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COMPARATIVE STUDY BETWEEN RESULTS OF RETROGRADE INTRAMEDULLARY NAILING (RN) VS LOCKED PLATING (LP) IN TREATMENT OF DISTAL FEMUR FRACTURES: A PROSPECTIVE ANALYSIS

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Keywords:

RN-retrograde nailing, LP-locked plating, KOOS score-knee injury osteoarthritis severity score

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ABSTRACT: Introduction: Distal femoral fractures are among challenging orthopaedic injury constituting 0.4% of all fractures. Despite recent evaluation in operating techniques and surgical implants, debate continues around the choice of implant for various types of distal femur fractures. **Method and Material:** In prospective randomized study from 2020 to 2022, analysis of 40 patients was done out of which 20 cases were treated in each group with follow-up at 2,6,12,24 weeks and 6 months. **Results:** Clinical and radiographic evaluation according to KOOS functional score demonstrated that in RL group, 3 case were excellent, 10 cases were good, 07 cases were fair, while in LP group: 01 case was excellent, 07 cases were Good, and 11 cases were fair and 01 case was poor. Over 90% of fractures under RN and LP healed within 6 months with average time being 21.15 weeks (range 12 to 28 weeks) in RN and 23.30 weeks (range 12-32 weeks) in LP group. Out of 20 cases of RN group, 2 went for delayed union requiring dynamisation and in LP group 3 went for delayed union and 1 for nonunion. **Conclusion:** Mean KOOS score was found to be significantly better in RN group for type A fractures. However, for type C fractures results were statistically insignificant. Difference for parameters, time to osseous healing, knee motion, pain, rate of second surgery, post-op complication etc were found to be statistically insignificant, proving both RN and LP as adequate options.

INTRODUCTION: In this era of rapid industrialization and fast pace of life, there exist concomitant rise in road traffic accident (RTA), that cripples many lives as well as increased life expectancy, old age population, carrying dangers of osteoporosis and fractures.

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These major factors contribute to complex fractures of distal femur, accounting for 0.4% of all fractures and 6% of femoral fractures. Most high energy distal femoral fractures occur in males 18-30 years and low energy fractures occur in osteoporotic women aged more than 50 years.

Distal femoral fractures comprising Supracondylar femoral fractures are often difficult to treat and they are notorious for many complications. Inspite of advances in techniques and improvements in surgical implants, confusion still prevails regarding use of specific implants, post operative management and rehabilitation in treatment of

these fractures. Long term disability can still occur in patients with extensive articular cartillage damage, marked bone communitions in severe soft tissue injury. The purpose of this study was to compare functional and radiological outcome of surgical management of distal femur fractures treated with Retrograde Intramedullary Nailing versus Locked Plating, and to look for the complications associated with these and their managements.

AIMS & OBJECTIVES: To compare functional and radiological outcome of surgical management of distal femur fracture treated with Retrograde Intramedullary nailing *vs* locked plating. To assess the complications associated with both the technique & their management.

MATERIAL AND METHODS: We prospectively studied 40 patients with distal femur fracture that were presented to the hospital emergency room between September 2020 and August 2022. The patients were treated at the Department of Orthopaedics and Traumatology, M.G.M. Medical College and M.Y. Hospital, Indore. All patients reported to the emergency room with a history of trauma, swelling in the thigh, severe pain and inability to move the joint. Primary and secondary survey was done with recording of the vitals and limb assessed for neurovascular compromise. After the necessary interventions like fluids and analgesics, standard anteroposterior and lateral radiographs were advised. Appropriate splints were given, admitted and advised limb elevation and ice fermentation in the wards.

The patients who completed the following criteria were included in the study:

1. All patients of type A and type C1, C2 (according to AO classification).
2. Age 18-60 years.
3. Duration less than 3 weeks and unilateral fractures.
4. Grade 1 compound fractures of Gustilio anderson classification.

The following were excluded from our study:

1. Type B and Type C3 fractures as per AO classification.
2. Grade 2 and Grade 3 compound fractures.
3. Immunocompromised patients.
4. Patients with Uncontrolled Diabetes mellitus.
5. Patients with neurologic conditions (polio, spinal cord injury, etc).
6. Fractures with Neurovascular compromise.
7. Refusal of inclusion by the patient.

FIG. 1: FRACTURE SUPRACONDYLAR FEMUR IN A 54-YEAR-OLD MALE PATIENT

FIG. 2: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT

FIG. 3: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT. SIGNIFICANT UNION CAN BE SEEN ON THE 12 WEEKS FOLLOW UP

FIG. 4: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT. THIS PATIENT SCORED 90 POINTS BY THE KNEE INJURY OSTEOARTHRITIS OUTCOME SCORE SYSTEM WHICH SUGGESTS AN 'EXCELLENT' OUTCOME

FIG. 5: FRACTURE SUPRACONDYLAR FEMUR IN A 22-YEAR-OLD MALE PATIENT

FIG. 6: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT

FIG. 7: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT. SIGNIFICANT UNION CAN BE SEEN ON THE 12 WEEKS FOLLOW UP

FIG. 8: WEEKS FOLLOW UP AP AND LATERAL RADIOGRAPHS OF THE SAME PATIENT. THIS PATIENT SCORED 79 POINTS BY THE KNEE INJURY OSTEOARTHRITIS OUTCOME SCORE SYSTEM WHICH SUGGESTS AN 'GOOD' OUTCOME

Post Operative Assessment: Post operatively, the patients were assessed radiographically and clinically. Radiographic and clinical assessment was done by the Knee injury Osteoarthritis outcome score.

The clinical outcome was assessed according to the Knee injury Osteoarthritis outcome score. The Overall clinical outcome was graded as follows.

- Excellent: 80-100
- Good(satisfactory) : 70-79
- Fair: 60-69
- Poor: <60

Statistical Analysis: Statistical analysis was conducted using the student T test and Pearsons chi square test to compare groups with categorical variables. A probability (p value) of <0.05 was considered to be statistically significant.

Observation and Results: The study was conducted on Forty distal femur fractures in 40 patients who presented to the emergency room of MGM Medical College and Maharaja Yashwantrao Hospital, Indore from September 2017 to August 2019 and were treated by retrograde intramedullary nailing and locked plating by the department of Orthopaedics and traumatology. The details of the various variables and data is presented as follows.

TABLE 1: AGE DISTRIBUTION

Age Group	No. of Patients
18-30 years	14
31-40 years	8
41-50 years	3
51-60 years	15

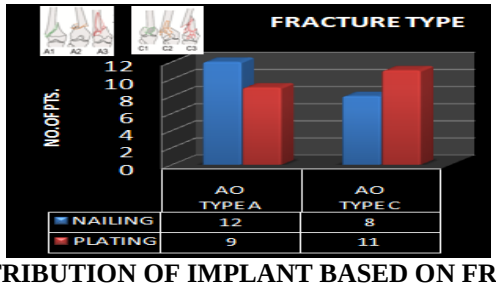
TABLE 2: SEX DISTRIBUTION

Group	Male	Female	Total
Retrograde Intramedullary Nailing	13	7	20
Locked Plating	12	8	20
Total	25	15	40

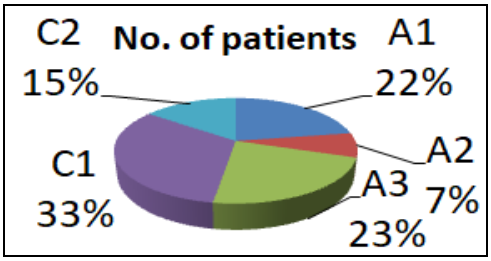
Laterality: Most patients who presented had fractured their Right distal femur, with the right to left ratio being 1.10:1.

Mode of Injury: In our Indian scenario, with rising motor vehicles on the roads and the lack of driving sense with very few people following traffic rules, road traffic accidents form the major mode of injury among high energy distal femoral fractures sustained by our patients with respect to fall and assault.

Choice of Implant:



GRAPH 1: DISTRIBUTION OF IMPLANT BASED ON FRACTURE TYPE



GRAPH 2: DISTRIBUTION OF PATIENT AS PER FRACTURE TYPE

TABLE 3: DISTRIBUTION OF PATIENTS ACCORDING TO AO CLASSIFICATION

AO Fracture Type	Nail Group	Plate Group	Total
A1	4	5	9
	20.0%	25.0%	22.5%
A2	3	0	3
	15.0%	0.0%	7.5%
A3	5	4	9
	25.0%	20.0%	22.5%
C1	5	8	13
	25.0%	40.0%	32.5%
C2	3	3	6
	15.0%	15.0%	15.0%
Total	20	20	40
	100.0%	100.0%	100.0%

Pearson chi-square value = 3.915, df=4, P value = 0.418, Not significant.

Operating Time:

TABLE 4: COMPARISON OF MEAN OPERATIVE TIME (MINUTES) BETWEEN THE TWO GROUPS

Group	Mean ± SD	't' value	P value
Nail group	81.50 ± 8.59	-10.242, df=38	0.000*
Plate group	111.50 ± 9.88		

Unpaired 't' test applied. P value = 0.000, Significant.

Union Tim:

TABLE 5: COMPARISON OF UNION TIME (WEEKS) BETWEEN THE TWO GROUPS

Group	Mean ± SD	't' value	P value
Nail group	21.15 ± 3.39	-1.936, df=38	0.060, NS
Plate group	23.30 ± 3.63		

Unpaired 't' test applied. P value = 0.060, Not Significant.

TABLE 6: NAIL AND PLATE GROUP

Group	No.	Mean ± SD	't' value	P value
Nail group	12	111.25 ± 8.56	4.964, df=19	0.000*
Plate group	9	93.89 ± 6.97		

Type C Fracture:

TABLE 7: NAIL AND PLATE GROUP

Group	No.	Mean ± SD	't' value	P value
Nail group	8	100.00 ± 7.56	0.322, df=17	0.752, NS
Plate group	11	98.18 ± 14.54		

TABLE 8: COMPARISON OF MEAN KOOS SCORE BETWEEN THE TWO GROUPS FOR TYPE A FRACTURES

Group	No.	Mean ± SD	't' value	P value
Nail group	12	75.58 ± 8.99	2.213, df=19	0.039*
Plate group	9	68.11 ± 5.30		

Unpaired 't' test applied. P value = 0.039, Significant.

TABLE 9: COMPARISON OF MEAN KOOS SCORE BETWEEN THE TWO GROUPS FOR TYPE C FRACTURES

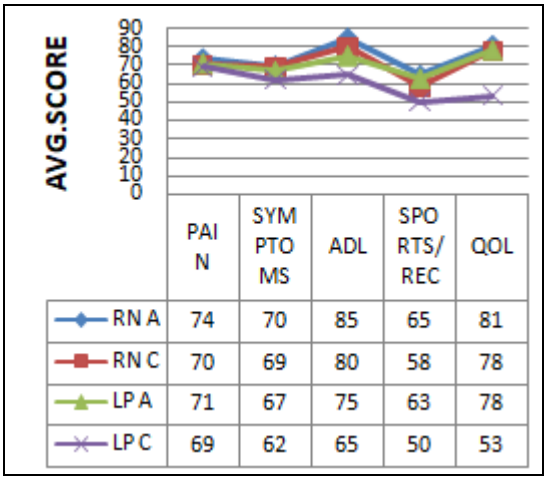
Group	No.	Mean ± SD	'T' Value	P Value
Nail Group	8	72.75 ± 4.56	2.103, DF=17	0.051, NS
Plate Group	11	67.55 ± 5.80		

Unpaired 't' test applied. P value = 0.051, Not Significant.

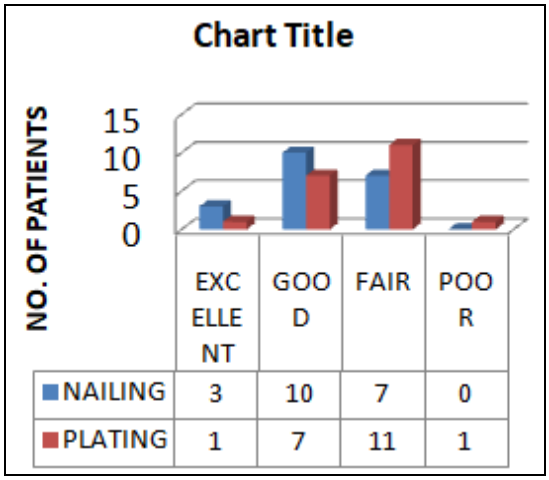
Post Op Complications among Subject:

TABLE 9: FUNCTIONAL OUTCOME KOOS SCORE

S. no.	Complication	RN Group	LP Group
1	Superficial infection	NIL	3
2	Deep infection	1	1
3	Stiffness	2	4
4	Anterior knee pain	3	0
5	Non union	0	1
6	Malunion	0	0
7	Hardware failure	0	1
8	Neurovascular injury	0	0



GRAPH 3: FUNCTIONAL OUTCOME KOOS SCORE



GRAPH 4: DISTRIBUTION OF PATIENTS ACCORDING TO KOOS SCORE CATEGORY

TABLE 10: KOOS SCORE

KOOS Score	Nailing	Plating	Total
Excellent	3	1	4
Good	10	7	17
Fair	7	11	18
Poor	0	1	1

DISCUSSION: Our study showed a biphasic age distribution of the patient population as is usually seen in studies (Bell *et al,* 1992) and shroff *et al* [1]. Majority of patients belonged to young age group (55 % of patients were 40 year and below) reflecting the mechanism of injury which was high energy trauma in 60% of entire patient population.

Sex distribution was quite similar in both RN and LP group with 65 % male in RN group and 60 % male in LP group. Above reports are compared to reports made by Kanda *et al* (2012) [2] who reported 74.47% male in RN group and 63.15% male in LP group. High male ratio in this study was mainly due to males being commonly involved in road traffic accidents and lack of driving sense in our Indian scenario. The right and left side of fracture in both groups were found to be approximately in same proportion, ratio being 1.10:1, with slight right dominance.

Fracture pattern distribution also resemble that of study by Bell *et al* (1992) [3] with high incidence of articular involvement, complex type C fractures, fracture community on and associated injuries in these fractures reflecting high energy trauma being prime cause for these fractures. The relatively low incidence of intra-articular fractures (47.5%) as compared to extra-articular fractures (52.5%) in our study is due to the fact that type C3 fractures are excluded from the study which forms the majority of intra- articular fractures, as retrograde nailing is impossible in these type C3 fractures [3].

In LP group there were 9 type A fractures and 11 type C fractures while in RN group, 12 type A fractures and 8 type C fractures were distributed. This distribution of fracture pattern for RN and LP group was found to be statistically insignificant with p value = 0.418, avoiding allocation bias.

Out of 40 patients 23 were compound (grade 1) fractures with the remaining being simple fractures. The nature of fracture was almost same in both LP (compound fractures 57%) and RN group (compound fractures 60%).

Mean intra-operative blood loss was significantly higher in LP group as compared to RN group even after tourniquet application. Mean operating time for RN group was significantly less as compared to LP group (p value=0.000) as in study of Jillala *et al* [4]. Equivocal results were found in study conducted by Kanda *et al* [2] while paradoxical results as seen in study of Paul Tornetta *et al* [5].

Out of 40 patients 11 had follow-up for more than 6 months, remaining patients had follow-up between 3 months to 6 months. The mean union time for LP group was 23.30 ± 3.63 weeks which was higher as compared to RN group, 21.15 ± 3.39 weeks, with results being statistically insignificant. (p value = 0.060) same as being in study of Gill *et al* [6]. However similar but statistically significant results were seen in study by Shailendra et al [7]. In our study, Fracture union was assessed clinically and radiologically. Clinically fracture was considered as united if there is no pain at fracture site at palpation and attempted movements of knee, no local increase in warmth at fracture site, no pain during attempted eight bearing, radiologically the fracture was considered united when serial Roentgenograms shows bony trabeculae crossing the fracture site and/or calus formation in three cortices in two views seen. There was one case of non-union (with screw failure), as defined by our criteria of failure of fracture to show progressive sign of healing over 3 months or if loss of initial fracture fixation in less than 9 months. Paradoxical results were obtained in study of SKV Gupta *et al* [9] with early union in LP group as compared to RN group. Luzan TJ [8] *et al* concluded in his study that locking plate used to bridge fractures of the distal femur led on average to less callus formation than IM nails and early union. Similarly in study of Kanda Gao *et a*l [2], union disturbance rate in the LP group was higher than in the RN group. However further analysis of their studies revealed that clinical outcome may largely depend on surgical technique rather than on the choice of implant.

Mean range of motion for type A fractures was significantly higher in RN group (0 to105 degrees) as compared to LP group (0 to 90.25 degrees)which further increased ,0 to111.25 degrees for RN and 0 to 93.89 degrees for LP group respectively by 6 months follow up, after vigorous physiotherapy,

(p value=0.000), more among young patient as they being more compliant to physiotherapy exercises. Paradoxically, in studies of SKV Gupta *et al* [9], Markmiller *et al* [10] and Ramanand *et al* [11] the range of motion results favoured towards LP as compared

to RN at 1 year follow up. In our study, for type C fractures, range of motion values were slightly favouring towards RN group (0 to 100 degrees) as compared to LP group (0 to 98.18 degrees) with results being statistically insignificant. (p value = 0.752). Thus flexion at knee joint is better in RN group as compared to LP group with similar results quoted in study of Jillala *et al* [4].

Although numerous rating scales exist for assessment of functional outcome of surgically treated distal femur fractures, example NEER score, Hospital for special surgery score (HSS), Karlstrom and Olerud, Hammer score, Lysholm and Gillquist scoring system (LGSS), SMFA (Short Musculo Skel *et al* Functional Assesment) score. But we took KOOS, Knee injury Osteoarthritis Outcome Score, since it focuses more on functional outcome variables such as pain, activity of daily living, sports and recreational activities along with knee quality of life. However, no rating score is found to be superior to others.

Results were graded according to KOOS score taking into account 5 parameters: Pain, Symptom, Activity of Daily living (ADL), Sports & recreational activity and Knee related quality of living (QoL). In RN group there were 3 excellent, 10 good, 7 fair and nil poor cases were reported. However, in LP group, 1 excellent, 7 Good, 11 fair and 1 poor case was reported. Mean KOOS score for RN group (75.58+/-8.99) was found to be statistically higher as compared to LP group (68.11+/-5.30) with p-value=0.039. Similar results were documented by study conducted by Hoskins *et al* [12] were a significant difference in quality of life was revealed in favour of Retrograde intramedullary nailing using EuroQol-5 dimension score at 6 months, however paradoxical results were quoted in other studies using different scoring system for example, Demirtas A. *et al* [13] using Sanders criteria, Markmiller M. *et al* [10] with Lysholm Gillchrist scoring system, Gupta SKV *et al* [9] employing Hospital for special surgery score. For type C fractures the mean KOOS score for RN group (72.75+/-4.56) was found to be higher as compared to LP group (67.55+/-5.80). However, this difference was found to be statistically insignificant (p-value=0.051). It was further concluded that extra-articular fractures had better results as compared to intra-articular fractures with significantly derangement of KOOS score in young patient with Intra-articular fractures which can be explained by severe metaphy seal communition present in these set of fractures with high energy fracture mechanism RTA being most common mode of injury (81.8% of patients < 40 years had RTA as mode of injury).

Evaluation of both groups in terms of excellent and good results indicated that 65% (13 patients out of 20 patients) who underwent RN, 40% (8 patients out of 20 patients) who underwent LP fell into the excellent and good results category.

Looking onto the complications that occurred in our study, 3 patients in LP group developed superficial infection however 1 patient in each group developed deep infection requiring I&D and higher antibiotic coverage. Persistant anterior knee joint pain was common in nailing group (3 out of 20) due to tip of nail within joint, as compared to nil case reported in LP group. Similiar findings were quoted in study by Shroff *et al.* [1] and Shailendra *et al* [7]. One patient in LP group developed non-union with screw failure for which revised plating and bone grafting was done. Apart from this, 4 cases of LP group and 2 cases of RN group had stiffness, more being in older age patient population owing to poor compliance to physiotherapy exercices explained to them.

CONCLUSION: Mean KOOS score was found to be significantly better in RN group as compared to type A fractures. However for type C fractures results were statistically insignificant. Good to excellent results were seen in 65% (13 patients out of 20 patients) who underwent RN, 40% (8 patients out of 20 patients) who underwent LP, according to Knee injury Osteoarthritis Outcome score at the end of 6 months.

This study showed statistically better results in terms of range of motion in RN technique for type A fractures. Average time of surgery was lesser in retrograde nailing group.30% of the patients had follow up of more than 6 months, the average time of union was found to be less in RN group as compared to LP group, but it was not significant. Overall, Knee injury Osteoarthritis Outcome score was better for extraarticular fractures. Most of the patients in RN group showed excellent results.

Difference for parameters, time to osseous healing, knee motion, pain, rate of second surgery, post-op complication etc were found to be statistically insignificant, proving both RN and LCP as adequate options. Although LP can be used for all fractures including complex type C and osteoporotic fractures, RN is preferred in terms of operating time, blood loss, knee flexion, early weight bearing, bone union and show good results in extra articular type-A fractures. However, for type C fractures, need of the hour is to focus on proper pre-op planning, surgical technique and experience rather than implant of choice

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