction of the greater tuberosity difficult (**Fig. 2f**). In order to address this problem allografts are shaped and impacted into the fracture site (**Fig. 2g**). The use of allografts pro-

vides additional stability to the humeral head and the greater tuberosity.

For reduction and securing of the lesser tuberosity, an additional suture cerclage is inserted at the tendinous-osseous junction of the subscapularis muscle (**Fig. 2h**). Once an anatomical position is achieved with the help of the FiberWire sutures (Arthrex, Naples, FL, USA) of the anterior and posterior cuff, the cerclage is tensioned and knotted together, so that the fracture gap between the greater and lesser tuberosity is closed (**Fig. 2i**).

Locking plate osteosynthesis

In the case presented here, an angular stable plate with a proximal humerus interlocking system (DePuy Synthes, Switzerland) was used (**Fig. 2j**). In order to avoid a subacromial plate impingement, the position of the plate is controlled in the true AP view (**Fig. 2k**). Once the correct position is achieved, the plate is temporarily fixed with two 1.6-mm K-wires proximally and distally and the position of the plate is re-evaluated in the axillary view. Before the locking screws are inserted, the plate is temporarily fixed to the proximal humerus using a standard 3.5-mm cortical screw that is inserted into the center of the long proximal shaft hole of the plate (**Fig. 2l, m**). Once the screw is inserted, the two 1.6-mm K-wires can be removed.

The locking screws are inserted from proximal to distal. This can be performed either using the aiming device that is attached to the plate or by using drill sleeves that are directly inserted into the holes of the angular stable plate (**Fig. 2n**).

Two bicortical locking screws are inserted in the two most inferior plate holes for distal plate fixation. If medial support is required, one or two calcar screws are used that provide additional stability to the humeral head. Finally, the most proximal locking screw is inserted into the shaft and the cortical screw can be removed (**Fig. 2o**). The K-Wires are then retrieved, and the final construct is evaluated clinically and under image-intensifier guidance (**Fig. 1b**).

Before wound closure, proper irrigation is performed, and the rotator interval is closed. The incision is closed in a standard fashion. For immobilization, the arm is placed in a neutral rotational brace. Range-of-motion exercises are usually initiated at day two after surgery.

Discussion

Proximal humeral fractures are common in the aging society and surgical treatment can be challenging. Owing to the variety and complexity of these fractures, the complication rate is high. In particular, loss of reduction and penetration of the proximal screws is a frequent complication reported in the literature [5]. Most of the complications are observed during the first weeks after surgery when the patients start active range-of-motion exercises. However, also nonunion, pseudarthrosis, or humeral head necrosis must be monitored and are a common reason for revision surgery [6]. Several aspects must be considered in order to achieve a clinically and radiologically satisfying result for the patient also in the long term. Allograft augmentation and use of a suture cerclage can be helpful, especially in comminuted fractures. Anatomical reduction with restoration of the medial calcar is important for vascularization and in order to prevent a secondary dislocation.

Our technique allows for anatomical reduction and high primary stability in the treatment of proximal humeral fractures, facilitating an early active and passive range-of-motion rehabilitation process and might decrease the number of complications that have been reported using angular stable plates.

Corresponding address

Prof. Dr. med. Markus Scheibel
Department of Shoulder and Elbow Surgery, Center for Musculoskeletal Surgery, Charité-Universitätsmedizin Berlin
Augustenburger Platz 1, 13353 Berlin, Germany
markus.scheibel@charite.de

Compliance with ethical guidelines

Conflict of interest M. Minkus has not received any financial payments or other benefits from any commercial entity related to the subject of this article. M. Scheibel received consultant payments from Arthrex Company related to this work.

For this article no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case. For images or other information within the manuscript which identify patients, consent was obtained from them and/or their legal guardians.

References

1. Kannus P, Palvanen M, Niemi S, Sievanen H, Parkkari J (2009) Rate of proximal humeral fractures in older Finnish women between 1970 and 2007. Bone 44(4):656–659
2. Hodgson S (2006) Proximal humerus fracture rehabilitation. Clin Orthop Relat Res 442:131–138
3. Iyengar JJ, Devcic Z, Sproul RC, Feeley BT (2011) Nonoperative treatment of proximal humerus fractures: a systematic review. J Orthop Trauma 25(10):612–617
4. Laux CJ, Grubhofer F, Werner CML, Simmen HP, Osterhoff G (2017) Current concepts in locking plate fixation of proximal humerus fractures. J Orthop Surg Res 12(1):137
5. Thanasas C, Kontakis G, Angoules A, Limb D, Giannoudis P (2009) Treatment of proximal humerus fractures with locking plates: a systematic review. J Shoulder Elb Surg / Am Shoulder Elb Surg [et Al] 18(6):837–844
6. Clavert P, Adam P, Bevort A, Bonnomet F, Kempf JF (2010) Pitfalls and complications with locking plate for proximal humerus fracture. J Shoulder Elb Surg / Am Shoulder Elb Surg [et Al] 19(4):489–494