

## Comparative Study of Shaft of Humerus Fractures Fixation between Intramedullary Interlocking Nailing and Locking Compression Plate

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### Abstract

**Introduction:** A fractures of the humeral shaft is a very common event and accounts for 1-3% of all fractures<sup>1</sup>. Most commonly managed conservatively. However loss of reduction in the plaster cast invariably leads to malunion or non-union. The aim of our study is to find the difference in the functional outcome between intramedullary interlocking nailing and Osteosynthesis with Locking Compression plating in diaphyseal fractures of the humerus in adults.

**Methodology:** Prospective observational study was conducted at J.J.M. Medical College, Davangere between July 2015 to Jan 2018. A total of 65 patients with diaphyseal fractures of the humerus were treated with intramedullary interlocking nailing (45) or using Locking compression plate (20) after randomizing. Postoperatively both groups received same type of physiotherapy (mobilization). They were followed up regularly at 1&1/2, 3, 6 & 12 months. The time taken for radiological union in the two groups was compared. After satisfactory radiological union, the functional outcome was assessed by using Rommens., *et al.* Series grading.

**Results:** 20 patients were treated with LCP osteosynthesis & 45 patients were treated with IMIL. There was no statistically significant difference in the two groups with respect to age, mode of injury, side of injury and AO type. Males outnumbered the females. Road traffic accident was the most common mode of injury. The right side humerus was involved more often. Primary radial nerve palsy was seen in 3 patients underwent LCP plating and recovered in 8 weeks showing a neuropraxia kind of injury.

**Conclusion:** This study concludes that there is a very small difference between the two groups of fixation with respect to functional outcome, union rates & complication rates. We are of the opinion that the operative treatment of humeral shaft fractures should be purely based on patient selection depending on the type and nature of the fracture, presentation of patient and quality of the bone. LCP was preferred for a pure transverse fracture, distal 1/3 fractures, primary radial nerve palsy, delayed presentation or old non unions. IMIL was preferred for Type1&2 compound fractures, fresh midshaft-upper 1/3 fractures, oblique, segmental and pathological fractures.

**Keywords:** Humeral shaft fracture; IMIL nailing; Locking compression plate; Radial nerve injury

### Introduction

A fractures of the humeral shaft is a very common event and accounts for 1-3% of all fractures [1]. Of these, about 10% are open fractures & 20% of those are humeral shaft fractures. Incidence is 11.5 per 100,000 people annually, or 0.011% [2].

Shaft of humeral fractures were most commonly treated conservatively in the earlier days with hanging cast and functional bracing, but due to the increase number of complication of malunion, non union and primary radial nerve injuries, fixation by internal plating and nailing has found its way as the preferred surgeons method in today's time. But the best option for the fixation of the shaft of humerus has still been under debate. With multiple journals being published over the years comparing the various modality options for the fixation including Dynamic compression plate, Limited contact DCP, Locking compression plate, External fixation, Intramedullary interlocking nailing, TENS flexible nailing system, it has not been possible to get any conclusive evidence for the same.

Plate fixation (load bearing) results in high union rates using the principle of fracture union by compression, but requires extensive dissection and stripping of the soft tissue from the bone, with a higher risk of infection, implant failure, loss of fracture haematoma and Radial nerve damage and chances of failed fixation in osteoporotic bones. Further there is stress shielding of bone by the plate and reduced strength of union due to primary bone healing compared to the callus healing seen in biological fixation with IM nailing. Recently developed minimal invasive bridge plating osteosynthesis has been shown to be a secure technique with good results.

IM nailing avoids all these problems and is biomechanically stronger (a load sharing device). It involves minimal surgical intervention, biological fixation, no periosteal stripping with rotational and torsional stability, anatomical reduction, and early immobilisation, preservation of fracture hematoma [3-5]. However it has its own disadvantages of rotator cuff impingement and restricted elbow movements. But with the dynamic success of intramedullary fixation of fractures of the femur and tibia, there was speculation that intramedullary nailing might be more appropriate for humeral shaft fractures than locking compression plating.

According to recent studies the preferred method of fixation of humeral fractures is by plating. Locking compression plate is a device in which the screws are locked into the threads provided in the hole of the plates. This is an advantage that backing out of the screw resulting in loosening of the plate with failure of fixation may not occur especially in case of osteoporotic bone, poor quality bone, metaphyseal fixation [6,7]. It offers numerous fixation possibilities and has proven its worth in complex fracture situations and in revision operations after the failure of other implants.

The purpose of this study is meant to compare & analyse the outcomes of each method of fixation (Locking compression plating and Interlocking nailing) for the fracture shaft of humerus and to analyse statistically significant difference in the results of functional outcomes, union rates & complication of these two methods.

### Materials and Methods

20 patients were included in the Locking Compression plating group (anterolateral and posterior approaches depending on the fracture site and the surgeon's choice) and 45 patients were included in the intramedullary interlocking group (antergrade method) of July 2015 to January 2018. Adult patients above 18 years of age with simple Humeral shaft fracture at all proximal 1/3<sup>rd</sup>, midshaft and distal 1/3<sup>rd</sup> humeral shaft fractures were included in the study. We excluded patients with compartment syndrome, pathological fractures, type 3 compound fractures, fractures of proximal or distal humerus, patients younger than 18 years and those not willing for surgery.

All patients had plain radiographs and fractures were calcified according to AO/OTA classification of fracture of Humerus shaft (12 OTA for Humerus shaft). The patients were taken for surgery after routine investigation, obtaining fitness for surgery from physician and anesthetist and after obtaining proper written informed consent in the patient's own language. Postoperatively both groups received same type of physiotherapy (mobilization). They were followed up regularly at 1&1/2, 3, 6 & 12 months. The time taken for radiological

union in the two groups was compared. After satisfactory radiological union, the functional outcome was assessed by using Rommens et al Series grading [16].

### Surgical Technique

#### LCP Plating Group

Posterior approach for distal third & middle 1/3 fractures by splitting the triceps muscle, taking care of radial nerve and Anterolateral approach for upper and middle third fractures. The fracture was fixed with a 4.5 mm Locking Compression Plate. A minimum of 8 cortices were purchased on either side of the fracture with 4.5 mm cortical screws or 4.9 mm locking cortical screws.

#### Nailing Group

New Tran's deltoid approach or rotator cuff splitting approach is used with careful retraction of rotator cuff to avoid damage. All the interlocking humeral nails were inserted ANTEGRADE after serial reaming and nail with largest diameter was inserted. The proximal interlocking is done with the help of zig lateral to medially and the distal interlocking is done by free hand technique in an anteroposterior direction. The entire procedure is done with help of image intensifier (c-arm).

#### Post-operative management for both groups

The wound was inspected on the 2<sup>nd</sup> postoperative day. The patients were discharged on the 6<sup>th</sup> post-operative day i.e. after 5 days of IV antibiotics; with the arm in an arm pouch and advised to perform shoulder, elbow wrist and finger movements. They were prohibited from lifting weight or putting additional stress on the affected limb. Sutures/staples were removed on 10-12<sup>th</sup> postoperative day during follow up and check x-ray in anteroposterior and lateral views were obtained.

#### Follow up

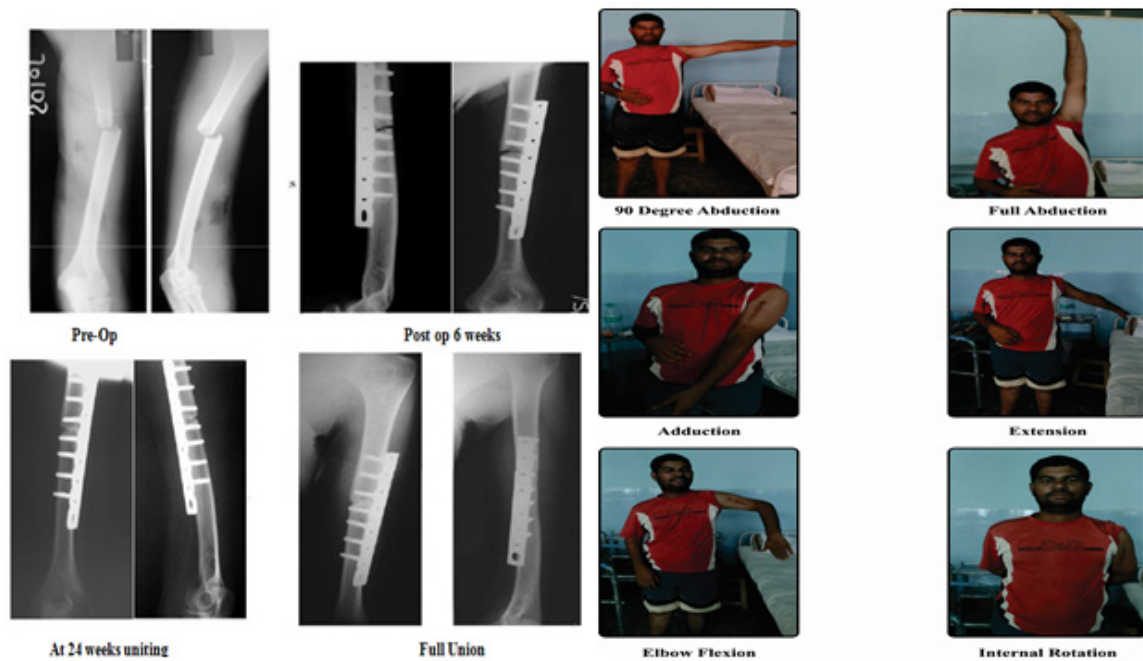
All the patients were followed up at monthly interval for the first 3 months later at 3 monthly intervals till fracture union and once in 6 months till the completion of study. They were examined in details clinically and special stress was laid on shoulder and elbow range of movements and subjective complaints.



IMIL Case: 1



*IMIL case: 2*



*LCP case: 1*





LCP case: 2

**Results**

Our study had 65 fracture of shaft of humerus, 45 cases (69.2%) treated with Intramedullary Interlocking Nailing and 20 cases (30.8%) were treated with Osteosynthesis with locking Compression Plate. The study was conducted over a period of 2 & 1/2 years between July 2015 and Jan 2018. All the Patients were followed up for a minimum period of 6 months or until complete union.

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Type of Fracture	Group		Total
	IMIL (n = 45) n (%)	LCP (n = 20) n (%)	
Comminuted	2 (3.0)	4 (6.1)	6 (9.2)
Long spiral	5 (7.6)	0 (0.0)	5 (7.6)
Oblique	11 (16.9)	2 (3.1)	13 (20.0)
Segmental	2 (2.8)	0 (0.0)	2(2.8)
Transverse	25 (38.4)	14 (21.5)	39 (60.0)

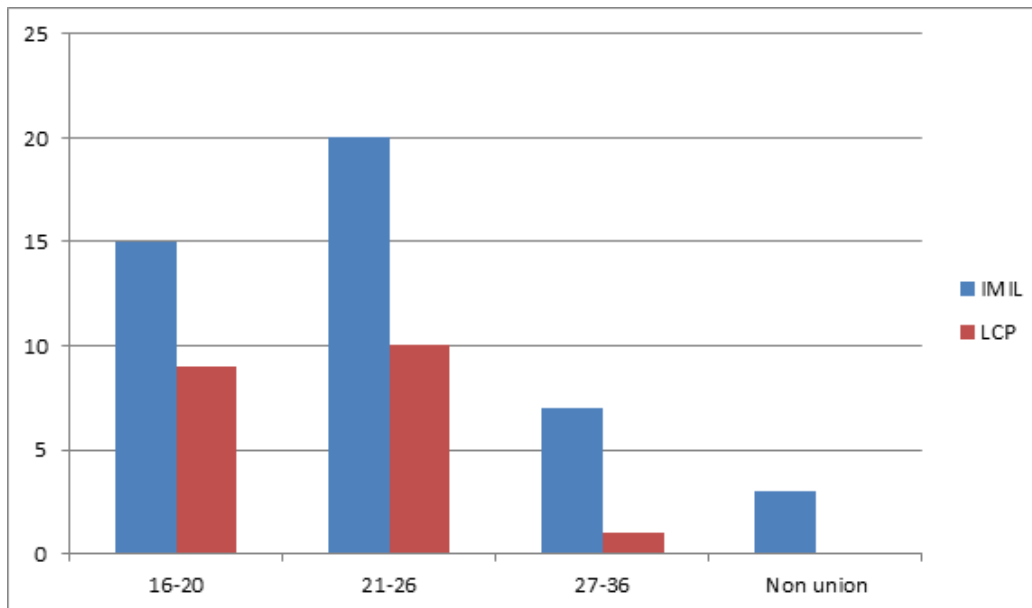
**Table 1:** Comparison of Type of Fracture among Imil and LCP Group (N = 65).

Complications	Group		Total
	IMIL (n = 45) n (%)	LCP (n = 20) n (%)	
None	31 (66.6)	15 (57.7)	46 (65.4)
No DL	2 (5.6)	0 (0.0)	2 (3.8)
Shoulder stiff	9 (25.0)	0 (0.0)	9 (17.3)
Non-union	3 (6.6)	0 (0.0)	3 (5.8)
Infection	2 (5.6)	2 (12.6)	4 (7.6)
Open reduction	7 (19.5)	0 (0.0)	6 (13.4)
Splintering of DF	1 (2.8)	0 (0.0)	1 (1.9)
Stiff Elbow	2 (5.6)	1 (6.3)	3 (5.8)
Wrist drop	0 (0.0)	3 (18.8)	3 (5.8)

Table 2: Complications among Imil and Dcp Group (N = 65).

Time of Union	Group		Total
	IMIL (n = 45) n (%)	DCP (n = 20) n (%)	
16-20	15(33.3)	9 (45.0)	24 (36.9)
21-26	20 (44.4)	10 (50.0)	30 (46.1)
27-36	7 (15.5)	1 (5.0)	8 (12.3)
Non-union	3 (6.6)	0 (0.0)	3 (4.6)

Table 3: Comparison of Time of Union between 2 Groups.

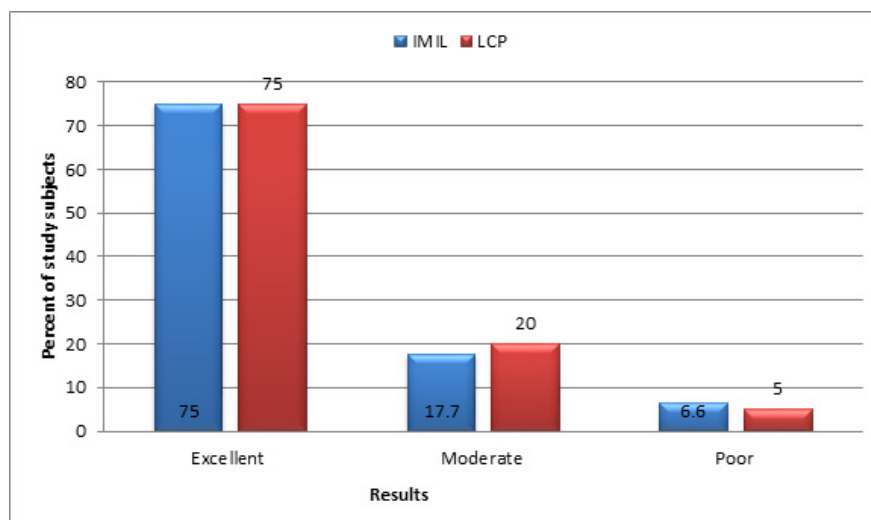


Graph 1: Time of union.

In our study, 35 (77.7%) patients in the IMIL group had solid union in less than 26 weeks, 7 (15.5%) cases had delayed union (27-36 weeks) and 3 (6.6%) cases ended up in non union. The LCP group 19 cases had solid union in less than 24 weeks, 1 case had delayed union and no case had non-union.

Results	Group		Total
	IMIL (n = 45) n (%)	LCP (n = 20) n (%)	
Excellent	34 (75.5)	15 (75.0)	39 (75.0)
Moderate	8 (17.7)	4 (20.0)	9 (13.8)
Poor	3 (6.6)	1 (5.0)	4 (6.2)

**Table 4:** Comparison of Results among IMIL and LCP Group (N = 65).



**Graph 2:** Comparative graph of all functional outcome in both groups.

Functional outcome assessed using Rommens., *et al.* grading series [16]. 34 (75.5%) patients in IMIL group had Excellent results, 8 (17.7%) patients had Moderate results and 3 (6.6%) had Poor results. Where as in the LCP group, 15 (75%) patients had excellent results, 4 (20.0%) patients had moderate and 1 (5.0%) patient had poor results. There was no significant difference between the IMIL and LCP group (p value- 0.955\_)

**Discussion**

The management of fracture shaft of humerus has always been a challenging problem to the Orthopaedic surgeon, also as they are very frequently associated with multiple injuries, leading to complications of rotation, infection, delayed union, non-union & radial nerve injury (neuropraxia). The main aim of treatment is to achieve proper length and alignment and give finally good union. In several reported series, the presence of associated multiple injures was the most frequent indication for internal fixation of humeral shaft.

In 2004, KARATAGLIS D., *et al.* [8] studied the results of 39 humeral diaphyseal fracture (37 patients) treated with antegrade locked nailing reported that this method offers a dependable solution for the treatment of humeral diaphyseal fractures especially in poly-trauma patients and cases of segmental or pathological fractures.

Study	No. of patients	Detail of Study	Excellent & Moderate Results
KARATAGLIS D <sup>8</sup> (2004)	39	IM Nailing	92.3%
PARK <sup>9</sup> (2008)	34	IM Nailing	90.0%
M Shantharam Shetty <sup>10</sup> (2007)	32	LCP	84.3%
Malhar N Kumar <sup>11</sup> (2007)	24	LCP in implant failure	48.0%
Yin P., <i>et al.</i> <sup>12</sup> (2010)	22	LCP	91.7%
	24	IMIL	95.5%
Angad Jolly <sup>13</sup> (2013)	30	LCP	80%
	30	IMIL	76%
Ashwin Kasturi <sup>14</sup> (2015)	27	DCP	84%
	25	IMIL	92%
Present Study (2018)	40	IMIL	94.4%
	25	LCP	95%

*Comparison of results obtained in various studies are as given below.*

In 2008, PARK., *et al.* [9] in their study evaluated 33 patients with 34 humeral fractures who underwent Antegrade humeral nailing through the rotator cuff interval: a new entry portal and concluded that the overall satisfaction rate was more than 90%, according to the ASES (American Shoulder and Elbow Society) score and primary bone union was achieved in 32 of the 34 cases.

In 2008, M SHANTHARAM SHETTY., *et al.* [10] studied 32 adult patients with diaphyseal fractures of the humerus treated with MIPO between June 2007 and October 2008. All cases were treated with closed indirect reduction and locking plate (LCP) fixation using the MIPO technique. The mean radiological fracture union time was 12.9 weeks. Shoulder function was excellent in 27 cases and good in remaining 5 cases. Elbow function was excellent in 26 cases good in 5 cases and fair in 1 case. They concluded that MIPO of the humerus gives good functional and cosmetic results and should be considered one of the management options in the treatment of humeral diaphyseal fractures.

In 2007, MALHAR N KUMAR., *et al.* [11], conducted a study on 24 patients of nonunion of humeral shaft fractures following failed internal fixation. All 24 patients underwent osteosynthesis using LCP and autologous bone grafting (corticocancellous iliac crest graft combined with or without fibular strut graft). 23 out of 24 fractures united following osteosynthesis. Average time to union was 16 weeks. They concluded that Locking compression plating and cancellous bone grafting is a reliable option for achieving union in humeral diaphyseal nonunion with failed previous internal fixation and results in good functional outcome in patients with higher physiological demands.

In 2010, YIN P., *et al.* [12] did a comparative study of effectiveness between locking compression plate (LCP) and locked intramedullary nail (IMN) for humeral shaft fractures of types B and C. LCP was used for internal fixation in 22 cases and IMN in 24 cases. The operation time and intraoperative blood loss in IMN group were significantly lower than those in LCP group. Between LCP and IMN groups, significant differences were found in radial nerve injury (4 cases vs. 0 case) and impingement of shoulder (0 case vs. 6 cases) but no significant difference in superficial infection (1 case vs. 0 case) and iatrogenic fracture (1 case vs. 2 cases). There was no significant difference in shoulder function and elbow. They concluded that LCP fixation and IMN fixation for humeral shaft function at 1 year after operation between 2 groups. Fractures of types B and C can achieved satisfactory results. More attention should be paid to avoiding radial nerve injury by fixation of LCP; nail tail should be buried deeply into the cortex of the greater tuberosity and rotator cuff should be protected to decrease the rate of impingement of shoulder by fixation of IMN.

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In 2013, ANGAD JOLLY, *et al.* [13], conducted a comparison study of IMIL and LCP on a group of 30 patients each. Functional outcome in both the groups was comparable except for a statistically significant increase in the incidence of shoulder related complications, and increased risk of implant failure in the IMIL nail group. They concluded that ORIF with locking compression plates is a better surgical option for managing humerus shaft fractures as compared to CRIF with IMIL nails due to a better functional outcome and lesser chance of implant failure, despite there being a larger volume of intra-op blood loss and longer duration of surgery.

In 2015, ASHWIN KASTURI, *et al.* [14], at Malla Reddy Institute of Medical Sciences, Hyderabad, conducted a comparative study on 52 patients with humeral shaft fractures with 2 methods of fixation (25 IMIL and 27 DCP plating). The study showed that the number of males were higher than female. 84% union rates were seen in DCP (<20 weeks) and 92% union rates were seen in IMIL (<20 weeks). Shoulder stiffness being the most common complication with IMIL group (20%) and Infection being the most common complication in DCP group (15%). The result showed that intramedullary nailing was superior to DCP as it was a minimally invasive procedure with lesser blood loss and lower infection rates.

In 2016, LOYA LAVA KUMAR [15], from MR Medical College, Kalaburagi, Karnataka, published in a journal regarding the comparison between DCP and IMIL fixation for humeral shaft fractures of 86 randomly selected patients. They were followed up for 36 weeks or till complete union. The result showed that only 14% patients in DCP group took more than 20 weeks to achieve union while in IMIL group it reduced to 9.3%. Shoulder stiffness was seen in 16.3% patients in DCP group but in IMIL group it was only 4.7%. Though technically more demanding procedures, IMIL has shown to be better than compression plating group. As seen in other studies, the comparison between LCP and IMIL over the years due to good knowledge of various complications, careful retraction and suturing of rotator cuffs, trans deltoid approach to protect rotator cuff damage, improved surgical skills early mobilization of shoulder, less infection, less hospital stay, nailing is gaining popularity in the recent times and is becoming the treatment of choice for humeral shaft fracture.

### Conclusion

Both modalities of treatment (Osteosynthesis with LCP and IMIL nailing) are good as far as functional outcome and rate of complications are concerned, but considering union rates our results show that plating offers better results than interlocking nailing with respect to pain and stiffness of shoulder and elbow joint and non-union. *We are of the opinion that the operative treatment of humeral shaft fractures should be purely based on patient selection depending on the type and nature of the fracture, presentation of patient and quality of the bone.*

LCP was preferred for a pure transverse fractures where compression could be achieved, Distal 1/3 fractures where nailing would fail due to short working length, Primary radial nerve palsy need exploration and release, delayed presentation or old non unions which were treated conservatively, needed compression with LCP and bone grafting. IMIL was preferred Type I, II compound fractures, fresh midshaft and upper 1/3 fractures, Oblique, segmental and pathological fractures.

*Nailing is technically a very challenging procedure, but if done right by following all the steps meticulously, the associated complications like shoulder-elbow stiffness, shoulder impingement syndrome, nonunion, etc can be reduced significantly and this procedure can prove to be a better modality of treatment in experienced hands.*

We therefore conclude that in such cases both types of treatment can be done, but patient selection is very important. The fallacies in our study are, the sample size is small and we have not taken retrograde nailing into consideration, also the follow up was only 1 to 1 1/2 years.

### Conflict of interest

No any financial interest or any conflict of interest exists.

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