

Internal fixation of proximal humeral fractures with a locking compression plate

A retrospective evaluation of 72 patients followed for a minimum of 1 year

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Background Proximal humeral fractures, particularly in osteoporotic patients, remain an unsolved problem as regards the durability of the osteosynthesis. The AO/ASIF group has developed a new technique which aims to preserve the biological integrity of the humeral head and secures the reduction using multiple locking screws with angular stability (Philos), thus allowing an early mobilization.

Patients and outcome We retrospectively reviewed the complications and functional outcome after a minimum follow-up of 1 year in 72 patients treated with this new method. 2 fractures failed to unite, and 3 patients developed an avascular necrosis of the humeral head. In addition, 2 implant failures were observed due to a technical error. According to the Constant score, the functional outcome was acceptable even in elderly patients.

Interpretation The Philos method appears to be safe and can be recommended for the treatment of proximal humeral fractures in patients with poor bone quality.

controversial, since many of them are liable to a failure of osteosynthesis, avascular necrosis of the humeral head, and also a nonunion or malunion of the fracture, which may all result in a painful shoulder with poor function (Paavolainen et al. 1983, Wijnman et al. 2002). Moreover, prosthetic replacement of the humeral head in fractures has also yielded unsatisfactory results with regard to function (Movin et al. 1998). In order to avoid the common problems associated with this fracture, the AO-ASIF has recently developed a new technique (Philo) which aims to preserve the biological integrity of the humeral head and to secure an anatomical reduction using multiple screws with angular stability (Frigg 2003).

We performed a retrospective evaluation of outcome in 72 patients who were operated using this new locking compression plate method.

Patients and methods

The incidence of proximal humeral fractures is increasing, probably due to the ageing society and the associated increase in the incidence of osteoporosis (Kannus et al. 2000). About 80% of fractures of the proximal part of the humerus are only slightly displaced and yield a good functional result when treated nonoperatively (Iannotti et al. 2003), but other types of fracture are a therapeutic challenge and have variable prognosis. The optimal treatment of these fractures is still

72 patients (44 women) with an acute fracture of the proximal humerus were treated with the locking compression plate (Philos) at our department between February 2002 and January 2003. The mean age of the patients was 67 (27–89) years. All fractures met the indications for operative treatment outlined by Neer (1970), i.e. an angulation of the articular surface of more than 45°, a displacement between the major fracture segments of more than 1 cm, or a fracture with valgus impaction. Patients

Table 1. Classifications according to Neer and AO/ASIF of the proximal humeral fractures in a series of 72 patients treated with a locking plate (Philos)

Neer	n	AO/ASIF	n	Subtotal	
2-part	38	Type A	2.2	5	38
			3.1	9	
			3.2	22	
			3.3	2	
3-part	22	Type B	1.3	5	22
			2.1	6	
			2.2	11	
4-part	12	Type C	2.3	4	12
			3.2	8	
Total	72			72	

with multiple injuries and those with a pathological fracture were excluded from the study.

Using plain radiographs, all fractures were classified according to Neer (1970) and AO (Müller et al. 1990) by one author (J-MB) in order to exclude inter-observer error (Table 1). CT scan was used only in selected cases in order to estimate the extent of articular surface involvement and the amount of tuberosity displacement in comminuted fractures.

Operative technique

The patients were operated within 3 days of injury. All patients received a prophylactic dose of 1.5 g Cefuroxime intravenously preoperatively. We used a modified lateral delto-pectoral approach, with the patient in a beach-chair position. The fragments were indirectly reduced with the help of traction sutures, which were placed in the insertions of rotator cuff tendons, and by extremity rotation. When acceptable reduction was obtained, the Philos plate was placed at least 1 cm distal to the upper end of the greater tubercle and fixed to the humeral shaft with conventional cortical screws. An aiming device was then attached to the upper part of the plate, and the head fragments were secured with Kirschner wires after image intensifier control. The required lengths of the locking head screws were determined with a direct measuring device over the Kirschner wire, and 6–9 locking screws were then inserted using a specially designed hexagonal screwdriver with a predeter-

mined torque of 1.5 Nm. The arm was placed in a sling after wound closure. Passive elevation and rotation exercises were started on the 2nd or 3rd postoperative day. Active range-of-motion exercises with terminal stretching of the capsule were started at 4–6 weeks. Resistive strengthening was begun when fracture union was ensured.

Scheduled follow-up controls were performed at 6 weeks and at 3, 6 and 2 months, including a measure of the active and passive range-of-motion and strength of the involved shoulder. The functional outcome was assessed according to the scoring of Constant (Constant and Murley 1987) and Neer (1970). The Constant score was graded as poor (0–55 points), moderate (56–70), good (71–85), or excellent (86–100).

Standard anteroposterior scapular, lateral scapular and axillary radiographs were obtained and evaluated for bony healing or signs of malunion, nonunion or avascular necrosis.

Results

No deep wound infections, nerve injuries or vascular injuries were observed. Of the 72 fractures, 48 healed uneventfully in a good anatomical position (Figure 1), and 19 healed in a slight varus position (Figure 2). 2 fractures failed to unite and were reoperated. Avascular necrosis was observed in 3 fractures, all being of AO/ASIF type C. Moreover, 2 patients had to be reoperated due to a loss of fixation at the humeral shaft. A technical error was identified in these cases, in that the drill holes in the shaft had been made with a drill bit that was too large. These fractures finally united in a good position, however, after refixation of the plate to the shaft, since no real redislocation occurred in the fracture.

At the final control, 4 of the patients had an excellent functional outcome, 32 patients had a good score, 31 patients a moderate score, and 5 patients had a poor outcome according to the Constant score (Tables 2 and 3).

There was no subacromial impingement due to a due to a plate that was too prone, or a displaced tuberculum majus fragment. Of the 23 patients who had been working before the injury, 18 of them returned to their previous occupation.

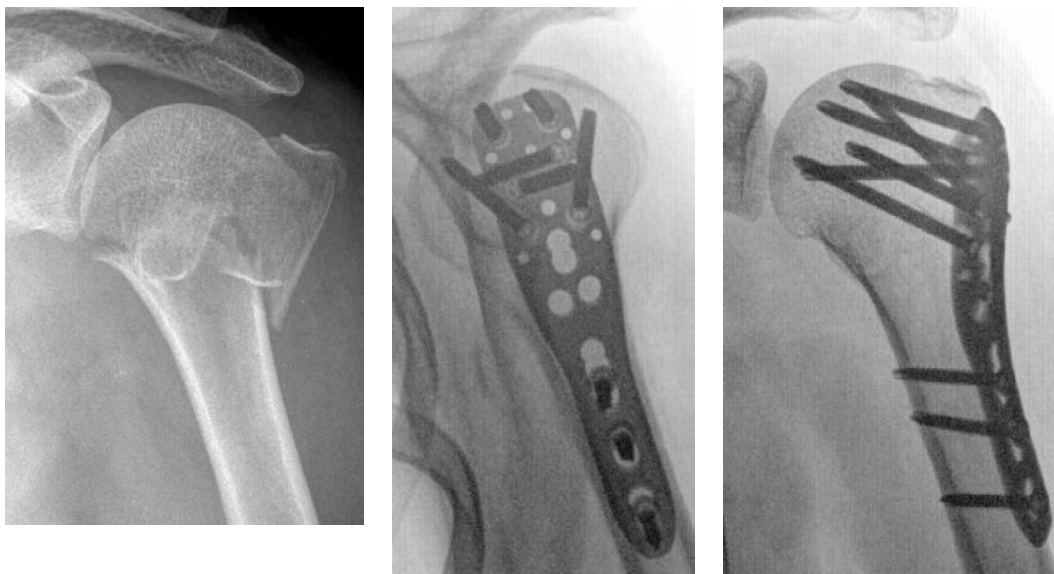


Figure 1. A four-part fracture treated with a Philos plate. Note the multiple-angle screw fixation and the solid bony union in an anatomical position at 12 months, with no signs of avascular necrosis.

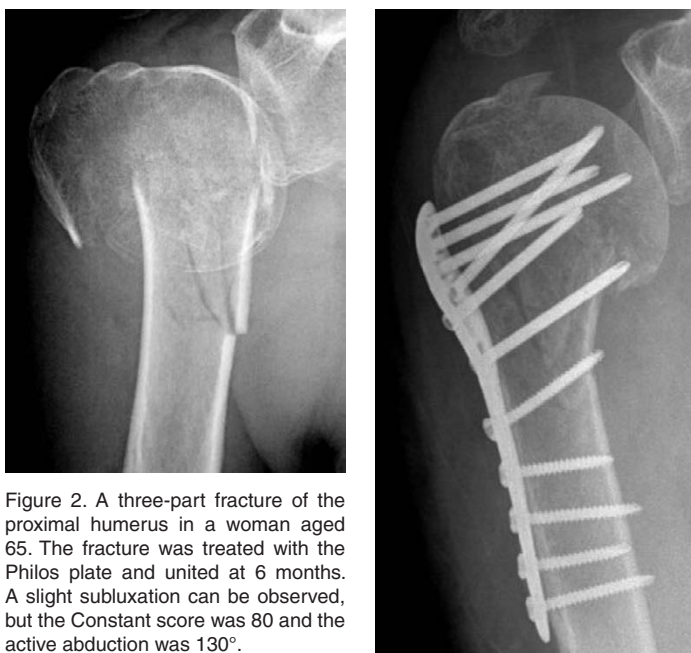


Figure 2. A three-part fracture of the proximal humerus in a woman aged 65. The fracture was treated with the Philos plate and united at 6 months. A slight subluxation can be observed, but the Constant score was 80 and the active abduction was 130°.

According to self-reporting, all patients were able to return to the same level of activity that they had had [sic] before the injury. In addition, none of the patients lost their independence in daily living due to the fracture.

Discussion

Some authors have reported excellent results after conventional plate osteosynthesis of proximal humeral fractures (Wanner et al. 2003). This method has also been associated with a high complication rate, however, particularly in elderly patients with comminuted fractures (Cofield 1988). The technique often requires an extensive soft tissue stripping, which may compromise the vascular supply to the humeral head. On the other hand, less invasive methods such as closed reduction and percutaneous pinning require advanced skills and good bone quality, minimal fracture comminution and a cooperative patient (Herscovici et al. 2000). In the elderly population with osteoporosis, this method has also yielded poor outcome (Cordasco and Bigliani 1997). In order to obtain better and reproducible results, the AO-ASIF has developed a special locking compression plate (Philos) for fractures of the proximal

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Table 2. Functional outcome in the different fracture types, presented as mean and range of the Constant score at 3, 6 and 12-month follow-up

Follow-up	Constant score according to fracture type			
	All n=72	2-part n=38	3-part n=22	4-part n=12
3 months	57 (30–82)	76 (68–82)	55 (40–72)	42 (30–55)
6 months	72 (30–93)	80 (76–93)	71 (54–84)	51 (30–63)
12 months	77 (30–93)	84 (79–93)	78 (70–90)	60 (30–72)

Table 3. Functional outcome in the different age classes, presented as mean of the Constant score at 3, 6 and 12-month follow-up

Follow-up	Constant score according to age class				
	<50 n=7	51–60 n=16	61–70 n=14	71–80 n=25	>80 years n=10
3 months	75 (62–80)	70 (51–78)	60 (38–75)	40 (30–48)	42 (30–50)
6 months	80 (71–93)	78 (62–84)	75 (46–86)	67 (46–74)	54 (30–58)
12 months	85 (78–93)	83 (77–90)	72 (54–86)	66 (46–74)	59 (30–63)

humerus (Frigg 2003, Ring and Jupiter 2003). According to our own findings, the main advantage of the new plate is apparent in elderly patients, since we had no failures of the internal fixation in this particular group, and they could attain an activity level that was sufficient to satisfy their needs regarding independent daily living. As can be seen from Figure 3, the plate can even withstand a new fall, which in the case in question caused a fracture of the humeral diaphysis a few weeks after osteosynthesis of a proximal fracture.

Patients with good bone quality have previously been treated successfully with the conventional plate osteosynthesis (Wijgman et al. 2002). The outcome for the younger patients in our study is comparable to that seen in previous studies (Ko and Yamamoto 1996), and suggests that the Philos plate has no additional advantages in this group. However, the conventional plate osteosynthesis has



Figure 3. A two-part fracture in an 86-year-old woman. Note the bone healing and the stable fixation. A new fracture of the humeral shaft occurred after a new fall 2 weeks after the first fracture. 1 year after surgery.

been associated with frequent hardware impingement (Cordasco and Bigliani 1997). We have not observed any such symptoms in our patients, but our follow-up may be too short to allow a reliable analysis regarding this complication.

The functional outcome was better in the 2 or 3-fragment fracture group than in patients with 4-part fractures in our series (Table 2). Also, as expected, the mean Constant score declined with increasing age (Table 3). The number of complications did not differ between the groups, however, and the difference was mostly explained by the lower strength and a more limited range-of-motion in the elderly population. The subjective outcome was not often influenced by this fact, since the level of expectation was also lower for the elderly patients.

Although the follow-up time in our study was relatively short and it was not a randomized controlled study, the results demonstrate several benefits of the Philos plate. Most importantly, it is easy to use, it is biological in the sense that the blood circulation to the humeral head is not compromised, the plate does not need to be configured and the angular screw fixation ensures a fixed-angle stabilization. Moreover, complications associated with the plate were few, and the functional outcome was comparable with earlier studies. Thus, many of the common complications of the conventional plating can possibly be avoided. Although the Philos implant is expensive, the number of second or more occasions of surgery is minimal. We therefore recommend the use of the Philos plate, especially in elderly patients with osteoporotic bone. Randomized studies will of course be needed in the future to validate the possible advantages associated with this new method.

No competing interests declared.

- Cofield R H. Comminuted fractures of the proximal humerus. *Clin Orthop* 1988; (230): 49-57.
- Constant C R, Murphy A H. A clinical method of functional assessment of the shoulder. *Clin Orthop* 1987; (214): 160-4.
- Cordasco F A, Bigliani L U. Complications of proximal humerus fractures. *Tech Orthop* 1997; 12: -50.
- Frigg R. Development of the locking compression plate. *Injury (Suppl 2)*: 2003; 34: 6-10.
- Herscovici D Jr, Saunders DT, Johnson MP, Sanders R, DiPasquale T. Percutaneous fixation of proximal humeral fractures. *Clin Orthop* 2000; (375): 97-104.
- Iannotti J P, Ramsey M L, Williams G R, Warner J P. Non-prosthetic management of proximal humeral fractures. *J Bone Joint Surg (Am)* 2003; 85: 1578-93.
- Kannus P, Palvanen M, Niemi S, Paakkari J, Järvinen M, Vuori I. Osteoporotic fractures of the proximal humerus in elderly Finnish persons: sharp increase in 1970-1998 and alarming projections for the new millennium. *Acta Orthop Scand* 2000; 71: 465-70.
- Ko J Y, Yamamoto R. Surgical treatment of complex fracture of the proximal humerus. *Clin Orthop* 1996; (327): 225-37.
- Müller M E, Nazarian S, Koch P, Schatzker J. The comprehensive classification of fractures of long bones. Springer Verlag Berlin 1990.
- Movin T, Sjöden G O J, Ahrengart L. Poor function after shoulder replacement in fracture patients. *Acta Orthop Scand* 1998; 69: 392-6.
- Neer C S II. Displaced proximal humeral fractures. Part I. Classification and evaluation. *J Bone Joint Surg (Am)* 1970; 52: 1077-89.
- Paavolainen P, Björkenheim J-M, Slätis P, Pauku P. Operative treatment of severe proximal humeral fractures. *Acta Orthop Scand* 1983; 54: 374-9.
- Ring D, Jupiter J B. Internal fixation of the humerus with locking compression plates. *Tech Shoulder and Elbow Surg* 2003; 4 (3): 169-71.
- Wanner G A, Wanner-Schmid E, Romero J, Hersche O, von Smekal A, Trentz O, Ertel W. Internal fixation of displaced proximal humeral fractures with two one-third tubular plates. *J Trauma* 2003; 54 (3): 536-44.
- Wijgman A J, Roolker W, Patt T W, Raaymakers E L, Marti R K. Open reduction and internal fixation of three and four-part fractures of the proximal part of the humerus. *J Bone Joint Surg (Am)* 2002; 84: 1919-25.