Management of Humeral Shaft Fractures With Intramedullary Interlocking Nail Versus Locking Compression Plate

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abstract

Surgical fixation of humeral shaft fractures generally involves plating or nailing. It is unclear whether one method is more effective than the other. The aim of this study was to compare the results of the intramedullary nail and locking compression plate for the treatment of humeral shaft fractures. A total of 60 patients with humeral shaft fractures were randomized to undergo surgery with an intramedullary interlocking nail (n=30) or locking compression plate (n=30). The outcome was assessed in terms of intraoperative blood loss, operative time, hospital stay, union time, union rate, functional outcome, and incidence of complications. Functional outcome was assessed using the Constant score and the American Shoulder and Elbow Surgeons (ASES) score. Intraoperative blood loss, operative time, and hospital stay in group A (intramedullary interlocking nail) were significantly lower than those in group B (locking compression plate). No statistically significant difference was found regarding the union rate, mean Constant score, and mean ASES score between the groups. The average union time was found to be significantly lower for the intramedullary interlocking nail compared with the locking compression plate. The incidence of complications such as radial nerve palsy was found to be higher with the locking compression plate compared with the intramedullary interlocking nail. The intramedullary interlocking nail can be considered a better surgical option for the management of humeral shaft fractures because it offers decreased intraoperative blood loss; shorter operative times, hospital stays, and union times; and a lower incidence of serious complications such as radial nerve palsy. [Orthopedics. 2015; 38(9):e825-e829.]

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Fractures of the humeral diaphysis and their complications are a major cause of morbidity in trauma patients. Fractures of the humeral shaft account for 20% of humeral fractures and approximately 3% to 5% of all fractures. Options for the treatment of humeral shaft fractures include functional bracing, intramedullary nailing (IMN), internal plate fixation, and external fixation.

Plate fixation results in high rates of union but requires extensive open surgery with stripping of the soft tissues from the bone. It also provides less secure fixation, especially in osteoporotic bone and if crutch walking is required. However, some studies recommend IMN as a standard surgical method through either antegrade or retrograde nailing whereas other studies report that IMN may lead to damage of the shoulder joint and a poor union rate. Therefore, the efficacy of plate fixation and IMN is still debated.

Many randomized, controlled trials have reported dynamic compression plate (DCP) fixation and IMN fixation of humeral shaft fractures. However, it is unclear whether one method is more effective than the other. The newly developed locking compression plate (LCP) system, which has specially designed combinations of holes that allow the system to be used both as a conventional DCP and as a locked internal fixator, can offer improved fixation stability over conventional DCP. The goal of the current study was to evaluate and compare the IMN and the LCP for the treatment of humeral shaft fractures with regard to intraoperative blood loss, operative time, duration of hospital stay, union time, union rate, functional outcomes, and incidence of complications.

**Materials and Methods**

The study was approved by the ethics committee of Peking Union Medical College Hospital, and written informed consent was obtained from all patients. All surgeries were performed by 2 senior surgeons familiar with both procedures (Y.F., Y.-W.L.). Between January 2010 and December 2012, a total of 60 patients with humeral shaft fractures were randomized to undergo surgery with an IMN (n=30) or LCP (n=30). Inclusion criteria were (1) humeral shaft fractures that required operative intervention and were treated with interlocking or plating procedures, (2) unilaterally closed humeral shaft fractures, and (3) patient age of 18 years or older. Exclusion criteria were (1) patient age younger than 18 years, (2) pathological fractures, (3) neurovascular injury, (4) a history of previous humeral fractures, (5) grade III fractures, and (6) fractures older than 2 weeks.

Only antegrade nailing was performed in the IMN group; no cases were treated with retrograde nailing. However, in the LCP group, the anterolateral approach was used in patients with fractures of the upper and middle thirds of the humeral shaft, and the posterior approach was used in patients with fractures of the lower third of the humeral shaft. In the IMN group, a standard IMN was used, and in the LCP group, a 4.5-mm LCP (Synthes, West Chester, Pennsylvania) was used. Surgery was performed with patients under general anesthesia.

A loading dose of antibiotics was given intravenously at a dose of 30 mg/kg every 12 hours for 3 days postoperatively. All patients were advised on postoperative shoulder and elbow exercises. Plain radiographs were obtained every month until evidence of fracture healing was confirmed. Follow-up was continued until 12 months postoperatively.

Operative time, intraoperative blood loss, duration of hospital stay, functional outcomes, union time, and incidence of complications were compared between the IMN and LCP groups. Functional outcomes were assessed using the Constant shoulder score and the American Shoulder and Elbow Surgeons (ASES) score. Fracture healing was assessed by sequential radiographs. Union was considered to be achieved when bridging callus was seen within a period of 6 months. Delayed union and nonunion were defined as no definite union at 8 and 11 months, respectively, after the initial injury. Malunion was defined as more than 5° of angular deformity or 10° of rotational deformity.

Symptoms of nerve injury such as weakness, paresthesia, and sensory loss were considered as iatrogenic nerve palsy. Complications such as iatrogenic fractures, hardware failure, shoulder or elbow morbidity, radial nerve palsy, and compartment syndrome were recorded.

**Statistical Analysis**

Qualitative data are expressed as frequency and percentage. Fisher’s exact test or chi-square test was used to examine the relationship between qualitative variables. Normally distributed continuous data are presented as mean±SD and were compared using t tests. Non-normally distributed continuous data are presented as median and range and were compared using the Wilcoxon rank sum test. A P value less than 0.05 was considered statistically significant. All data were analyzed by an experienced statistician using SPSS version 12.0 statistical software (IBM, Armonk, New York).

A power analysis was performed to define the number of patients in each group. A mean difference of 1.0 with an SD of 1.0 was assumed. This was selected as the smallest effect that would be important to detect, in the sense that any smaller effect would not be of clinical significance. With the proposed sample size of 22 pairs of cases, the study would have a power of 90%, which means that the probability of detecting mean differences greater than 1.0 is 90%. Therefore, 30 cases included in each group was appropriate to perform statistical analysis.

**Results**

Mean patient age was 39.3±10.8 years in the IMN group and 39.2±10.3 years in the LCP group. The IMN group comprised 18 (60%) males and 12 (40%) females, and the LCP group comprised 19 (63.3%) males and 11 (36.7%) females. Fractures...
were classified according to the AO classification system. Most of the fractures were classified as 30B (50%), followed by 18C (30%). Most patients sustained injuries in road traffic accidents (21 [70%] in the IMN group and 23 [76.7%] in the LCP group); the second most common mechanism of injury was being hit by heavy objects (6 [20%] in the IMN group and 5 [16.7%] in the LCP group). No statistically significant differences were observed between the groups regarding patient age, sex, fracture type, and mechanism of injury (P>0.05) (Table 1). Intraoperative blood loss, operative time, and duration of hospital stay were significantly lower (P<0.05) in the IMN group than in the LCP group.

**Functional Outcomes**

All patients in both groups were able to return to their previous jobs within 6 months, except for 1 patient in the IMN group and 2 in the LCP group who developed nonunion (Table 2). No statistically significant difference was found in mean Constant score (90.20±1.19 vs 90.33±1.32; P=0.682) and ASES score (90.53±1.07 vs 90.37±1.13; P=0.560) between the groups (Table 3).

**Fracture Union**

Average union time was 6.7 weeks in the IMN group and 10.6 weeks in the LCP group, which was a statistically significant difference (P<0.001). There was no significant difference in union rate or incidence of nonunion between the groups (Table 3).

**Complications**

Three (10%) patients in the LCP group and 0 (0%) patients in the IMN group developed radial nerve palsy; all resolved within 3 months.

**DISCUSSION**

Many randomized, controlled trials have reported DCP fixation and IMN fixation of humeral shaft fractures.\(^1\)\(^4\)\(^8\)\(^12\)-\(^18\)\(^22\) To the current authors’ knowledge, there has been no consensus on the efficacy of these 2 methods. Therefore, they evaluated and compared the IMN and the LCP for the treatment of humeral shaft fractures with regard to intraoperative blood loss, operative time, duration of hospital stay, union time, union rate, functional outcomes, and incidence of complications. Of these, intraoperative blood loss, operative time, duration of hospital stay, and average union time were significantly less in the IMN group compared with the LCP group. In addition, no statistically significant differences were found in mean Constant score, ASES score, union rate, and incidence of complications between the 2 groups. The lower values for intraoperative blood loss, operative time, and duration of hospital stay in the IMN group may indicate that IMN may be a better internal fixation technique than LCP, hastening patient recovery and increasing patient satisfaction.

Restriction of shoulder movements and risk of delayed union have been suggested as concerns with IMN techniques.\(^23\)\(^25\) Impairment of shoulder function with antrigade IMN may be a result of impinge-
ment due to proximal nail migration, rotator cuff violation, adhesive capsulitis, or an unexplained cause. However, the current study found no difference in functional scores between the 2 groups, which was contrary to the findings of previous studies. This may be explained by careful intraoperative manipulation and postoperative rehabilitation.

In previous reports of plate fixation, the incidence of nonunion has ranged from 2% to 10%. In the current study, nonunion occurred in 2 (6.7%) of 30 patients in the LCP group. Retrospective studies of IMN fixation quote incidences of nonunion ranging from 0% to 8%. Hems and Bhullar suggested that antegrade nailing affects fracture healing by distracting the fracture and soft tissues. In the current study, nonunion was seen in 1 (3.3%) patient in the IMN group. This patient was managed by decortication. In addition, no difference was found in the union and nonunion rates between the 2 groups, which is consistent with the findings of previous reports.

The incidence of radial nerve palsy with humeral shaft fractures varies from 6% to 15%. In the LCP group, 3 (10%) patients had radial nerve palsy. They were managed by neurotrophic drugs followed by bracing and passive dorsiflexed movements of the wrist joint, and they recovered fully within 3 months postoperatively. The IMN group had no incidences of radial nerve palsy.

### Table 3

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Constant Score</th>
<th>ASES Score</th>
<th>Union Rate, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMN</td>
<td>30</td>
<td>90.20±1.19</td>
<td>90.37±1.13</td>
<td>29 (96.7)</td>
</tr>
<tr>
<td>LCP</td>
<td>30</td>
<td>90.33±1.32</td>
<td>90.53±1.07</td>
<td>28 (93.3)</td>
</tr>
<tr>
<td>P</td>
<td>.682</td>
<td>.560</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** ASES, American Shoulder and Elbow Surgeons; IMN, intramedullary interlocking nail; LCP, locking compression plate.

### Conclusion

A limitation of this study is the lack of a large patient cohort; however, despite this, the study shows that IMN may be a better surgical option than LCP for the management of humeral shaft fractures. It offers decreased intraoperative blood loss; shorter operative times, hospital stays, and union times; and a lower incidence of serious complications such as radial nerve palsy. However, there is no significant difference between IMN and DCP in terms of union rate and functional outcomes.

### References


