

# Comparison of Shoulder Function, Radial Nerve Palsy and Infection After Nailing Versus Plating in Humeral Shaft Fractures

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## ABSTRACT

**Objective:** To compare shoulder function, radial nerve palsy and infection after interlocking nailing with plating of fractures of shaft of humerus during 30 weeks of follow-up.

**Study Design:** Experimental study.

**Place and Duration of Study:** Orthopaedic Wards of Combined Military Hospital, Rawalpindi, from November 2006 to November 2008.

**Methodology:** Two groups of 30 patients each were inducted. Group A (n=30) was treated with intramedullary interlocking nailing while Group B (n=30) underwent plating with dynamic compression plate (DCP). Shoulder function using ASES score, radial nerve palsy and infection were observed for 30 weeks.

**Results:** In group A, 11 patients had severe or moderate shoulder dysfunction (ASES score below 39), out of whom 8 (72%) were above 50 years. This age related disability was significant ( $p=0.003$ ). Transient palsy was observed in 3 patients (10%) and mild wound infection in 2 (6%), which was not associated with age or open fracture. In group B, only 1 patient had severe shoulder dysfunction, the difference was statistically significant between the two groups ( $p=0.001$ ), especially in patients above 50 years of age. There was no statistical difference in infection and palsy rates between the two groups.

**Conclusion:** Although nailing and plating are effective treatments for fractures of shaft of humerus, ante-grade nailing may not be suitable in elderly patients, as it can cause significant shoulder dysfunction.

**Key words:** Humerus. Shaft. Fracture. Interlocking nailing. Plating. Complication. Shoulder function. Radial nerve palsy.

## INTRODUCTION

Fracture of shaft of humerus is a common condition, usually managed non-operatively. Operation is indicated in segmental, non-united, open, severely distracted, bilateral or fractures with vascular injury or floating elbow. Operations include plating in normal or bridging mode, nailing (ante grade or retrograde), external fixation or even two-plate fixation.<sup>1,2</sup>

Plating is technically easier and economical but needs wider exposure and handling of radial nerve by posterior approach. Locking nails are biomechanically stronger, need minimal exposure with lesser operative time and blood loss,<sup>3</sup> but requires expertise, image intensifier and more expenditure. Shoulder stiffness is a problem after ante-grade nailing. It may not persist if performed properly.<sup>4</sup> Infection, non-union, radial nerve injury, malunion, implant failure etc. can occur after both procedures.

Controversy persists in the literature regarding the best treatment, nailing or plating for such fractures, as both

have positive and negative points. There is no consensus on the subject amongst orthopaedic surgeons.

The objective of this study was to compare infection, radial nerve palsy and shoulder dysfunction after either operation to find which of the two operative modalities had less of these complications.

## METHODOLOGY

This experimental study was done in 3 orthopaedic wards of Combined Military Hospital, Rawalpindi, from November 2006 to November 2008. Two groups of 30 patients each with non-probability purposive sampling were inducted. Inclusion criteria was closed humeral diaphyseal fractures, open Gustillo fracture [types I and II] and nonunited fractures. Exclusion criteria was epiphysio-metaphyseal extension, Gustillo fracture types III, age below 15 years, previous operation on the same side, infected fracture, recent shoulder stiffness, radial palsy or follow-up less than 30 weeks.

Patients were divided in two groups, taking their wishes into consideration, for the operative procedure or implant. They were examined postoperatively at day 1 (nerve function), day 15 (wound infection and nerve function), day 42 for wound, nerve, and ASES (American Shoulder and Elbow Surgeons Shoulder Score)<sup>5</sup> and day 210 for wound, nerve and ASES score.

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Received September 10, 2008; accepted December 23, 2009.

Variables of age, gender, open fractures, difficulty in reduction, arm side, type of operation, associated procedure, occupation, diabetes were assessed in relation to the complications.

Mild infection was considered with presence of pain, tenderness, erythema, raised temperature or mild discharge; severe infection was considered if it did not settle with antibiotics and abscess formed.

Shoulder and elbow function was assessed by ASES score,<sup>5</sup> at 6 and 30 weeks for 13 daily activities.

The daily activities include back pocket usage, wash opposite axilla, comb hair, carry 10 lbs. at side, sleep on affected side, use hand overhead, lift arm, perineal care, eat with utensil, use arm at shoulder level, dress, pull and throw. Score for each activity was 4 for normal, 3 for mild compromise, 2 for difficulty, 1 for with aid, 0 for not available. Total score was 52. Patients scoring 0-20 were considered to have severe dysfunction, 21-39 as moderate dysfunction, 40-51 as mild dysfunction and 52 points as normal.

Radial nerve palsy was considered transient if it showed recovery or as persisting if it was not recovering at 30 weeks. Nerve conduction studies were carried out in every case of palsy at 06 and 30 weeks.

Ante grade intramedullary interlocking stainless steel nailing [BIOMET®] was done in supine position with the arm and shoulder over radiolucent side arm-board in every case. Entry point was medial to the greater tuberosity and 0.5 cm posterior to bicipital groove. Closed reduction and guide wire passage under image intensifier was followed by appropriate reaming, removal of guide-wire and insertion of solid nail of appropriate length and 8 or 9 mm diameter. The nails were locked both proximally and distally by side jig or free hand technique, lateromedially. The arm was supported in a comfort sling for few days. Isometric exercises were started on first postoperative day, isotonic exercises during first week while rotatory movements were not allowed till 4 weeks.

Nailing was analysed in both age groups regarding shoulder dysfunction, infection, radial palsy, gustillo type, difficulty in reduction, occupation, arm side and associated procedure. By using chi-square test, their results were compared with that of plating and p-value for different variables was achieved.

Open reduction internal fixation by 4.5 mm narrow DCP was done by Henry's posterior approach. Radial nerve was identified, mobilised, protected and was placed over the plate and site of crossing recorded in documents.

Age was analysed for both groups to see for any statistical difference by using chi-square test.

Patients were divided at the time of data analysis into two groups, one below 50 years and the other above 50

years. This variable was then assessed in relation to shoulder dysfunction in both age groups of nailing as well as plating by cross tabs chi-square test. Both age groups were also analysed with rate of infection in nailing and plating groups separately with chi-square test.

Open/closed fractures: Open fractures were divided according to Gustillo classification.

Difficulty in reduction was assessed with the frequency of radial palsy in both nail and plate groups and p value was calculated using chi-square test.

Inj Amoxicillin Clavulanic acid and amikacin were used for 72 hours after all operations, followed by appropriate and prolonged antibiotics for open fracture.

Results were analysed by SPSS DATA Editor version 15 using chi-square test and p-value  $\leq 0.05$  was taken as significant.

## RESULTS

Table I illustrates distribution of age, gender, occupation, Gustillo type, arm side, fracture pattern, indications for operation, associated and any further procedures for both groups.

**Table I:** Comparing nailing and plating group.

	Nail [n= 30]	Plate [n=30]
Average age	43 years (20-75)	39 years (20-68)
Gender	Male 21 (70%)	Male 21 (70%)
Occupation	Soldiers 11 (36%) Housewives 9 (30%) Household 6 (20%) Businessman 4 (14%)	Housewives 9 (30%) Businessman 7 (23%) Soldiers 9 (30%) Household 5 (17%)
Fracture type	12A (10), 12B (12), 12C (8)	12A (9), 12B (11), 12C (10)
Closed/open	Closed 23 (77%) Open 7 (g 1-5, g 2-2)	Closed 22 (73%) Open 8 (g 1-6, g 2-2)
Side	Rt 13 (43%), Lt 17 (57%)	Rt 16 (53), Lt 14 (47%)
Indication for operation	Distracted 8 (27%) Nonunited 6 (20%) Severe angulation 6 (20%) Others 10 (33%)	Nonunited 10 (33%) Distracted 8 (27%) Severe angulation 5 (17%) Others 7 (23%)
Associated procedure	Bone grafting 6 Plating RAD ulna 1 Nailing femur 1	Bone graft 12 Plating RAD 2 Plating ulna 1 Plating RAD ulna 1
Further procedure	Removal prox screw (2)	None

In group A, 5 patients (16%) had associated injuries and fractures, 7 had associated medical problems like asthma (n=1), hypertension (n=2), Diabetes (n=2) and obesity (n=2). Perioperative problems were encountered in 7 patients (difficult reduction in 4, distal locking in 3). At 30 weeks, 11 patients (36%) had severe to moderate and 19 (64%) had normal or mild shoulder dysfunction by ASES score. Two patients underwent further related procedure that was removal of proximal locking screws for impingement. Eleven patients were aged 50 years or more. Out of those, 8 developed severe or moderate

shoulder dysfunction (ASES score 0-39), while 3 developed either mild shoulder dysfunction or had normal shoulder function (ASES score 40-52).

Nineteen patients were below 50 years, of whom only 3 developed severe to moderate dysfunction while 16 either developed mild dysfunction or had normal shoulder function.

This difference of shoulder dysfunction, between patients of subgroup 50 years or more and patients of subgroup below 50 years was statistically significant ( $p=0.003$ ).

The shoulder dysfunction was independent of the arm-side (right or left,  $p=0.09$ ) or the gender, ( $p=0.161$ ). The shoulder dysfunction to any associated procedure was also not statistically insignificant ( $p=0.637$ ).

Transient palsy was observed in 3 (10%; 2 recovered within 06 weeks and one was recovering at 30 weeks, (Figure 1). Palsy was not statistically associated with either difficult reduction ( $p=0.360$ ) or with the indication of operation ( $p=0.683$ ). Two patients (6%) developed mild wound infection which settled with antibiotics. No patient developed severe wound infection. Infection was not related to age ( $p=0.607$ ), Diabetes ( $p=0.131$ ) or open fractures ( $p=0.582$ ).

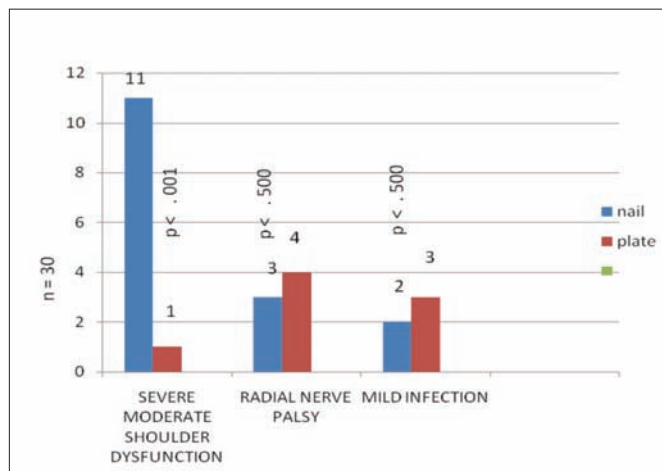


Figure 1: Comparing complications after nailing and plating.

In group B, 5 patients (16%) had associated fractures. Six patients (20%) had other medical problems like Diabetes ( $n=2$ ), hypertension ( $n=2$ ) and asthma ( $n=2$ ). Peroperative problems were encountered in 6 patients (marked blood loss in 3 non-unions, difficult reduction in 2 patients and nerve mobilization in dense adhesions in one patient). No patient underwent further related procedure. Eight (26%) were above 50 years and none developed severe or moderate shoulder dysfunction. Twenty two (74%) were below 50 years and one had severe shoulder dysfunction. Shoulder dysfunction was not statistically related to age ( $p=0.733$ ), arm side ( $p=0.533$ ) or gender ( $p=0.700$ ). Transient nerve palsy was observed in 4 (13%), 2 of whom recovered within 06

weeks and 2 were recovering at 30 weeks (assessed by clinically and nerve conduction studies). Difficulty in reduction was observed in 2 of 4 radial palsies ( $p=0.014$ ). Three cases (10%) developed mild wound infection settling with antibiotics. None developed severe wound infection. Infection was not statistically related to age ( $p=0.621$ ), Diabetes ( $p=0.807$ ) or to open fractures ( $p=0.621$ ).

Analyzing both groups together, the shoulder dysfunction at 30 weeks between both groups was statistically significant ( $p=0.001$ ). Age, occupation, arm side, associated injuries and their treatment, open fractures were statistically similar between the two groups. The nerve palsy and infections were also comparable for both groups ( $p=0.500$  and  $p=0.500$  respectively).

## DISCUSSION

The incidence of fracture shaft of humerus varies with the age of the patient, e.g. each year 14 new cases per 100,000 of young population are seen as compared to 60 per 100,000 of elderly patients in ninth decade.<sup>8</sup> This fracture needs neither perfect reduction nor immobilization.<sup>9</sup> Conservative (non-operative) treatment is easy, reliable and is recommended in most of the patients especially in young. This consists of slings, plaster slabs, casts and splints for comfort and immobilization. But sometimes surgery becomes necessary as already mentioned in introduction. Both nailing and plating are equally reliable methods for fixation stability. For patients who use walker or crutches for mobilization, nailing remains better because it requires higher load for failure.<sup>10</sup>

Majority i.e. 64% and 69% of the presently studied patients were below the age of 50 years in group A and B respectively, most of them pursuing some active profession (33% soldiers). These complications affect the job related activities (e.g. physical training in military) and the day-to-day activities (30% housewives in this series).

Altogether in both groups, 10 patients also sustained other fractures, of which 5 fractures were operated before humerus, during the same anaesthesia, for stabilization, which facilitated humeral reduction.

Distal locking is usually done by long sidearm jig. Some deformation of such nails is inevitable so simple jigs do not provide accurate distal aiming. A little movement of the jig proximally magnifies distally, resulting in aim failure. Seating the drill-bit on sharp lateral supra-condylar ridge also contributes. This technique should be used to minimize radiation exposure, till translation free jigs or modular aiming device [ModAD],<sup>9</sup> is widely available or anteroposterior locking nails are used.

Absence of severe infection in both the groups was encouraging while mild wound infection (6% in A and



10% in B) settled quickly with antibiotics. It was not related to age, Diabetes or open fractures. Crates reported no infection in 73 nailings (36% open) and Ting cited only one case of infection in 92 platings and nailings.<sup>10,11</sup> Both procedure can be done safely in open fractures till Gustillo II, under adequate debridement and antibiotics. Asif *et al.* reports no infection in 28 platings and nailings for non-union.<sup>12</sup>

There were 10% and 13% cases of radial palsy after nailing and plating respectively in this series. The persisting palsy in one case of nailing and 2 cases of plating showed encouraging recovery at 30 weeks by clinical, nerve conduction tests and electromyography follow-up, negating their exploration. Difficulty in reduction was encountered in one such case during nailing (1 out of 3 palsies] and 2 cases of plating (2 out of 4 palsies,  $p < .014$ ). Neuropraxia probably followed as a result of excessive interfragmentary traction. Crates reported 2.7% incidence of transient radial palsy, while Ting experienced one palsy in 24 nailings (4%) and 2 in 36 platings (6%).<sup>10,11</sup> Martinez reported 3 cases of transient palsy after plating in 26 patients.<sup>13</sup> Posterior approach was used in all cases because of familiarity and standardization. Benegas recommended minimally invasive anterior surface plating to avoid nerve.<sup>1</sup>

The significant difference of ASES scores at 30 weeks between nailing and plating became more prominent with age analysis in this study (Figure 2).

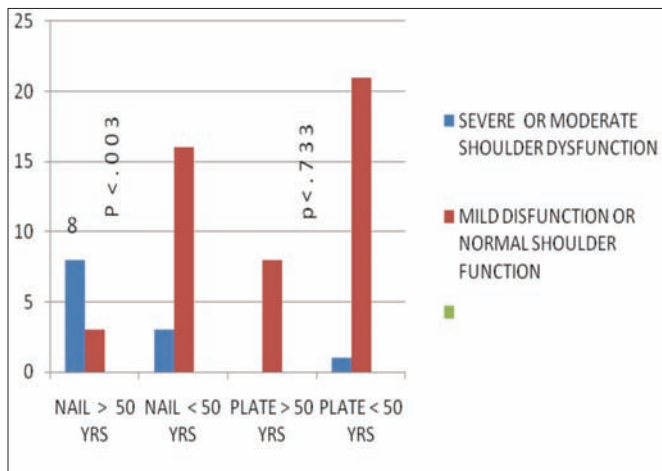


Figure 2: Age related shoulder disability after nailing and plating.

Although the average ASES score of 44 (nailing) and 47 (plating) seems similar, yet 8 cases of severe to moderate shoulder dysfunction after nailing were statistically significant ( $p=0.001$ ) when compared to only one after plating. Intra-group study revealed that out of 11 patients above 50 years, after nailing, 8 (72%) developed severe or moderate dysfunction,  $p=0.003$ . In 2 such cases the disability was attributed to impingement of rotator cuff by proximal screws, limiting abduction and external rotation. We had to remove proximal locking screws in both of our cases, after

evidence of union, resulting in remarkable symptomatic and objective improvement in shoulder function. Demirel also faced similar problem of shoulder pain because of nail impingement in 4.3% of his patients.<sup>5</sup>

Chapman compared 38 nailings with 46 platings and commented that decreased ROM was significant ( $p=0.007$ ) with nailing while infection and palsy was not.<sup>4</sup> To avoid rotator cuff, Stannard used flexible retrograde nailing with variable results,<sup>15</sup> while Bulant used inflatable nails with better shoulder function.<sup>16</sup> He observed shoulder problem in plated patients also.<sup>16</sup> Benegas compared bridging plating with nailing with comparable postoperative complications and functional results.<sup>1</sup>

Flinkkila observed that shoulder scores and isometric strength show no difference after nailing and plating but flexion was better after plating so antegrade nailing if performed properly is not responsible for shoulder joint dysfunction.<sup>4</sup> Martinez found functional results and the ROM of the shoulder and elbow to be similar with nailing and plating while treating non-united fractures.<sup>13</sup> Demirel experienced 92% excellent or satisfactory recovery of shoulder joint function after nailing.<sup>5</sup> He consider injury to rotator cuff with inadequate repair, prominent nail head or locking screws, axillary nerve injury, and intra-operative comminution of the humeral head for poor recovery of shoulder function.<sup>5</sup> Changulani *et al.* while comparing 23 nails and 24 DCPs found no significant difference in ASES scores between the two groups.<sup>17</sup> Complications such as infection were found to be higher with DCP as compared to nail, while restriction of shoulder movements were found to be higher with nail, this improved in all patients following the removal of the nail once the fracture had healed.

Routinely the nail was inserted medial to the tip of the greater tuberosity, 0.5 cm posterior to the bicipital groove to minimize damage to the rotator cuff and also properly countersinking the tip of the nail, as recommended by Russell-Taylor and Petsatodes respectively.<sup>18,19</sup> The aging rotator cuff probably reacts more adversely to insertion insult and screw penetration than young shoulders. Ultrasonography has been used to detect scarring and adhesions in the gliding tissues of rotator cuff.

In this study, infection and transient radial nerve palsy was more frequently observed with plating, although the difference was statistically insignificant, yet it would be wise to avoid it in younger patients, while shoulder dysfunction after nailing, was observed in elderly patient with statistical significance. While both nailing and plating are useful means to treat humeral shaft fractures, avoidance of nailing in patients above 50 years should be practiced, except for pathological fractures,<sup>21</sup> to prevent significant shoulder dysfunction. If nailing is to be done in elderly, it should be followed by early and supervised physiotherapy.

## CONCLUSION

Although nailing and plating are effective treatments for fractures of shaft of humerus, ante-grade nailing may not be suitable in elderly patients as it can cause significant shoulder dysfunction.

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