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Antegrade interlocking nailing versus dynamic compression plating for humeral shaft fractures

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ABSTRACT

Purpose. To compare antegrade interlocking nailing with dynamic compression plating for humeral shaft fractures in terms of functional outcomes, union and complication rates.

Methods. 34 men and 22 women aged >18 years with fresh humeral shaft fractures (up to grade IIIa) with or without neurological deficits underwent either antegrade interlocking nailing (n=31) or dynamic compression plating (n=25). Functional outcome of the upper limbs (according to the American Shoulder and Elbow Surgeons [ASES] score), pain, rates of union, and complications in the 2 groups were compared.

Results. Respectively in the nailing and plating groups, mean operating times were 65 and 112 minutes (p<0.001), mean blood loss volumes were 20 and 232 ml (p<0.001), mean ASES scores were 31.4 and 29.0 (p=0.448), complication rates were 20% (6/31) and 24% (6/25) [p=0.900], non-union rates were 13% (4/31) and 8% (2/25) [p=0.625], and delayed union rates were 7% (2/31) and 4% (1/25) [p=0.787].

Conclusion. Both techniques were appropriate for treating humeral shaft fractures.

Key words: *bone plates; fracture fixation; intramedullary; humeral fractures*

INTRODUCTION

Humeral shaft fractures account for 3 to 5% of all fractures.[1] Function of the upper extremity is not affected even when there is up to 20º of anterior angulation, 30º of varus angulation, and 3 cm of shortening of the humeral shaft.[2] Conservative treatment using prefabricated braces enabled early restoration of joint motion and alignment with minimal morbidity in 51 humeral shaft fractures.[3] Nonetheless, the humerus is difficult to immobilise rigidly, because of its articulation with scapula, as scapulohumeral joint is the most mobile of joints.[4] Constant contraction of the surrounding muscles and the pull of gravity tend to distract the fracture fragments. Other disadvantages of conservative treatment include joint stiffness, oedema, muscle

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atrophy, and osteoporosis. Inadequate immobilisation may lead to delayed union and non-union, whereas prolonged immobilisation may lead to stiffness of elbow and shoulder joint.[5]

Rigid plate osteosynthesis is widely used for humeral diaphyseal fractures,[6,7] but is associated with large incisions, stripping off of soft tissues and periosteum from the bone that increases the risk of non-union or delayed union, infection, radial nerve damage,[8] less secure fixation in osteopenic bone, and delayed mobilisation of shoulder and elbow. In addition, there is stress shielding of the bone by the plate and reduced strength of union, owing to primary osteal as opposed to callus healing.

Intramedullary nailing (a load-sharing device) avoids all these problems and is biomechanically stronger. The most common indication for operative treatment is the presence of associated multiple injuries.[9,10] Other indications include open or segmental fractures, vascular injury, and failed conservative management.[11,12] We compared antegrade interlocking nailing with dynamic compression plating for humeral shaft fractures in terms of functional outcomes, union and complication rates.

MATERIALS AND METHODS

Between August 2008 and August 2010, 34 men and 22 women aged >18 years with fresh humeral shaft fractures (up to grade IIIa in the Gustilo-Anderson classification[13]) with or without neurological deficits underwent either antegrade interlocking nailing (n=31) or dynamic compression plating (n=25). Patients with pathological fractures, malunited fractures, grade IIIb and IIIc compound fractures,[13] non-unions, or osteoporotic bones were excluded. Fracture characteristics played an important role in determining the fixation options. Other associated morbidities included fractures of the patellar, femoral shaft, both forearm bones, etc.

Of the 25 men and 6 women in the nailing group, the causes of injury were falls (n=13), road traffic accidents (n=17), and assault (n=1). According to the AO classification,[1] the most common fracture type was B2 (n=10), followed by A2 (n=9) and A3 (n=7) [Table 1]. According to the Gustilo-Anderson classification,[13] the fractures were closed in 28 patients and open in 3 patients (2 grade 1 and one grade 2). Three patients had radial nerve palsies. The most common fracture pattern was oblique (n=20), followed by transverse (n=10) and spiral (n=1).

Of 19 men and 6 women in the plating group, the causes of injury were falls (n=8), road traffic accidents (n=14), and assault (n=3). The most common fracture type was A2 (n=8), followed by A3 (n=7) [Table 1]. The fractures were closed in 22 patients and open in 3 (2 grade 1 and one grade 3A). Three patients had radial nerve palsies. The most common fracture pattern was oblique (n=13), followed by transverse (n=9) and spiral (n=3).

All open wounds were thoroughly debrided, and intravenous antibiotics were started and continued postoperatively.

For the nailing group, 7- to 8-mm diameter nails were used with an apex medial bend with length ranging from 18 to 28 cm. A longitudinal skin incision

Table 1
Distribution of patients according to the AO classification of fractures

Fracture type	No. (%) of patients with antegrade interlocking nailing	No. (%) of patients with dynamic compression plating
A1 (simple wedge)	0 (0)	0 (0)
A2 (simple oblique)	9 (29)	8 (32)
A3 (simple transverse)	7 (23)	7 (28)
B1 (spiral wedge)	1 (3)	3 (12)
B2 (bending wedge)	10 (32)	2 (8)
B3 (fragmented wedge)	3 (10)	2 (8)
C1 (complex spiral)	0 (0)	0 (0)
C2 (complex segmental)	1 (3)	0 (0)
C3 (complex irregular)	0 (0)	0 (0)

Table 2
Distribution of patients by age

Age (years)	No. of patients with antegrade interlocking nailing	No. of patients with dynamic compression plating
10–20	1	0
21–30	7	8
31–40	9	8
41–50	11	6
51–60	3	1
61–70	0	1
>70	0	1

Table 3
The American Shoulder and Elbow Surgeons (ASES) scores of both groups

ASES score	No. (%) of patients with antegrade interlocking nailing	No. (%) of patients with dynamic compression plating
40–52	7 (23)	4 (16)
27–39	14 (47)	11 (44)
14–26	5 (17)	8 (32)
1–13	4 (13)	2 (8)
Mean	**31.4**	**29.04**

was made from the most lateral point of the acromion, centering over the tip of the greater tuberosity. The entry portal was made at a point just medial to the tip of greater tuberosity and 0.5 cm posterior to the bicipetal groove using a small curved bone awl. Its position in the centre of the canal was confirmed using an image intensifier. The nail was then fixed with proximal and distal locking.

For the plating group, the patient was placed in a prone position for the posterior approach and a supine position for the anterolateral approach with the arm on a sideboard. Soft-tissue and periosteal stripping was minimised to avoid disturbance of blood supply to the bone. A small curette haematoma at the fracture ends was removed, and the medullary canal was opened. Anatomic reduction was achieved, and a dynamic compression plate of adequate size was fixed with at least 3 to 4 cortical holds on each side.

Active and active-assisted range of motion exercises of the elbow and pendulum exercises of the shoulder were started as early as possible. Patients were followed up at weeks 6, 10, and 16, and monthly thereafter. Lifting of weights and heavy work was not allowed before fracture healing.

Functional outcome of the upper limb was assessed using the American Shoulder and Elbow Surgeons (ASES) score.[14] Results of the 2 groups were compared using unpaired t test and Chi squared test as appropriate. A p value of <0.05 was considered statistically significant.

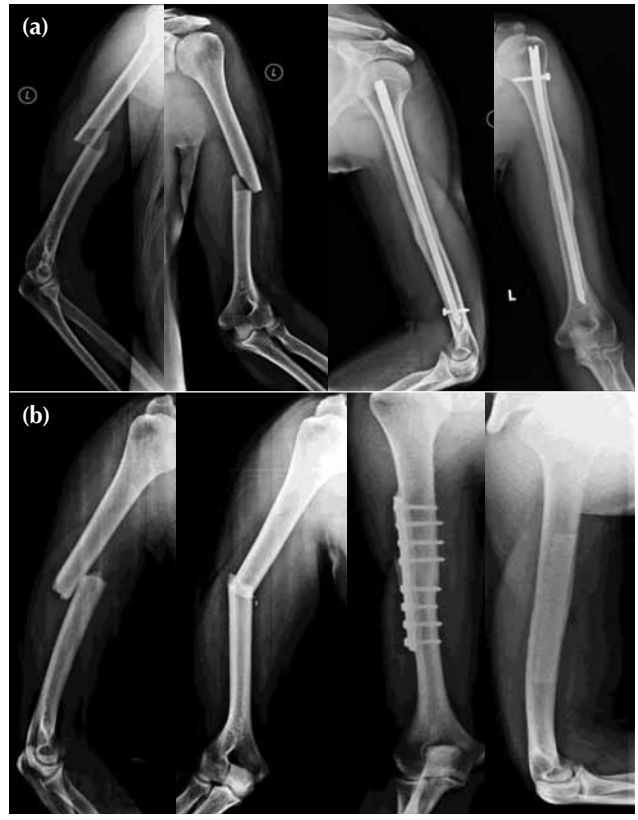

Figure 1 Humeral shaft fractures treated with **(a)** antegrade interlocking nailing and **(b)** dynamic compression plating showing anatomic reduction and bone union.

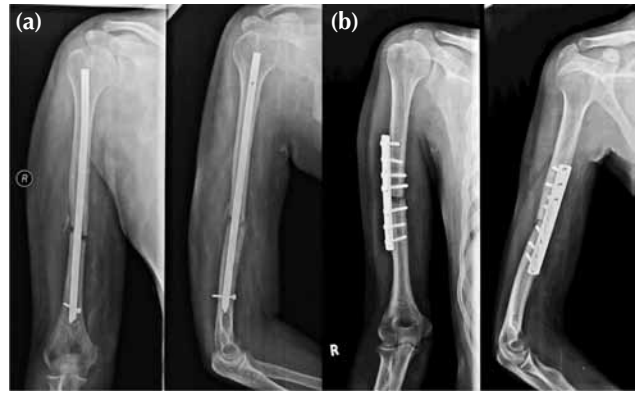

Figure 2 Humeral shaft fractures treated with **(a)** antegrade interlocking nailing and **(b)** dynamic compression plating showing non-union.

RESULTS

Respectively in the nailing and plating groups, mean patient ages were 39 (range, 20–60) and 39 (range, 22–77) years (p=0.939, Table 2), mean follow-up periods were 10 and 12 months (p=0.344), mean times to union were 16 and 17 weeks (p=0.568, Fig. 1), mean operating times were 65 and 112 minutes (p<0.001), mean blood loss volumes were 20 and 232 ml (p<0.001), mean ASES scores were 31.4 and 29.04 (p=0.448, Table 3), complication rates were 20% (6/31) and 24% (6/25) [p=0.900], non-union rates were 13% (4/31) and 8% (2/25) [p=0.625], and delayed union rates were 7% (2/31) and 4% (1/25) [p=0.787].

In the nailing group, 3 of the 7 patients with transverse fractures had non-union secondary to fracture site distraction (transverse fractures usually result from high-velocity trauma and tend to distract at the time of nail insertion[15]) [Fig. 2], whereas the 2 of the 9 patients with oblique fractures had delayed union secondary to decreased vascularity of the surrounding tissues after high-velocity trauma. In the plating group, one patient with an oblique fracture and another with a spiral fracture had non-union secondary to loss of fixation (Fig. 2), whereas one patient with an oblique fracture had delayed union secondary to infection. Three patients in the plating group had postoperative radial nerve palsies.

DISCUSSION

Dynamic compression plating is considered the gold standard of operative treatment,[16] achieving high rates of union and good outcome.[17] However, it is associated with extensive open surgery with periosteal stripping of soft tissues from bone,[18] a longer operating time,[11] and less secure fixation, especially in elderly patients with osteoporotic bone and if crutch walking is required.[11,18] Its common complications include infection, non-union, and radial nerve injury.[12] Transverse fractures should be treated with a dynamic compression plate, as it aids achieving bone-to-bone contact, and dynamic compression screws can pull opposite fracture fragments together when tightened.

Intramedullary nailing involves a simpler technique with minimal exposure[19] and shorter operating time and less blood loss.[20–23] The preservation of fracture haematomas, soft tissues, and periosteum around the fracture enables higher rates of union and good results,[12,20] with no risk of iatrogenic radial nerve palsy.[16] Locked nailing is rotationally stable and avoids backing out noted in unlocked nails.[18] However, the anatomic configuration of the humeral shaft may lead to residual fracture site distraction,[20,22,23] especially when the sagittal diameter of the distal humerus is small, and eventually delayed union and non-union may ensue. Unlike for more tubular bones like the femur and tibia, interlocking nailing is not recommended as standard management for humeral shaft fractures. In addition, antegrade nailing may violate the rotator cuff. A medial starting point may avoid the avascular area of the cuff and give straight access to the medullary canal, without compromising rotator cuff healing.[24] Adhesive capsulitis of the shoulder has also been reported after antegrade nailing.[11,20]

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