6.1.8 Intraarticular impacted proximal humeral fracture with displacement—11-C2

1 Case description

75-year-old very active woman, fell on the stairs in her house. Lived alone before the accident, did all housework and gardening by herself. Unstable painful fracture of her left proximal humerus, nondominant arm. 11–C2.1 fracture with valgus impaction of the articular segment, posterior—superior dislocation of the greater tuberosity, an additional fracture of the lesser tuberosity with multiple fragments, and a medial displacement of the humeral shaft. Marked osteoporosis.

Fig 6.1.8-1a–e
a AP view.
b Axial view.
c CT scan in frontal plane.
d–e CT scan in sagittal plane showing comminution and dislocation of the greater tuberosity.
6.1 Humerus, proximal

**Indication**

Unstable intraarticular proximal humeral fracture with valgus impaction of the articular segment, posterior and superior displacement of the multiple fractured greater tuberosity, medial displacement of the shaft, marked osteoporosis, severe pain, no additional nerve lesion or vascular damage.

Conservative treatment is not a good option in this case due to marked displacement. It would only be considered if operative treatment would appear too risky due to comorbidity in a low demand patient. Closed reduction and percutaneous pinning with additional screw fixation is possible but, due to the multiply fractured greater tuberosity and additional osteoporosis, percutaneous screw fixation may provide insufficient stability and could lead to secondary displacement. Due to displacement of the shaft, closed and percutaneous pinning reduction may be difficult. An additional immobilization for 3–4 weeks as well as a second operation for pin removal would be necessary. Considering this and the patients request for early independence, careful open reduction under visual control and internal fixation with locking proximal humeral plate and additional tension banding is chosen. This offers the advantage of open reduction and preservation of the periosteal bridges to the fracture fragments and a stable fixation with early functional rehabilitation. Quick pain relief is achieved.

**Preoperative planning**

**Equipment**

- Locking proximal humeral plate (LPHP), 5 holes (alternatively: 8 holes)
- 3.5 mm self-tapping locking head screws (LHS)
- 3.5 mm cortex screw
- 1.8 mm K-wires
- Nonabsorbable sutures

(Size of system, instruments, and implants can vary according to anatomy.)

**Patient preparation and positioning**

General anesthesia is recommended, alternatively a scalene block can be used.

*Fig 6.1.8-2* Patient is placed in beach chair position. The arm is freedraped for intraoperative mobility. An image intensifier is helpful.
2 Surgical approach

Fig 6.1.8-3a–c
a–b Deltopectoral approach. Perform a 12 cm incision from the coracoid process to the deltoid insertion, split the deltoid and the pectoralis major. Use the cephalic vein as a landmark and leave the cephalic vein with the deltoid to the lateral side. Cautious blunt preparation of the subdeltoid space with the fingers.

c Identify the tendon of the long head of the biceps brachii muscles and anchor strong nonabsorbable sutures through the supraspinatus, infraspinatus, and subscapularis tendon at the tendon-bone interface. These sutures allow gentle manipulation of the humeral head fragments. Fracture lines should be identified but not completely exposed.

3 Reduction

Fig 6.1.8-4 Reduce the humeral head fragments by gently pulling the sutures anchored in the supraspinatus, infraspinatus, and subscapularis tendon. Reduce the articular segment by using a small elevator. In unstable situations temporary pinning may be advisable.
3 Reduction (cont)

**Fig 6.1.8-5a–b** Reduce the shaft approximately by an indirect reduction maneuver.

- a Pull and rotate the distal part of the humerus.
- b Control of the reduced fragments.

4 Fixation

**Fig 6.1.8-6** Adapt the 5-hole locking proximal humeral plate (LPHP) to the proximal part of the humerus and fix it temporarily with 1.8 mm K-wires through the suture holes. Place the upper end of the plate 5–7 mm below the tip of the greater tuberosity and about 5 mm posterior to the bicipital groove. Checking the correct position of the implants with the image intensifier is advisable.
4 Fixation (cont)

**Fig 6.1.8-7a–b** Insert a 3.5 mm cortex screw through the first hole below the subcapital fracture line. By tightening the screw the humeral shaft will be gently reduced towards the plate, against the medializing muscle forces of the pectoralis major muscles.

**Fig 6.1.8-8a–b** Insert the threaded drill guide into the two proximal parallel locking holes and use the 2.8 mm drill bit for the preparation of the holes. Do not perforate the articular surface. Lasermarks and a plastic ring on the drill bit facilitate direct reading of the drilled depth.
4 Fixation (cont)

Fig 6.1.8-9a–c

a Insert two 3.5 mm self-tapping locking head screws (LHS) into the upper holes using the torque-limiting attachment to the screwdriver. Check ideal length of these locking head screws by image intensifier in order not to penetrate the articular surface (leave about 3 mm between the tip of the screw and the articular surface).

b Insert the threaded LCP drill guide into the holes at the humeral shaft. Use a 2.8 mm drill bit and, after measurement of the length, insert a bicortical 3.5 mm self-tapping LHS into each hole using the torque-limiting attachment on the screwdriver. Notice that a minimum of two bicortical 3.5 mm self-tapping LHS should be placed in the shaft fragment. The hole at the end of the plate may be equipped with a monocortical 3.5 mm, self-drilling, self-tapping LHS.

c Insert the threaded LCP drill guide into the remaining three divergent drill holes in the proximal part of the plate using the guiding block. After drilling, insert 3.5 mm self-tapping LHS using the torque-limiting attachment on the screwdriver in each of these holes. Check all screw lengths carefully with the image intensifier.
4 Fixation (cont)

Fig 6.1.8-10 Fix the anchored sutures through the suture holes in the plate and tie them tightly to neutralize the muscle forces of the rotator cuff.

Fig 6.1.8-11a–c
a  Check shoulder mobility and fracture stability by passive motion. Perform wound closure after irrigation and drainage.
b–c  Postoperative x-rays show good reduction and positioning of the implant.

5 Rehabilitation

Fig 6.1.8-12a–c  X-rays at one year follow-up show complete healing of the fracture without signs of avascular necrosis. One screw seems to penetrate the articular surface without causing any clinical symptoms.
6.1 Humerus, proximal

5 Rehabilitation (cont)

Fig 6.1.8-13a–d
Satisfactory functional result at one year follow-up. The patient is free of pain and without restriction in everyday activities.

6 Pitfalls –

Approach
Too extensive exposure of the fracture fragments may damage vascularity and lead to a high rate of avascular necrosis.

Reduction
Brisk reduction maneuvers with reduction forceps may damage blood supply and any residual intact periosteum on the fragments. Incorrect positioning of the plate may lead to subacromial impingement and restricted range of motion.

Fixation
Incorrect length of the LHS leads to perforation of the articular surface of the humeral head. 3.5 mm cortex screws may lead to reduced stability in osteoporotic bone and premature loosening. Lack of sufficient medial buttress without adjustment of the rehabilitation protocol may lead to implant failure.

7 Pearls +

Approach
Open procedure without extensive exposure of the fracture lines may help to preserve the blood supply of the segments. Alternative: small anterolateral splitting of the deltoid muscle.

Reduction
Indirect reduction maneuvers help to preserve blood supply and residual periosteum in this open procedure. Optimal positioning of the anatomically preshaped plate, controlled by image intensification, prevents hardware impingement and enables unrestricted range of motion.

Fixation
Optimal length, especially of the LHS, avoids perforation of the articular surface. LHS, in combination with 3-D orientation, lead to improved stability even in osteoporotic bone, but exact locking remains essential. Reconstruction of the medial buttress leads to sufficient stability for early functional rehabilitation.

Fig 6.1.8-14 In the case of a homogeneous fragment of the lesser tuberosity, the suture through the subscapularis tendon may be replaced by a 3.5 mm cortex screw from the lesser tuberosity to the humeral shaft.