Percutaneous fixation of segmental fractures of the humerus

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Objective

To present our experience of treatment of patients with diaphyseal segmental fractures of the humerus using minimal access surgery and a standard low-contact dynamic compression plate.

Patients and methods

Twenty four patients (18 men and six women), average age 29.8 years (range 17–46 years), presented with a closed segmental diaphyseal fracture of the humerus without neurological deficit and were operated upon by minimal access and percutaneous fixation to preserve the soft tissue and the fracture hematoma.

Results

Twenty three fractures united, and all patients had good range of motion in the adjacent joints. Axial and rotational malalignment did not exceed 15° and did not affect limb function. In one patient, there was delayed union at the distal level of fracture by the end of the third month and bone grafting was performed without revision of fixation.

Conclusion

Percutaneous fixation of segmental fractures of the humeral shaft is an alternative to standard open surgery and intramedullary fixation, reducing surgical impact and yielding an excellent functional result.

Keywords:

percutaneous fixation, segmental humeral fractures, intramedullary fixation

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Introduction

Segmental humeral fractures, usually associated with high-energy trauma, have been characterized by significant soft tissue disruption and a high level of instability at the fracture site. Conservative treatment usually results in nonunion at one level of the fracture because of compromised biology and difficulty in achieving and maintaining alignment and stability at two levels of the fracture [1].

There is no consensus in the literature on the best treatment for segmental humeral factures. Surgical stabilization techniques have been described including intramedullary nailing [2–6], open reduction and internal fixation [5,7–9], or external fixator [8].

Intramedullary nailing had an obvious advantage over the plate [2,3,5], but led to a significant complication rate [3,5,6,10]. Also, open reduction and plate osteosynthesis require extensive soft tissue exposure and periosteal stripping, thus disturbing the already compromised and critical vascularity of the separated segment of the diaphysis [2,3,5,6,9].

Minimal access surgery as an alternative to standard open reduction and internal fixation has increasingly been used in the treatment of comminuted diaphyseal fractures [9,11]. The advantage of this technique is minimization of surgical trauma to the soft tissue and bone and reduction of blood transfusions necessary during the procedure [9,11–14].

The aim of this study was to present our experience with the use of percutaneous plate fixation in segmental fractures of the humerus.

Patients and methods

Between the years of 2007 and 2010, 24 patients (18 men and six women) were treated. Their average age was 29.8 years (range 17–46 years; Table 1). All patients had closed segmental fractures of humerus without neurological deficit. The principle of minimal access surgery and biological fixation that maximally preserved soft tissue and fracture hematoma was used. Fifteen patients were involved in road traffic accidents, eight falls from a height, and one slipped while walking. All patients were followed up to monitor clinical and radiological progress until union.

Surgical technique

The fracture was reduced under an image intensifier using manipulation or a femoral distractor. The bone was accessed from a small distal anterior midline incision about 2 cm long, and the long plate was gently passed into the sub-brachialis space; then, another small proximal incision was performed at the upper end of the plate (Fig. 1). All attempts were made to align the

Table 1 Patient characteristics, time of union, and range of motion

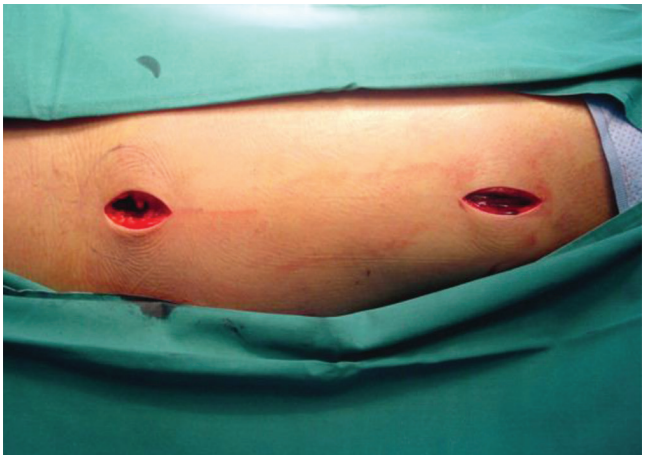
Case number	Age (years)	Sex	Union time (weeks)	Shoulder range of motion	Elbow range of motion (flexion/extension/ hyperextension) (deg.)
1	34	F	15	Full	130/0/0
2	25	M	13	Full	130/0/15
3	29	M	13	Full	130/10/0
4	27	M	16	Full	130/0/0
5	46	M	20	Full	130/0/0
6	40	M	12	Full	120/10/0
7	17	M	14	Full	115/10/0
8	24	F	13	Full	120/0/0
9	43	M	14	Full	120/0/0
10	27	M	15	Full	115/10/0
11	22	F	12	Full	120/0/0
12	27	M	14	Full	115/5/0
13	34	F	15	Full	130/0/0
14	25	M	13	Full	130/0/15
15	29	M	13	Full	130/10/0
16	27	M	16	Full	130/0/0
17	46	M	16	Full	130/0/0
18	40	M	12	Full	120/10/0
19	17	F	13	Full	120/0/0
20	24	M	14	Full	115/10/0
21	27	M	14	Full	120/0/0
22	43	F	15	Full	115/10/0
23	21	M	12	Full	120/0/0
24	28	M	14	Full	115/10/0

diaphyseal segment with proximal and distal fragments and achieve contact between fragments even if perfect alignment could not be restored. Two or three cortical screws were used to fix the plate at each side according to the local situation. No attempts were made to fix the diaphyseal segment with screws. In all cases except two, where a broad standard dynamic compression plate was used, a standard broad low-contact dynamic plate was the method of choice. The wound was closed and a simple dressing was applied. In case number 6, the fixation was reinforced by two additional screws from the same proximal incision 2 days after the first operation because of shattering of the cortex in one of the proximal screws, which was observed after surgery. Gentle mobilization of both the shoulder and the elbow joints was encouraged. The average surgical time was 75 min. All patients were followed up at 3-week intervals and when callus appeared, more active exercises were started. Alignment and range of movement of the shoulder and the elbow were assessed at the final examination. In most cases, a humeral Sarmiento brace or a plaster of Paris slab was applied postoperatively.

Results

Twenty three cases united within 12–16 weeks. One case (4.16%) went on to delayed – union at the distal

Figure 1



Surgical approach with proximal and distal incision on the anterior aspect of the upper arm.

level of the fracture by the end of the third month and bone grafting from the iliac crest was performed without revision of fixation and united by 5 months. All patients had a good range of motion in the adjacent joints (Table 1). Axial and rotational malalignment did not exceed 15°. Radiographs of two cases are presented in Figs 2 and 3, where initial, early postoperative, and final radiograph show healing and callus formation.

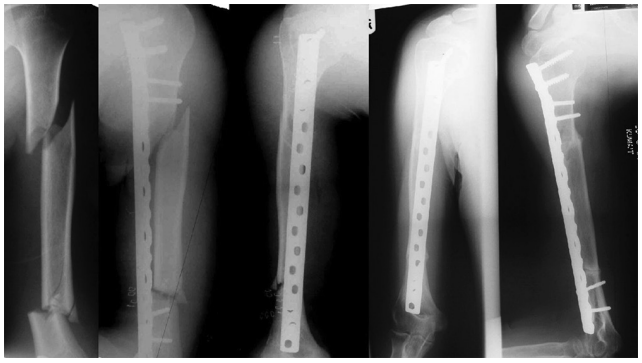
Discussion

Treatment of segmental humeral fractures remains a subject of debate. Balfour *et al*. and Sarmiento *et al*. reported that when uncomplicated diaphyseal fractures are treated conservatively, successful healing occurs in 95–98% of cases [15,16]. However, in nonoperative treatment of segmental humeral fractures, the rate of nonunion was 27.2% [1]. Although there are several methods of operative intervention for segmental humeral fractures, the internal fixation method can be grouped broadly as plating or intramedullary techniques.

Intramedullary fixation in segmental humeral fractures offers the advantages of biomechanical load-sharing, a closed insertion technique, decreased soft tissue disruption, and preservation of the extramedullary blood supply [2,3,5]. However, this method has been implicated in the development of shoulder and elbow dysfunction, delayed union, and radial nerve palsy [3,5,6,10].

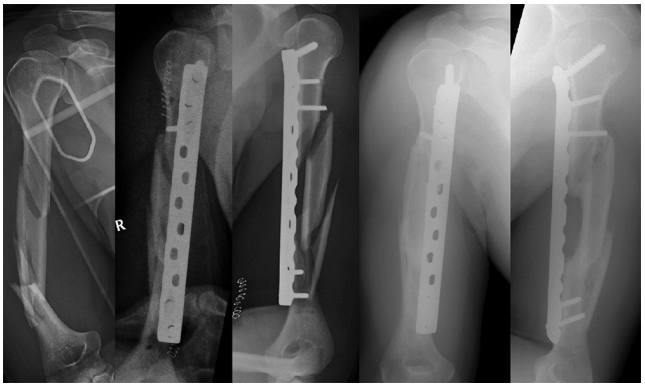
Chen and colleagues reported that conventional plating techniques allow early active mobilization of the shoulder and elbow, but may require extensive soft tissue exposure and periosteal stripping, thus disturbing

Figure 2



Preoperative, postoperative, and final radiographs show a united segmental fracture humerus at 3 months.

Figure 3



Preoperative, postoperative, and final radiographs show a united segmental fracture humerus at 4 months.

the local biological substrate of the fracture with a risk of infection, nonunion, and radial nerve palsy in the treatment of segmental humeral fractures [2,3,5,6,9].

In the last decade, minimal access surgery has been introduced in many surgical specialties. In orthopedic trauma, biological plating is gradually finding its place in the armamentarium of the trauma surgeon [17]. Minimally invasive plate osteosynthesis has been introduced to minimize dissection of broken bone fragments, thereby preserving vascularity and healing potential [18]. Biological plating is in common use for the fixation of comminuted diaphyseal fractures of the femur and tibia [19,20]. In the fractures of the humeral shaft, percutaneous plating is less popular because of the risk of injury to the neurovascular structure and the radial nerve in particular. Anatomical studies and dissections show that the anterior surface of the humeral shaft and anterior approach is safest for the passage of the plate without a risk of damage or need for visualization of neurovascular structures [9,21,22]. The anterior approach to the humeral shaft has been reported in many studies [23,24]. The length of the implant is related directly to its stability [25,26]; therefore the longer the plate, the more stable the fixation. As bending stresses are distributed over a long segment of the plate, the stress per unit is correspondingly low, which reduces the risk of plate failure.

In our study, in most cases, only two or three screws were used proximally and distally, and there was not a single case of metal failure or loss of fixation. An essential factor in good screw purchase is youth; indeed, all our patients were young, with good bone quality. We believe that in this type of fixation, union occurs before the implant can become loose because of the preserved good vascularity of fragments. In case number 6, four screws were used for proximal fixation. In case number 5, delayed union occurred at the distal level of fracture by the end of the third month and bone grafting from the iliac crest was performed without delay to avoid loosening of fixation.

In this study, despite moderate axial and rotational malalignment of fragments, good callus formation was observed, with excellent function of shoulder and elbow joints (Table 1). There were no neurological complications in our study, with shorter surgical time and blood loss compared with conventional plating techniques.

Conclusion

Percutaneous plating of segmental fractures of the humeral diaphysis using two small incisions and a standard low-contact dynamic compression plate yields an excellent clinical and radiological result, with sound union and no complications. It is a useful alternative to other methods of fixation.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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