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Is dynamic compression plate better than interlocking nail in treatment of adult fracture shaft of Humerus? - A prospective comparative study

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Abstract
Introduction: In past all fracture shaft humerus due to low velocity trauma was managed conservatively. However, in recent years the increasing high-speed motor vehicular accidents has posed a greater challenge on treating surgeon for managing varied patterns of those fractures. The advances in implants, operative techniques and expectations of the patients has led to change in the perspective of management towards more of surgical treatment.
Material and methods: For closed fracture shaft humerus two main modalities of fixation are available. 1. ORIF using DC plate, 2. CRIF using intramedullary interlocking nails. This study intends to study and compare the advantages and disadvantages of both modalities.
Two groups of 15 patients each having fracture shaft of humerus were managed by above two methods from July 2015 – Dec 2017. The results were assessed on following points: primary union rate, time needed for union, incidence of complications and functional scoring was done using Stewart and Hundley criteria.
Results: There were 9 (60%) excellent results in the DCP group and 4 (27%) in interlocking group. 5(33%) good results in the DCP group and 4(27%) in interlocking group. 5 (33%) fair results in interlocking group and none in DCP group. 2(13%) under interlocking group and 1(7%) under plating group got poor.
The complications were more in the interlocking group with most of them pertaining to poor shoulder function with pain. Though both modalities of treatment offer good union, the rate of secondary complication were more with interlocking nail, which makes dynamic compression plating a more favorable option.
Conclusion: Open reduction and internal fixation with a DCP remains a better treatment option as against intramedullary interlocking nails for fractures of the shaft humerus.

Keywords: Fracture shaft humerus, dynamic compression plating, closed intramedullary interlocking nailing

Introduction
Fracture of the shaft of humerus is commonly encountered in road traffic accidents, playgrounds, factory and assault. In past, all low velocity trauma was treated conservatively. However, with increasing numbers of high velocity trauma and varied complex fracture patterns, and also the growing expectations of patients, more of them are being managed surgically now. Contrary to popular ideas- the operative treatment of fractures is much simpler than non-operative. (John Charnley) [2].
Internal fixation of fracture of the shaft of humerus by either dynamic compression plating or interlocking nails allows for full, active, pain free mobilization with rapid return of function preventing fracture Disease.
The increased interest about the use of interlocking intramedullary nails is based on the theoretical advantages like less invasive surgery, fracture hematoma is not disturbed and the advantage of a load sharing device. However, there have been concerns about the reports of shoulder dysfunction due to invasion of rotator cuff, and increased incidence of delayed union and nonunion.

This study intends to investigate the advantages and disadvantages of both techniques and to conclude about which modality gives a better functional outcome.

Objectives

- To study the management of fracture shaft humerus using either dynamic compression plating or interlocking nail.
- To compare the results based on Primary union rate, time taken for union, operative time required, post-operative complications.
- To evaluate results using Stewart Hundley's Criteria.[1]

Materials & methods

Total of 30 adult patients of either sex having fracture shaft of humerus attending orthopaedic OPD during July 2015 to December 2017 were included in this study. Humerus shaft fractures included fractures from 3cm distal to greater tuberosity up to 5cm proximal to elbow joint.15 patients were treated with DCP and 15 were fixed using interlocking nails. Method of fixation was decided randomly.

Inclusion Criteria

- Fracture humerus shaft in patient greater than 18 years of age.
- Patient is fit for surgery.

Exclusion Criteria

- Age less than 18 years.
- Patients medically unfit for surgery.

Routine Protocol

1. Patients were admitted and evaluated in terms of time and mode of injury, and radiological assessment done to classify the fracture using AO fracture classification.
2. Routine standard preoperative protocol was followed.
3. Detailed pre-operative planning was done for-
   a. Classification of the fractures
   b. Size of the nail or DCP
   c. Interlocking bolts or screw
   d. technique of fixation
   e. Need of additional fixation
4. All surgeries performed under General anesthesia / supraclavicular block.
5. All the interlocking nailing were done in antegrade manner following a closed technique.
6. For ORIF with DCP- either anterior deltopectoral or posterior triceps-splitting approach was used depending up on the fracture level.
7. Post-operative immobilization done with U slab. It was discarded on 12th day.
   Cuff n collar sling given.

On discharge patients were strictly advised to avoid heavy work till fractur union.

They were reviewed in OPD after 1week, 3 weeks, six weeks, and then monthly for 6 months. Heavy work was allowed only after clinical and radiological union.

In order to compare the results between the two groups we used [1] Stewart Hundley Score as follows:

Functional results according to the Stewart and Hundley criteria

S. No	Pain	Joint stiffness	Complications	Score
1	None	None	None	Excellent
2	Occasional	less than 20°	Angulation <10°	Good
3	After Efforts	20°-40°	Angulation>10°	Fair
4	Permanent	>40°	Nonunion or radial nerve palsy	Poor

Observations and results

Age Incidence: The age group of patients in two groups are shown in following table

Age Group (years)	No of patients (%)	Plating	Interlocking Nail
10 – 20	1(3)	1	0
21 – 30	10(33)	4	6
31 – 40	11(37)	6	5
41 – 50	3(10)	1	2
51 – 60	1(3)	1	0
61 – 70	2(7)	1	1
71 – 80	2(7)	1	1
Total	30	15	15

The youngest patient is 18-year-old male and oldest patient is a 72-year-old female.

Sex Incidence: Amongst 30 patients 25 were male and 5 were female. The sex wise distribution in the two groups was as follows:

Sex	Plating	Interlock Nailing	Total
Male	12 (40)	13 (43.33)	25 (83.33)
Female	3 (10)	2 (6.67)	5 (16.67)
Total	15 (50)	15 (50)	30 (100)

Mechanism of Injury

Cause of injury	Plating	Interlock Nailing	Total
RTA	9 (30%)	11 (36.67%)	20 (66.67%)
FFH	4 (13.33%)	3 (10%)	7 (23.33%)
Pathological	2 (6.67%)	0%	2 (6.67%)
Others	0%	1 (3.33%)	1 (3.33%)
Total	15 (50%)	15 (50%)	30 (100^)

Side Distribution

Side	Plating	Interlock Nailing	Total
Right	6 (20)	5 (16.67)	11 (36.67)
Left	9 (30)	10 (33.33)	19 (63.33)
Total	15 (50)	15 (50)	30 (100)

Anatomical level of fracture

Level of fracture	Plating	Interlock Nailing	Total
Lower	5 (16.67)	0	5 (16.67)
Middle	8 (26.67)	14 (46.67)	22 (73.33)
Proximal	2 (6.67)	1 (3.33)	3 (10)
Total	15 (50)	15 (50)	30 (100)

The majority of the fractures were of middle third of the shaft (73%) followed by lower third and then the proximal third. None of lower third fractures were treated with interlocking nail.

AO Classification

AO class	Plating	Interlock Nailing	Total
A2	4 (13.33)	3 (10)	7 (23.33)
A3	4 (13.33)	8 (26.67)	12 (40)
B1	1 (3.33)	0	1 (3.33)
B2	6 (20)	3 (10)	9 (30)
C1	0	1 (3.33)	1 (3.33)
Total	15 (50)	15 (50)	30 (100)

As per the AO classification, majority of the cases in this study belonged to A3 group i.e. Simple transverse fractures followed by B2 group that includes bending wedge fractures. In our study there were only one case each in B1 (spiral wedge) and C1 (spiral complex) groups. There were no fractures belonging to A1, B3, C2 and C3 groups.

Associated injury to radial nerve

Radial Nerve Palsy	DC Plating	Interlocking nail	Total
Yes	3(10%)	0	3(10%)
No	12(40%)	15(50%)	27(90%)
Total	15(50%)	15(50%)	30(100%)

S. No.	Radial Nerve palsy	Number of Patients
1	On Admission	2
2	After Surgery	1
Total Radial Nerve Palsy		3

3 patients had Radial Nerve palsies. 2 were pre-operative and one developed after plating due to handling of the nerve.
The 2 patients with pre-operative radial nerve palsies, were taken up for radial nerve exploration and plating. Post operatively a dynamic cock up splint was given. Both cases recovered completely in 3 months. Another patient with post-operative radial nerve palsy recovered in 4 weeks.

Associated Injury

Associated injuries	Plating	Interlock Nailing	Total
Blunt injury abdomen	0	2 (6.67)	2 (6.67)
Forearm fracture	1 (3.33)	1 (3.33)	2 (6.67)
Hand & Foot Fracture	1 (3.33)	0	1 (3.33)
Head Injury	1 (3.33)	0	1 (3.33)
Neck femur	1 (3.33)	0	1 (3.33)
Sub TR. & Pelvis	1 (3.33)	0	1 (3.33)
No	10 (33.33)	12 (40)	22 (73.33)
Total	15 (50)	15 (50)	30 (100)

In our study, blunt injury abdomen and forearm fractures were the most common associated injuries and no significant difference was noted among the two groups.

Trauma - Surgery Interval

S. No.	Time Interval in days	Plating	Interlock Nailing	Total No. of patients
1	1	1	1	2 (7%)
2	4	4	4	8 (27%)
3	7	5	4	9 (30%)
4	10	3	4	7 (23%)
5	14	2	2	4 (13%)
Total		15	15	30

9 patients (30%) were operated after 7 days of trauma, 2 patients (7%) underwent surgery on the same day. Average time interval between trauma and surgery for plating group was 7.33 days and for interlocking nail group was 7.53 days.

Time taken for surgery

S. No.	Time Taken(min)	Plating (Percentage)	Interlock Nailing (Percentage)
1	45	4(26)	4 (26)
2	60	9(60)	6 (40)
3	75	1(7)	4 (26)
4	90	1(7)	0
	120	0	1(7)

Most of the cases undergoing plating (60%) were finished in 60 minutes whereas 40% cases of interlocking nail were finished in 60 min. One case undergoing interlock nailing took 120 min due to extensive comminution and difficulty in closed reduction.

Average time for each group is as follows

Surgery	Plating	Interlock Nailing
Time (Min)	59	64

Rate of union

Union Achieved	Plating	Interlock Nailing	Total
Yes	14 (46.67%)	13 (43.33%)	27 (90%)
No	1 (3.33%)	2 (6.67%)	3 (10%)
Total	15 (50%)	15 (50%)	30 (100%)

2 cases (6.67%) of interlock nailing and one case (3.33%) of DC Plating resulted in nonunion. In IMIL nailing cases, distraction at the fracture site was considered to be the reason for nonunion. One case with DC plating developed post-operative deep infection and led to nonunion.

Time taken for union

Eight cases of DC plating (53%) united within less than 17 weeks whereas eight cases (54%) of interlock nailing required 17 to 26 weeks for union. Average time for union is less for the plating (16.43 weeks) as compared to interlock nailing (18.08 weeks).

S No.	Time taken for union in weeks	Plating (%)	Interlocking Nailing (%)
1	< 17	8(53)	5(33)
2	< 26	6(40)	8(54)
3	Nonunion	1(7)	2(13)
Total		15	15

Pain

Sr. No	Grade	Plating (%)	Interlocking Nailing (%)
1	No Pain	14(93)	8(53)
2	Mild	0	6(40)
3	Persistent	1(7)	1(7)

There was a significantly lesser pain in the patients undergoing plating as compared to those undergoing interlock nailing.

Range of Motion Restriction

ROM restriction (%)	Plating	Interlock Nailing	Total
< 20	5 (16.67)	4 (13.33)	9 (30)
20 – 40	1 (3.33)	6 (20)	7 (23.33)
> 40	0	1 (3.33)	1 (3.33)
No	9 (30)	4 (13.33)	13 (43.33)
Total	15 (50)	15 (50)	30 (100)

Complications

Complications	Plating (n=15)	Interlock Nailing (n=15)	P Value
Infection	1 (6.67)	0	>0.05
Joint Stiffness	4 (26.7)	11 (73.33)	>0.05
Radial Nerve Palsy	1 (6.67)	0	>0.05
No	9 (60)	4 (27.67)	>0.05

The most common complication in both the groups was joint stiffness of shoulder and elbow, although interlock nailing patients had a much higher percentage of joint stiffness as compared to plating group. Infection and Radial N. Palsy were seen in one patient each with DC plating.

Criteria for Assessment

Results were evaluated considering the primary union rate, time to union in weeks, incidence of complications. [1]Stewart and Hundley 's Criteria to classify the results as excellent, good, fair and poor.

Primary Union Rate

14 (93%) out of the 15 patients with DC plating, and 13 (87%) out of the 15 patients with interlock nailing had primary unions.

Time taken for union

The average time taken for union after DC plating was 16.43 weeks and after interlock nailing it was 18.08 weeks.

Complications

The overall percentage of complications in interlock nailing was 46% as compared to the patients who underwent plating (20%). All patients were carefully evaluated according to the [1]Stewart Hundley's Criteria and the results were graded as follows:

Results	Plating (%)	Interlock Nailing (%)
Excellent	9(60)	4(27)
Good	5(33)	4(27)
Fair	0	5(33)
Poor	1(7)	2(13)

MW statistical test was applied to derive Z value and P value as follows

Parameter	Plating	Interlock Nailing	MW test - Z Value	P value
Result score	2.47	1.67	2.22	<0.05

Thus, plating gives statistically significant better results as compared to the patients undergoing interlock nailing.

Discussion

This study focuses on 30 cases of fracture shaft humerus out of which 15 were treated with dynamic compression plating and 15 were treated with closed interlock nailing. As most of the patients are 20 – 40 years in age group which form the active earning member of the family, early mobilization of these patients could gain early return to work for earning. In our study majority of the fractures were caused by Road Traffic Accident (67%) followed by fall from height (23%). Assault is a rare cause of fracture seen in one case only.

Union of fractures

In our series, out of 15 cases of plating 14 united primarily. Out of the 14 cases, 8 cases i.e. 53% united in less than 17 weeks and 6 cases (40%) united in less than 26 weeks. One case of nonunion was due to post-operative infection leading to infective nonunion.

Out of 15 cases of interlock nailing 5(33%) cases united in less than 17 weeks and 8 cases (54%) united in less than 26 weeks. There were 2 cases of nonunion due to distraction at the fracture site.

We compared our union rates with various published series as follow

Rate of Non-Union		
Name of Study	**Plating**	**Interlock Nailing**
Current Study	6.7%	13.3%
[4]Chapman JR *et al*	2.7%	5.2%
[5]McCormack *et al*	4.3%	9.2%
[6]Kesemenli *et al*	3.7%	12.1%

As seen in above table, rate of nonunion is higher for Interlock nailing.

Pain

In our study the patients with interlock nailing had a significantly greater pain as compared to the patient with DC plating. In the plating group 93% patients were pain free whereas in nailing only 53% patients were pain free. In the study by Kesemenli *et al*, 24 cases (89%) were pain free in the plating group whereas 27 cases (82%) were pain free in the interlock nailing. Here also pain is more in the interlocking nail group.

Complication Rate

A total of 8 complications occurred in 6 patients of the plating group giving a complication rate of 40% as compared to 11 complications in 11 patients of interlock nailing i.e. a complication rate of 73.33%. Both of these are very high. After eliminating minor complications like mild joint stiffness etc., major complication rate came down to 13.33% in plating group as compared to 46.67% in interlock nailing group. So, the complication rate is higher in patients with interlock nailing.

Study by McCormack *et al*[5] and Kesemenli *et al* [6] also showed a significantly higher rate of complication in Interlock Nailing group as compared to the plating group. Study by Chapman JR [4] shows an equal prevalence of overall complication rates in both the groups however it shows a significantly more shoulder pain and restriction of ROM with patients undergoing Interlock Nailing. Our results are comparable to these results.

Infection

One case of DC plating had post-operative infection leading to nonunion. It led to moderate stiffness of shoulder and elbow joints and persistent pain. Ultimately the plate was removed. Thorough debridement done to control infection. Later plated again. Our study shows an infection rate of 7% for plating. No infection has been reported in case of interlock

nailing. Study by Griend *et al* [3] and Kesemenli *et al* [6] had reported no case of infection in closed fractures. In the study of AB Putti *et al* [7] one patient undergoing plating developed superficial infection which resolved with antibiotics.

Stiffness of shoulder and elbow joints

9 cases (60%) of DC plating and 4 cases (27%) of interlocking nail had full range of shoulder motion. The restriction of shoulder movements was a problem with interlock nailing whereas elbow stiffness was a more common problem with patients undergoing plating. In Chapman J R[4] series also, shoulder movement was a problem with interlock nailing and elbow stiffness was a problem with Dynamic compression plating especially with fractures of lower third of humerus. In interlock nailing, stiffness of shoulder was due rotator cuff damage and impingement of the nail under acromion which limited the abduction. However most of the cases with minimal and moderate stiffness seemed to be due to inadequate physiotherapy or patient's reluctance to use the operated limb. Ipsilateral forearm bone fractures and soft tissue injuries may be the cause in certain patients.

To summarize- there were 9 (60%) excellent results in the DCP group and 4 (27%) in interlocking group. 5(33%) good results in the DCP group and 4(27%) in interlocking group. 5 (33%) fair results in interlocking group and none in DCP group. 2(13%) under interlocking group and 1(7%) under plating group got poor.

The complications were more in the interlocking group with most of them pertaining to poor shoulder function with pain. Though both modalities of treatment offer good union, the rate of secondary complication were more with interlocking nail, which makes dynamic compression plating a more favorable option.

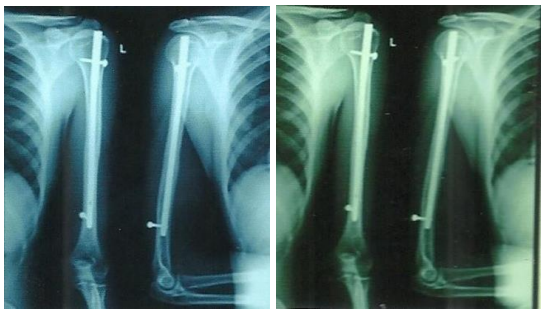
Case of dynamic compression plating

Pre – operative X-Ray Post OP X-Ray

18 weeks Post OP

Case of Interlocking Nail

Pre-Operative X-Ray Post-Operative X-Ray



12 Weeks Follow-up 6 months Follow-up

Conclusion

Open reduction and internal fixation with a DCP remain a better treatment option for fractures of the shaft humerus. Fixation by IMN may be indicated for specific situations, but is technically more demanding and has a higher rate of complications.

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