



# Treatment of humeral shaft fractures using antegrade nailing: functional outcome in the shoulder



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**Background:** The purpose of this study was to evaluate shoulder outcomes and function after humeral shaft fractures treated with antegrade nailing.

**Materials and methods:** Thirty patients with acute humeral shaft fractures who underwent antegrade locked intramedullary nailing were retrospectively studied. Range of motion (ROM) of the affected shoulder was evaluated, comparing it with the nonaffected shoulder, radiologic position of the nails, complications, and need for a second surgery.

**Results:** The study enrolled 20 men and 10 women (average age, 41.9 years). The average follow-up was 35.8 months. The average shoulder elevation averaged 157°, internal rotation was variable (reaching the sacroiliac joint to T7), and external rotation averaged 75°. Elbow flexion-extension ROM averaged 133° (115°-145°). According to the Rodriguez-Merchan criteria, 12 patients achieved excellent results (40%), 7 good (20%), and 6 fair (23.3%); poor results were found in 5 cases (16.6%). Twelve patients achieved full mobility of the shoulder, whereas 18 had some loss of motion, with significant differences between the affected and nonaffected shoulders ( $P = .001$ ).

**Conclusion:** Decreased shoulder ROM is common after antegrade nailing of humeral shaft fractures. Avoidance of nail impingement can improve final outcomes.

**Level of evidence:** Level IV, Case Series, Treatment Study.

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**Keywords:** Shoulder; shoulder function; humeral shaft fractures; fracture fixation; antegrade nailing

Treatment of humeral shaft fractures continues to be controversial. Nonoperative functional treatment has been considered the “gold standard” by numerous authors. This approach is based on publications such as that by Sarmiento et al.<sup>24</sup> Various absolute and relative surgical indications

have been published although not always well described. Examples of relative indications for surgery are intolerance to immobilization and inability to maintain an adequate reduction of the fracture.

The most accepted surgical techniques to treat humeral shaft fractures include internal fixation with plates and screws, antegrade or retrograde locked intramedullary (IM) nailing, and placement of an external fixator.<sup>15,16,25</sup> The main controversy discussed by different authors has been between open reduction and internal fixation (ORIF) and locked IM nailing.<sup>4,7,19</sup>

Institutional Review Board approval was obtained by, Comité de ética, Hospital Militar Central, No: HGRL 601-HMC.

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The objections to the use of IM nailing include a higher incidence of loss of shoulder function and range of motion (ROM), shoulder pain, the complex technique involved, and the greater need for further surgery.<sup>5,10</sup>

Numerous studies have been published reporting shoulder functional outcome after IM nailing of humeral shaft fractures. Most of the results were rated excellent or good, but shoulder ROM outcomes were not always described.

The objective of this study was to assess shoulder ROM in patients treated with antegrade IM nailing for humeral shaft fractures. How other factors affected the functional outcome, such as position of the nail, gender, associated injuries, and complications, was also evaluated.

## Materials and methods

The study identified 45 patients who were treated with IM nailing for acute humeral shaft fractures from January 2005 to January 2011. After exclusion of patients with <2 years, since surgery, the number was reduced to 37 individuals. Of these patients, 5 did not respond to requests for follow-up, 1 had died, and 1 had sustained a severe brachial plexus injury with no rehabilitation potential and was excluded, leaving 30 patients in the final study (Table I). The surgical indications were open fractures, multiple trauma, inability to maintain adequate reduction of the fracture, and lack of cooperation with noninvasive treatment. Preoperative and postoperative radiographic studies were reviewed. A new radiographic evaluation was performed at the time of the enrollment. The fractures were classified according to the AO standard (Arbeitsgemeinschaft für Osteosynthesefragen).<sup>17</sup> The radiologic position of the nail in the subacromial space, fracture healing status, and ROM of the shoulder, including flexion, external rotation, and internal rotation in both shoulders, were evaluated. The patients were also evaluated by the Rodriguez-Merchan criteria,<sup>22</sup> which simultaneously evaluate shoulder and elbow function using the ROM of the elbow and mobility of the shoulder. Subjective data, such as pain, were also considered on a graded scale: none, occasional, pain with activity, and variable pain. General subjective disability was rated as none, minimal, moderate, and severe. The final scores were qualified as excellent, good, fair, and poor, using the lowest score for the final result.

Shoulder flexion and external rotation were measured with a manual goniometer. Internal rotation was measured by the highest vertebral level reached, graded as follows: T7, excellent; T12, good; L5, fair; and <L5, poor.

Full ROM was considered shoulder flexion of 180°, external rotation of 90°, and internal rotation with hand placement at T7 or higher.

All surgeries were performed with the patient in a beach chair position by an anterolateral acromial approach, dissection between the anterior and middle deltoid, and a longitudinal incision through the supraspinatus tendon. The split in the supraspinatus tendon was repaired with side-to-side sutures. Cannulated nails were used in 27 cases and solid nails in 3.

## Statistical analysis

ROM comparison between the affected and nonaffected shoulders was evaluated by a  $\chi^2$  test. The cases with functional deficits were

analyzed by looking at age (arbitrarily divided at 50 years), gender, presence of subacromial nail protrusion seen radiographically, and other complications.

A logistic regression model was designed to determine if these factors could be considered predictors of loss of shoulder elevation. Statistical significance was set at  $P < .05$ .

The software used was R Core Team (2013), a language and environment for statistical computing (R Foundation for Statistical Computing, Vienna, Austria; <http://Rproject.org/>).

## Results

The median age was 41.9 years, with 20 men and 10 women. Average follow-up was 35.8 months (24-60). According to the AO classification,<sup>17</sup> 6 fractures were A1 (20%), 7 fractures were A2 (23.3%), 9 fractures were A3 (30%), 4 fractures were B1 (13.33%), 3 fractures were B2 (10%) and 1 fracture was C1 (3.33%).

In 12 cases (40%), shoulder ROM was full. Average (mean) shoulder elevation was 157° (90°-180°); external rotation averaged 75° (40°-90°); and internal rotation was variable, ranging from full (T7) to poor (S1).

ROM in the shoulder that was operated on was significantly different ( $P = .001$ ) from that in the contralateral shoulder.

Average elbow flexion-extension was 133° (115°-145°), with an average extension deficit of 3° (-15° to 0°), and average flexion was 137° (125°-145°).

Pain outcomes showed that 5 patients still had pain complaints, 3 with activity and 2 with only occasional pain. Functional limitations were observed in 4 patients, 2 with minimal deficits and 2 with moderate deficits. According to the grading system used, the results were excellent in 12 cases (40%), good in 7 (20%), fair in 6 (23.3%), and poor in 5 (16.6%) (Fig. 1; Table II).

In 8 cases (26%), postoperative radiographs revealed subacromial nail protrusion of 1 to 2 mm. Complete fracture healing was noted in 28 cases (92%). Complications included 1 case of granuloma at the distal screw level, 1 case of postoperative radial nerve neurapraxia with spontaneous resolution, 1 tuberosity fracture that healed with no further treatment, and 2 cases of nonunion. Eleven subjects required a second surgery: 7 for nail removal, 1 for distal screw removal, and 1 for a nail exchange due to unacceptable subacromial protrusion. In the 2 patients with nonunions, the nail was removed and the nonunions were treated with ORIF with plates, screws, and bone graft.

In comparing those patients with full ROM and those with decreased motion, no significant correlation was noted in regard to associated injuries ( $P = .93$ ), postoperative subacromial nail protrusion ( $P = .06$ ), complications ( $P = .82$ ), age older or younger than 50 years ( $P = .48$ ), and gender ( $P = .23$ ).

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