

PHILOS Plate Osteosynthesis in Metaphyseal Fractures of the Distal Humerus through an Anterolateral Approach

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Background: We described a surgical method for osteosynthesis and reported the resultant strength after application of a PHILOS plate through the anterolateral approach for the treatment of fractures of the distal humerus.

Methods: Between February 2010 and March 2012, open reduction and internal fixation operations with the PHILOS plate for treatment of fracture of the distal humerus were performed on a total of nine patients (five men, four women). The mean age was 40.8 years (range, 24–50 years), and the average follow-up period was 9.1 months (range, 6–15 months). Clinical evaluations were performed 6 months after the operation. Clinical assessment included determination of the range of motion of the elbow, the Mayo and Oxford elbow scores, and any postoperative complications.

Results: Fracture union was noted in all patients, with an average period of 12.4 weeks. The average Mayo elbow and Oxford elbow scores were 87.2 (of a total of 100) and 43.3 (of a total of 48), respectively. For the postoperative range of motion of the elbow, all patients showed complete recovery to the preoperative range of motion. No other conditions, such as neuroleptosis, plate breakage, or rotational deformity, were observed.

Conclusions: Open reduction and internal fixation of distal humerus fractures with a PHILOS plating system via anterolateral approach can be effective. A high rate of union with good outcomes can be assumed.

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Key Words: Humeral fractures; Fracture fixation

Introduction

Distal humerus fractures account for 30% of periarticular fractures of the elbow in adults, approximately 0.5% to 2.0% of the total reported incidence of fractures.¹⁾ The elbow is among the joints that are vulnerable to contracture, for which rigid fixation and quick joint movement recovery is important.²⁻⁴⁾ Thus far, various operating methods and instruments have been introduced and successful results have been reported in some cases.⁵⁻⁷⁾ The recent trend shows that treatment of transcondylar fractures through the posterior approach is associated with exact articular fixation and early joint mobility after a rigid fixation.⁸⁾ For a shaft fracture, either open reduction by the anterolateral approach or

fixation by intramedullary nailing is widely accepted as the most suitable approach. In the case of metaphyseal fractures with inadequate space for fixation to the humerus, several techniques have been reported as effective, including orthogonal plating and parallel plating. However, no optimal technique or instrument has been identified.

In general, the posterior approach is most often used for surgical treatment of fractures of the distal humerus.⁹⁻¹¹⁾ The posterior approach is associated with certain problems such as bleeding, decrease in muscular strength of the triceps, and formation of scar tissue, thereby leading to a limitation in the range of motion of the elbow.¹²⁾

We describe a useful method involving locking screw fixation

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for cases of distal humerus shaft fracture and metaphyseal fracture in which the distal fractured portion is not sufficient for use of a plate such as the locking compression plate. The PHILOS plate (Synthes, Oberdorf, Switzerland) was recently introduced and has mainly been used for fractures of the proximal humerus. However, it can also provide adequate reduction and rigid fixation in metaphyseal fractures of the distal humerus; a suitable fixation owing to the well-conformed anatomical framework between the plate and the anterior surface of the distal humerus; and adequate power for fixation with multi-directional locking screws.

In the current study, we described a surgical method for osteosynthesis and reported the resultant strength after application of a PHILOS plate through the anterolateral approach for treatment of fractures of the distal humerus.

Methods

Between February 2010 and March 2012, open reduction and internal fixation operations with the PHILOS plate for treatment of fracture of the distal humeral shaft were performed in Korea University Ansan Hospital. A total of nine patients (five men, four women) were enrolled in the current study. The mean age was 40.8 years (range, 24–50 years), and the average follow-up period was 9.1 months (range, 6–15 months). The causes of injury were misstepping in five patients, traffic accidents in three patients, and fall in one patient (Table 1).

Preoperative radiographic images of the anteroposterior, lateral, and oblique sides of the elbow were obtained for all patients. In cases where invasion of the joint was suspected, a computed tomography scan was also obtained. The fractures were classified according to the Orthopedic Trauma Association fracture and dislocation classification compendium, and its grade indicated 13-A2.1, 13-A2.2, 12-A1.3, 12-A2.3, and 12-B1.3.¹³⁾ In some cases where that the patient's general condition was poor, conservative treatment was administered. A regular plate

was used in cases where the fracture level was middle 1/3. The PHILOS plate was used in extraarticular fracture where the level was distal 1/3 of the humeral shaft.

The details of the surgical methodology were as follows: To facilitate an anterolateral approach, patients were placed on the operating table in a supine position under general anesthesia and with the forearm supinated. Using the anterolateral approach, a 7 to 10 cm longitudinal skin incision was made and fasciotomy was then performed along the lateral side of the biceps brachii muscle, which was then drawn medially by retractors. After confirming the brachialis muscle, the middle portion of the muscle was incised longitudinally. As the brachialis muscle was split between the musculocutaneous and radial nerves, it was possible to prevent muscular denervation and brachialis muscle dysfunction.⁹⁾ Therefore, the radial nerve was positioned on the lateral side of the brachialis muscle, which was naturally protected. After dissecting the brachialis muscle, the bone was exposed and adequate traction and reduction were applied. A lag screw was used in the case of an oblique fracture after the reduction of the fracture. In cases of transverse and comminuted

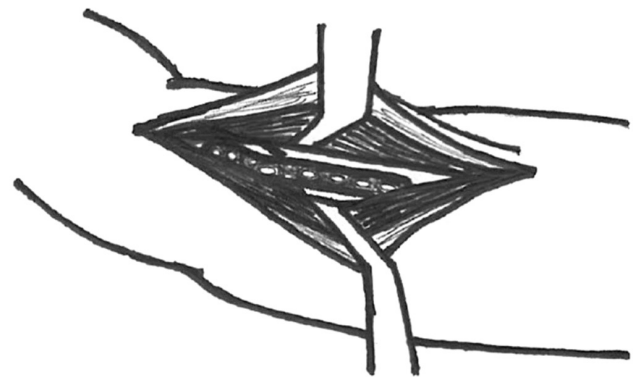


Fig. 1. The anterolateral surgical approach and PHILOS plate fixation. The distal humerus is identified by splitting the brachialis muscle in line with its fibers.

Table 1. Clinical Data for All 9 Patients

Patient No.	Sex	Age (yr)	OTA classification	Cause	Follow-up period (mo)	Time to union (wk)	Flexion contracture (°)	Further flexion (°)	Mayo elbow score	Oxford elbow score
1	Female	49	13-A2.1	Fall down	15	13	5	130	75	36
2	Male	24	13-A2.1	Traffic accident	6	10	0	140	100	48
3	Male	40	12-A2.3	Slipped down	6	11	5	130	85	43
4	Female	38	13-A2.1	Slipped down	7	11	0	135	95	46
5	Male	38	12-A2.3	Slipped down	7	12	0	135	90	41
6	Female	49	12-B1.3	Traffic accident	10	14	5	135	75	38
7	Male	49	13-A2.1	Slipped down	12	14	0	130	80	44
8	Female	50	13-A2.2	Slipped down	13	16	0	130	90	47
9	Male	30	12-A1.3	Traffic accident	6	11	0	140	95	47

fractures, the PHILOS plate was applied immediately. The plate was inserted between the brachialis fibers and positioned on the anterior surface of the distal humerus (Fig. 1). Reduction of fracture and suitability between bone and plate was checked using a C-arm system. The plate was well contoured on the anterior surface of the distal humerus. The plate length and position were also checked. Note that the plate should be positioned in the middle portion of the bone, and the distal portion of the plate should be placed above the coronoid fossa to prevent limitation of the range of motion. Thereafter, K-wire fixation was performed through a screw hole for temporary stabilization. Three locking head screws were then inserted in the proximal fragment. In the distal portion, we tried to use as many locking head screws as possible; owing to the features of this plate, a minimum of four and maximum of nine could be inserted (Fig. 2). Finally, the reduction and fixation were checked by using the C-arm, and the operation was completed after massive irrigation.

A long-arm splint was applied postoperatively. Once pain had

subsided after 2 to 3 days, gradual movement of the joint was permitted. Radiographic images of the anteroposterior, lateral, and both oblique sides were again obtained immediately after the operation for assessment of fracture reduction, plate position, and screw position (Fig. 3).

Postoperative radiological assessments were performed every four weeks to check for nonunion, malunion, or delayed union in the patients in the ambulatory state. Clinical evaluations were performed six months after the operation. Clinical assessment included determination of the range of motion of the elbow, the Mayo and Oxford elbow scores, and any postoperative complications.

Results

Fracture union was noted in all of the patients, with an average period of 12.4 weeks. The average Mayo elbow and Oxford elbow scores were 87.2 (of a total of 100) and 43.3 (of a total of

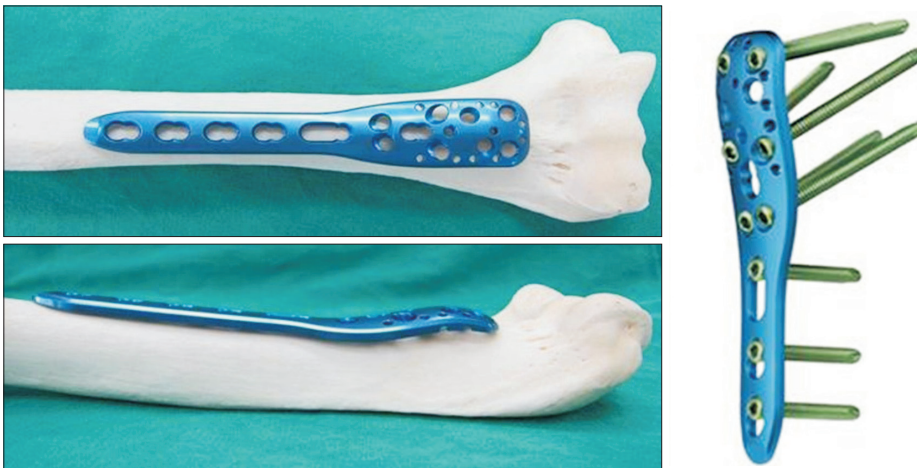


Fig. 2. Characteristics of the PHILOS plate. The PHILOS plate fits well on the anterior portion of the distal humerus. It can achieve rigid fixation by use of multidirectional locking screws.



Fig. 3. Case of a 50-year-old woman who sustained a fracture in an accident. (A) A plain radiograph indicating a spiral fracture of the distal humerus. (B) Open reduction and internal fixation was performed using a PHILOS plate and three lag screws.

48), respectively (Table 2). For the postoperative range of motion of the elbow, all patients showed complete recovery to the preoperative range of motion. No other conditions, such as neuroleptosis, plate breakage, or rotational deformity, were observed.

Case Example

In our research, we experienced an interesting case. A 63-year-old woman visited our hospital because of a distal humerus fracture after a fall. She had undergone a total elbow arthroplasty ten years ago. The previously inserted humeral stem interfered with the conventional screw insertion. Therefore, we decided to apply a PHILOS plate on this periprosthetic fracture. The PHILOS plate was placed slightly obliquely on the anterior portion of the distal humerus to avoid contact with the interamedullary stem. As characteristic of the PHILOS plate, the

fracture was stabilized firmly by multidirectional screws. Three months later, bony union was observed at the fracture site (Fig. 4). Finally, the patient showed complete recovery to the preoperative range of motion. No other complications were observed.

Discussion

In previous operations, the placement of the metal plate in the anterior direction was limited because of the need for insertion of a sufficient number of screws in the distal fracture. However, compared with previously used plates, the PHILOS plate allows for an adequate number of fixation screws, and has good anatomical conformity to the humerus. The PHILOS plate has other advantages, including the provision of multidirectional fixation and ensuring a higher degree of fixation in osteoporotic fractures.

In general, the posterior and anterolateral approach are most often used for surgical treatment of fractures of the humerus.⁹⁻¹¹ Exposure of the distal humerus and fixing the plates on both sides is easy.^{12,14} However, use of the posterior approach requires dissection of the triceps brachii in both the lateral and medial directions, which is associated with problems such as bleeding, decrease in muscular strength of the triceps, and formation of scar tissue, thereby leading to limitation in the range of motion of the elbow.¹²

To overcome the above mentioned disadvantages, we presented an alternative surgical method that facilitates the easy exposure of the fractured site through an anterolateral approach and involves placement of a plate in an anterior position for

Table 2. Summary of Cases

Variable	Value
Mean duration for bone union (wk)	12.4
Mayo elbow performance score	
Excellent (90–100)	5
Good (75–89)	4
Fair (60–74)	0
Poor (<60)	0
Mean Oxford elbow score	43.3
Mean postoperative range of motion (°)	132.2

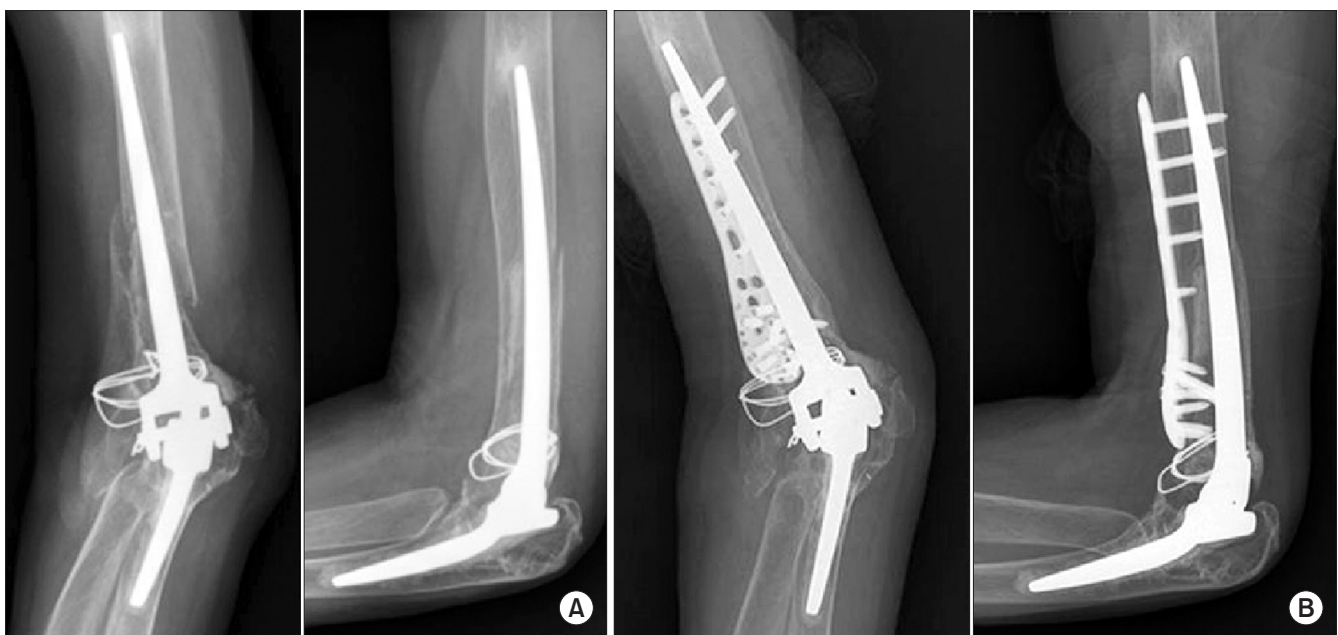


Fig. 4. Case of a 63-year-old woman who sustained a fracture after a fall. (A) Plain radiograph indicating a spiral fracture of the distal humerus and intramedullary stem. (B) Open reduction and internal fixation was performed using a PHILOS plate. The plate provided rigid fixation and good bony union.

fixation in the distal region. Unnecessary dissection and traction of the radial nerve could be avoided while exposing the lateral condyle to create space for screw insertion.

The approaches and instrumentations for treatment of humerus fractures are diverse and depend on the fracture type, involved region, inclusion or exclusion of the fracture surface, and nerve injury. For shaft fractures, open reduction through the conventional anterolateral approach or plate fixation is widely used. The fixation method involving intramedullary nailing is also a widely accepted method. There appears to be no significant difference between intramedullary nailing and plating in terms of the functional outcome and the rate of union of the fracture.^{15,16} However, anterograde intramedullary nailing is not adequate for treatment of distal humeral shaft fracture. In addition, retrograde intramedullary nailing can cause an insertion site fracture and radial nerve palsy.¹⁷

The disadvantage of this method is that it cannot be used if the fracture site is <2 to 3 cm from the coronoid fossa, because the plate tip should be located above the coronoid fossa to prevent limitation of elbow motion. And, in the current retrospective study, only the feasibility of the surgical technique was assessed and a control group was not used in the analysis. In addition, our study included only a short period of follow-up and a small number of patients.

Conclusion

Open reduction and internal fixation of distal humerus fractures with a PHILOS plating system via anterolateral approach can be effective. A high rate of union with good outcomes can be assumed.

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