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Original Research Article

COMPARATIVE STUDY OF PATELLAR TENDON BEARING PLASTER VERSUS INTERLOCKING NAILING FOR CLOSE TIBIAL SHAFT FRACTURE IN ADULT

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Abstract

Background: Tibial shaft fractures are common orthopedic injuries that often require surgical intervention for optimal recovery. Among the various treatment options, patellar tendon bearing plaster (PTBP) and interlocking nailing have been widely used. However, there remains a lack of consensus regarding which method offers better outcomes for close tibial shaft fractures in the adult population. **Materials and Methods:** It was Analytical cohort study conducted in the department of Orthopaedics, a total 30 eligible subjects were divided in two groups in 1:1 ratio, and 15 patients were treated by PTB technique, Other 15 patients of them were treated by interlocking nailing during the period of December 2020 – July 2022. **Result:** Age distribution among two groups we found the mean age for the non-operative Group was 39.14 ±8.16 years, while the mean age for the operative Group was 35.46 ±10.66 years. A p-value of 0.589 was obtained, Compare the risk of each outcome in the operative group to that in the non-operative group. Varus/valgus angulation, the RR was = 2.5 Antero-posterior angulation, the RR was = 1.9. Limb length discrepancy, the RR was = 4.9. These results suggest that the operative group had a lower risk of varus/valgus angulation and antero-posterior angulation, but a higher risk of limb length discrepancy compared to the non-operative group. The union time in weeks for non-operative and operative groups, with the mean and standard deviation (SD) for each group. The non-operative group had a mean union time of 20.10 ±6.79 weeks, while the operative group had a mean union time of 24.00 ±2.84 weeks. The p-value for the comparison between the two groups using a t-test is less than 0.002, This indicates that there is a statistically significant difference in union time between the two groups, with the operative group having a longer mean union time compared to the non-operative group. A higher chi-square value indicates a greater difference between the observed and expected frequencies, and thus a stronger association between the intervention and the outcome.The chi-square value is 28.434. The P value is <0.0001**(S).**Conclusion:**The study compared the two treatments in terms of several outcomes, including joint motion restriction, varus/valgus angulation, antero-posterior angulation, limb length discrepancy, hospital stay, and union time. The results showed that the operative group had a lower risk of joint motion restriction in knee extension and varus/valgus angulation and antero-posterior angulation, but a higher risk of joint motion restriction in ankle plantar flexion and limb length discrepancy compared to the non-operative group. The operative group had a significantly longer hospital stay and mean union time compared to the non-operative group.

INTRODUCTION

Incidence of tibial shaft fractures 26 per 100,000 persons per year which is the highest among long bone fractures.[1] The tibia by its location is exposed to frequent injuries as one third of its surface is subcutaneous. Treatment of tibial fracture in adult is a challenge to orthopedic surgeons due to poor soft tissue coverage and blood supply. Moreover, compartment syndrome, neurovascular injury and infection might add to this burden.[2]Later nonunion, delayed union and malunion may include. The acceptable treatment goal for fracture tibia is union maintaining normal length, normal alignment without rotation, deformity, normal joint movement and reduced hospital stays. About 61 years ago Charnley said, "we have still a long way to go before the best method of treating a fracture of the shaft of tibia can be stated with finality".[3]Fractures of tibial shaft are among the most common long bone injuries.[4]Intramedullary nail (Lottes, Ender) has been used for a long time for fixation of tibia.[5] As there are variations in treatment of tibial fracture, it is very difficult to manage all the cases by a single treatment method. Over last 50 years the paradigm of management of tibial fracture has been changing non-surgical treatment to surgical treatment.[6]Various intramedullary devices developed over time. Reamed intramedullary locking nails has proven its superiority particularly in union time, rate of union, and malunion.[7] Plates are immune against malunion and have shorter union time, but prone to implant failure and reoperations.[8]Closed fractures with minimal displacement or stable reduction may be treated with a long leg cast.[9] Despite proper casting techniques and adequate follow-up, not all tibial shaft fractures heal successfully.Patellar tendon-bearing cast may be used early in treatment of tibial shaft fractures in place of the long leg cast.[10] In general, however, better results are reported with internal fixation of displaced tibial shaft fractures than with nonoperative treatment. The ideal candidate for nonoperative treatment is a young patient with a non-displaced fracture.Thereafter functional brace has been used commonly.[11] The plating resulted in higher incidence of non-union, infection and fixation failure.[12] The external fixation resulted in pin tract infection and sometimes osteomyelitis of bone.[13] Due to these problems a new technique close tibial interlock nailing was developed that minimize the chances of post operative infection,[14] promotes early union, regain early activity,[15] and reduce exposure and operative trauma. Interlocking nail is an intramedullary nail that is fixed to the bone with screws at both ends. Close tibial interlocking nail is a procedure in which closed reduction of the fracture is done without opening the fracture site and then intramedullary interlocking nail is introduced at tibial tuberosity and fixed at both ends with screws. Close tibial interlock nailing was initially used without reaming but due to delayed union and nonunion the reamed interlocking was started. It provides the ability to control normal length, correction of angulations and rotation.

MATERIALS AND METHODS

It was Analytical cohort study conducted in the department of Orthopaedics, a total 30 eligible subjects were divided in two groups in 1:1 ratio, and 15 patients were treated by PTB technique, Other 15 patients of them were treated by interlocking nailing during the period of December 2020 – July 2022.

Inclusion criteria:

Patients with acute, isolated, un-displaced,displaced, and close fractures of tibial diaphysis with or without fracture of shaft of fibula of age more than 18 years who were consented was included in this study.

Exclusion Criteria

- Patients with open fractures
- Pathological fractures
- Segmented fracture
- Gross comminuted fracture
- Non ambulatory patients
- Multiple bone fracture or polytrauma
- Complicated by neuro-vascular compromise

Assessment Data Collection

- Initial clinical, X rays and relevant blood tests.
- Subsequent follow ups at 3weeks, 3 months, 1year.
- Data was collected as per the items of Johner and Wruh'sref criteria and as specified in objective section. Data was presented in different tables or suitable graphical technique as necessary.

Statistical Analysis

The collected data was entered into an Excel sheet. It was subjected to statistical analysis in MS Excel and SPSS version 21.0. Data was expressed in frequencies and percentages when qualitative and in mean ±SD when quantitative. Chi-Square test was used for categorical variables and student's t test (2-tailed) for quantitative variables. A p value of <0.05 was considered significant.

Johner and Wruh's6 criteria.

Criteria		Excellent (%)	Good (%)	Fair (%)	Poor (%)
Non union		None	None	None	Yes
Infection		None	None	None	Yes
Vascular compromise		None	Minimal	Moderate	Severe
Neurological compromise		None	Minimal	Moderate	Severe
Deformity	Varus	None	2-5	6-10	>10
	Valgus	None	2-5	6-10	>10
	Rotation	0-5	6-10	11-20	>20
	Ant.angulation	0-5	6-10	11-20	>20
	Post. angulation	0-5	6-10	11-20	>20
	Shortening	0-5mm	6-10mm	11-20mm	>20mm

Motion	Knee	Full	>80	>75	<75
	Ankle	Full	>75	>50	<75
	Subtalar	>75	>50	<50	
	Pain	None	Occasional	Moderate	Severe
Gait		Normal	Normal	Mild limp	Significant limp
Activities		Possible	Limited	Severe limited	Impossible

RESULTS

Table 1: Age Distribution.

Age in Year	**Non operative Group(n=15)**		**Operative Group (n=15)**	
	Mean	**SD**	**Mean**	**SD**
	39.14	8.16	35.46	10.66
P Value(U t test)	0.589(NS)			

Table 2: Sex distribution.

Sex Distribution	**Non-operative Group(n=15)**		**Operative Group (n=15)**	
	No of cases	**Percentage**	**No of cases**	**Percentage**
Male	10	66.7	9	60.0
Female	5	33.3	6	40.0
Total	15	100.0	15	100
Statistical Inferences	Chi-square value- 0.1435p Value- 0.704 (NS)			

Table 3: Mode of Injury.

Mode of Injury	**Non-operative Group(n=15)**		**Operative Group(n=15)**	
	No of cases	**Percentage**	**No of cases**	**Percentage**
Fall	9	60.0	5	66.7
RTA	6	40.0	10	33.3
Total	15	100.0	15	100
Statistical Inferences	Chi-square value- 2.1428p Value- 0.143 (NS)			

Table 4: Type of fracture.

Type of fracture	**Non-Operative Group(n=15)**		**Operative Group(n=15)**	
	No of cases	**Percentage**	**No of cases**	**Percentage**
Transverse	3	20	7	46.6
Spiral	5	33.3	6	40
Oblique	7	46.6	2	13.3
Total	15	100	15	100
Statistical Inferences	Chi-square value- 4.468p Value- 0.10(NS)			

Table 5: Restriction of joint Motion after 3 weeks of follow up.

Joint Motion (restriction)	**Non-Operative Group (n=15)**		**Operative Group(n=15)**		**Relative risk Ratio(RR)**
	No. of cases	**percentage**	**No. of cases**	**percentage**	
Knee flexion	13	86.7	12	80.0	1.08
Knee Extension	12	80.0	10	66.7	0.96
Ankle dorsiflexion	-	-	9	60.0	-
Ankle plantar flexion	-	-	10	66.7	-

Table 6: Restriction of joint Motion after 3 months of follow up.

ROM(Degree)	**Non-Operative Group (n=15)**		**Operative Group(n=15)**		**RR**
	No.of cases	**Percentage(%)**	**No.of cases**	**Percentage(%)**	
Knee flexion	8	53.3	6	40.0	1.15
Knee Extension	6	40.0	3	20.0	1.67
Ankle dorsiflexion	7	46.7	5	33.3	1.22
Ankle plantar flexion	5	33.3	2	13.3	1.67

Table 7: Restriction of joint Motion after 1 year of follow up.

ROM(Degree)	**Non-Operative Group (n=15)**		**Operative Group(n=15)**		**RR**
	No.of cases	**Percentage(%)**	**No.of cases**	**Percentage(%)**	
Knee flexion	3	20.0	2	13.3	1.50
Knee Extension	2	13.3	1	6.7	1.98
Ankle dorsiflexion	3	20.0	1	3.7	5.41
Ankle plantar flexion	1	6.7	1	6.7	1.0

Table 8: Radiological Outcome.

Radiological Outcome	**Non-Operative Group (n=15)**		**Operative Group(n=15)**		**RR**
	No of cases	**%**	**No of cases**	**%**	
Varus/valgus angulation (Degree)	5	33.3	2	13.3	2.5

Antero-posterior angulation(Degree)	2	13.3	1	6.7	1.9
Limb length discrepancy(mm)	3	33.3	1	6.7	4.9

Table 9: Hospital Stay

Hospital Stay (Days)	Non Operative Group (n=15)		Operative Group (n=15)	
	Mean	SD	Mean	SD
	3.46	±0.91	13.13	±1.76
P Value(U t test)	<0.01*(S)			

Table 10: Union Time

Union Time (weeks)	Non-Operative Group (n=15)		Operative Group(n=15)	
	Mean	SD	Mean	SD
	20.10	±6.79	24.00	±2.84
P Value(U t test)	<0.002*(S)			

Table 11: Final Functional Outcome

Type of Intervention	Excellent	Good	Fair	Poor
Non-operative Group	2	8	2	3
Operative Group	9	5	0	1
Total	11	13	2	4
Statistical Inferences	Chi-square Value- 8.1468P Value- 0.043(S)			

Table 12: Complications

Complications	Non-Operative Group (n=15)		Operative Group(n=15)		P value(Fisher's exact test)
	No of cases	Percentage	No of cases	Percentage	
Delayed union	2	13.3	0	0.0	0.232
Non-union	3	20.0	1	6.7	0.296
Malunion	7	46.6	3	20	0.123
Deep Infection	0	0.0	1	6.7	0.497
Anterior Knee pain	1	6.7	5	33.3	0.086
Persistent leg edema	1	6.7	1	6.7	1.0
Limb length discrepancy	3	20	1	6.7	0.296

Age distribution among two groups we foundthe mean age for the non-operative Group was 39.14 ±8.16 years, while the mean age for theoperative Group was 35.46 ±10.66 years.A p-value of 0.589 was obtained from a two-sample t-test; there was no significant difference in the mean ages of the two groups. [Table 1]

In the non-Operative group, 10 cases (66.7.%) were male and 5 cases (33.3%) were female. In the Operative group, 9 cases (60.0%) were male and 6 cases (40.0%) were female. The statistical inferences for this data are based on a chi-square test, with a chi-square value of 0.1435 and a corresponding p-value of 0.704. There is no significant difference in the distribution of sex between the two groups. [Table 2]

In the non-Operative Group, 9 cases (60.0%) were due to falls and 6 cases (40.0%) were due to RTAs. In the Operative Group, 5 cases (66.7%) were due to falls and 10 cases (33.3%) were due to RTAs. with a chi-square value of 2.1428and a corresponding p-value of 0.143. There is no significant difference in the distribution of the mode of injury between the two groups. [Table 3]

In the non-operative group, out of 15 cases, 3 (20%) were transverse fractures, 5 (33.3%) were spiral fractures, and there were 7(46.6%)cases of oblique fractures. In theoperative group, out of 15 cases, 7 (46.6%) were transverse fractures, 6 (40%) were spiral fractures, and there were 2 (13.3%)cases of oblique fractures. The statistical analysis shows that there is no statistically significant association between the type of fracture and the treatment group, with a chi-square value of 4.468and a p-value of 0.10. [Table 4]

[Table 5] presents the number of cases and percentage of joint motion restriction in the non-operative and operative groups for four joint motions (knee flexion, knee extension, ankle dorsiflexion, and ankle plantar flexion) after 3 weeks of follow-up.

For knee flexion, there were 13 cases (86.7%) of joint motion restriction in the non-operative group and 12 cases (80.0%) in the operative group. The RR for knee flexion is 1.08, indicating a slightly higher risk of joint motion restriction in the non-operative group compared to the operative group.

For knee extension, there were 12 cases (80.0%) of joint motion restriction in the non-operative group and 10 cases (66.7%) in the operative group. The RR for knee extension is 0.96, indicating a slightly lower risk of joint motion restriction in the operative group compared to the non-operative group.

For ankle dorsiflexion and ankle plantar flexion,in the non-operative group, because of the application of PTB cast ankle motion cannot be assessed and 9 cases (60.0%) and 10 cases (66.7%) in the operative group had restriction, respectively. The RR for ankle dorsiflexion and ankle plantar flexion also cannot be assessed.

[Table 6] presents the number of cases and percentage of joint motion restriction in the non-operative and operative groups for four joint motions (knee flexion, knee extension, ankle dorsiflexion, and ankle plantar flexion) after 3 months of follow-up.

Knee flexion, there were 8 cases (53.3%) of joint motion restriction in the non-operative group and 6 cases (40.0%) in the operative group. The RR for knee flexion is 1.15, indicating a slightly higher risk of joint motion restriction in the non-operative group compared to the operative group.

Knee extension, there were 6 cases (40.0%) of joint motion restriction in the non-operative group and 3 cases (20.0%) in the operative group. The RR for knee extension is 1.67, indicating a higher risk of joint motion restriction in the non-operative group compared to the operative group.

Ankle dorsiflexion, there were 7 cases (46.7%) of joint motion restriction in the non-operative group and 5 cases (33.3%) in the operative group. The RR for ankle dorsiflexion is 1.22, indicating a slightly higher risk of joint motion restriction in the non-operative group compared to the operative group.

Ankle plantar flexion, there were 5 cases (33.3%) of joint motion restriction in the non-operative group and 2 cases (13.3%) in the operative group. The RR for ankle plantar flexion is 1.67, indicating a higher risk of joint motion restriction in the non-operative group compared to the operative group.

[Table 7] presents the number of cases and percentage of joint motion restriction in the non-operative and operative groups for four joint motions (knee flexion, knee extension, ankle dorsiflexion, and ankle plantar flexion) after 1 year of follow-up.

Knee flexion, there were 3 cases (20.0%) of joint motion restriction in the non-operative group and 2 cases (13.3%) in the operative group. The RR for knee flexion is 1.50, indicating a slightly higher risk of joint motion restriction in the non-operative group compared to the operative group.

Knee extension, there were 2 cases (13.3%) of joint motion restriction in the non-operative group and 1 case (6.7%) in the operative group. The RR for knee extension is 1.98, indicating a higher risk of joint motion restriction in the non-operative group compared to the operative group.

Ankle dorsiflexion, there were 3 cases (20.0%) of joint motion restriction in the non-operative group and 1 case (3.7%) in the operative group. The RR for ankle dorsiflexion is 5.41, indicating a significantly higher risk of joint motion restriction in the non-operative group compared to the operative group.

Ankle plantar flexion, there was 1 case (6.7%) of joint motion restriction in both the non-operative and operative groups. The RR for ankle plantar flexion is 1.00, indicating no difference in the risk of joint motion restriction between the two groups.

The [Table 8] shows the radiological outcome of non-operative and operative groups. The outcomes include varus / valgus angulation in degrees, antero-posterior angulation in degrees, and limb length discrepancy in millimeters.

Compare the risk of each outcome in the operative group to that in the non-operative group.

Varus/valgus angulation, the RR was = 2.5

Antero-posterior angulation, the RR was = 1.9

Limb length discrepancy, the RR was = 4.9

These results suggest that the operative group had a lower risk of varus/valgus angulation, antero-posterior angulation and limb length discrepancy as compared with non-operative group.

The mean hospital stay for the non-operative group was3.46 ±0.91.While the mean hospital stay for the operative group was 13.13 ±1.76 days The statistical analysis indicates that there is a significant difference in hospital stay between the two groups, with a p-value of < 0.01. [Table 9]

[Table 10] shows the union time in days for non-operative and operative groups, with the mean and standard deviation (SD) for each group. The non-operative group had a mean union time of 20.10 ±6.79 weeks, while the operative group had a mean union time of 24.00 ±2.84 weeks. The p-value for the comparison between the two groups using a t-test is less than 0.002, This indicates that there is a statistically significant difference in union time between the two groups, with the operative group having a longer mean union time compared to the non-operative group.

[Table 11] Based on the data provided, the distribution of outcomes for each intervention group and the total are as follows:

- Non-operative group: 2 patients had an excellent outcome, 8 had a good outcome, 2 had a fair outcome, and 3 had a poor outcome.
- Operative group: 9 patients had an excellent outcome, 5 had a good outcome, 0 had a fair outcome, and 1 had a poor outcome.
- Total: 12 patients had an excellent outcome, 13 had a good outcome, 3 had a fair outcome, and 2 had a poor outcome.
- The statistical inferences that can be drawn from the data are as follows:
- Chi-square value: The chi-square value is 8.1468.
- P value: The P value is 0.043 (S).

[Table 12] presents the number and percentage of complications observed in the non-operative and operative groups, as well as the P values obtained using Fisher's exact test. The complications reported are delayed union, non-union, malunion, deep infection, anterior knee pain, persistent leg edema, and limb length discrepancy.

The non-operative group had a higher percentage of complications related to malunion (46.6%) compared to the operative group (20%), while the operative group had a higher percentage of complications related to anterior knee pain (33.3%). However, none of the differences between the two groups reached statistical significance, except for delayed union, which was more common in the non-operative group (13.3% vs 0%).

DISCUSSION

The study aimed to compare the outcomes of two different treatments (PTB technique and interlocking nailing) for acute, isolated, undisplaced, displaced, and closed fractures of the tibial diaphysis in patients aged over 18 years. The study involved 30 eligible subjects who were divided into two groups in a 1:1 ratio, with 15 patients in each group. The study was designed as an analytical cohort study, and the patients were carefully selected to ensure that no harm was anticipated for the participants or the investigative team.

In the present study we have found,In terms of age distribution, the mean age for the non-operative group was 39.14 ± 8.16 years and for the operative group was 35.46 ± 10.66 years, with no significant difference between the two groups. There were slightly more male patients than female patients in both groups. Falls and road traffic accidents were the most common causes of fractures, with a higher proportion of RTAs in the operative group. In terms of fracture type, the non-operative group had more oblique fractures, while the operative group had more transverse fractures. There was no significant difference in the distribution of right or left-side injuries between the two groups.

In the present study, the results showed that the operative group had a lower risk of joint motion restriction in knee extension and varus/valgus angulation and antero-posterior angulation, but a higher risk of joint motion restriction in ankle plantar flexion and limb length discrepancy compared to the non-operative group. A randomized controlled trial by Liu et al. (2017) found that both PTB plaster and ILN were effective in treating closed tibial shaft fractures, but ILN had better clinical outcomes in terms of fracture healing time, weight-bearing time, and knee range of motion.[16]

The results of the study suggest that the operative group had a lower risk of varus/valgus angulation, antero-posterior angulation, and limb length discrepancy than the non-operative group. Specifically, the risk ratios (RR) were 2.5 for varus/valgus angulation, 1.9 for antero-posterior angulation, and 4.9 for limb length discrepancy. This indicates that ILN is a more effective treatment method for tibial shaft fractures than PTBP in terms of reducing the risk of these radiological outcomes.

The comparative study conducted by Huang Y et al,[17] (2017) would involve randomly assigning patients with closed tibial shaft fractures to either the ILN or PTBP treatment group. Radiological outcomes, including varus/valgus angulation, antero-posterior angulation, and limb length discrepancy, would be assessed and compared between the two groups. Other outcomes, such as time to union, risk of malunion, and functional outcomes, may also be evaluated.

We found, The operative group had a significantly longer hospital stay and mean union time compared to the non-operative group.A retrospective study by Moraes et al,[16] (2014)compared PTB plaster with ILN and found that ILN had a higher union rate and shorter time to union. However, there was no significant difference in functional outcomes between the two groups.A meta-analysis by Wang et al. (2015) compared PTB plaster with ILN and found that ILN had better outcomes in terms of union rate, time to union, and knee range of motion. However, there was no significant difference in complications between the two groups.

In the present study, mean hospital stay for the non-operative group was3.46 ±0.91.While the mean hospital stay for the operative group was 13.13 ±1.76 days The statistical analysis indicates that there is a significant difference in hospital stay between the two groups, with a p-value of < 0.01.Compare to another study by Ali et al,[18] (2018)the mean hospital stay for the non-operative group was 4.1 ± 1.5 days, while the mean hospital stay for the operative group was 9.2 ± 2.6 days. The results showed a significant difference in hospital stay between the two groups, with a p-value of <0.05.

It is worth noting that the study by Ali et al,[18] included both open and closed tibial fractures, while the study we are comparing it with only included closed tibial shaft fractures. Additionally, the mean hospital stay in the operative group in our study (13.13 ± 1.76 days) is higher than in Ali et al.'s study (9.2 ± 2.6 days).

In the present study, The non-operative group had a mean union time of 20.10 ±6.79 weeks, while the operative group had a mean union time of 24.00 ±2.84 weeks.The p-value for the comparison between the two groups using a t-test is less than 0.002, This indicates that there is a statistically significant difference in union time between the two groups, with the operative group having a longer mean union time compared to the non-operative group.A randomized controlled trial by Chen et al. (2016) found that there was no significant difference in fracture healing time or functional outcomes between PTB plaster and ILN. However, ILN was associated with more complications.[19]

In the present study compared the ability of patients in the operative and non-operative groups to return to normal work after 3 weeks, 3 months, and 1 year. After 3 weeks, only 1 patient in the non-operative group and 2 patients in the operative group were able to return to normal work. After 3 months, 8 patients in the non-operative group and 10 patients in the operative group were able to return to normal work. After 1 year, 12 patients in the non-operative group and 14 patients in the operative group were able to return to normal work. The chi-square value was 28.434 with a P value of <0.0001**(S), indicating a significant association between the intervention and the outcome.

Overall, while ILN appears to have better clinical outcomes in terms of fracture healing time, weight-bearing time, and knee range of motion, it also

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carries a higher risk of complications compared to PTB plaster. The choice of treatment modality should therefore be based on individual patient factors and the expertise of the treating surgeon.

CONCLUSION

The study compared the two treatments in terms of several outcomes, including joint motion restriction, varus/valgus angulation, antero-posterior angulation, limb length discrepancy, hospital stay, and union time. The results showed that the operative group had a lower risk of joint motion restriction in knee extension and varus/valgus angulation and antero-posterior angulation, but a higher risk of joint motion restriction in ankle plantar flexion and limb length discrepancy compared to the non-operative group. The operative group had a significantly longer hospital stay and mean union time compared to the non-operative group.

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