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A Retrospective Comparison Between Retrograde Intramedullary Nail Fixation and Lateral Plate Fixation for Tibiotalocalcaneal Arthrodesis

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ABSTRACT

Tibiotalocalcaneal arthrodesis (TTCA) is an established surgical intervention for advanced tibiotalar and subtalar joint conditions. Two prevalent fixation methods-retrograde intramedullary nail fixation (RINF) and lateral plate fixation (LPF)-are utilized in TTCA, each with unique benefits and potential complications. This study aims to provide a comparative analysis of RINF and LPF in TTCA to guide optimal surgical decision-making. To compare the clinical efficacy and complication rates between RINF and LPF in TTCA patients. In a retrospective review of 30 patients, LPF demonstrated shorter operative times (76.16±6.16 minutes vs. 102.61±12.82 minutes, p<0.001) and less blood loss (83±18.28 ml vs. 160.17±20.62 ml, p<0.001) than RINF. RINF achieved faster fusion times (17±3 weeks vs. 19±4 weeks, p=0.0029). Both groups had comparable fusion rates and significant pain reduction postoperatively, with no significant difference in overall complication rates (p=0.80). Both RINF and LPF offer effective fixation for TTCA with similar morbidity profiles. LPF may be preferred for reduced operative time and blood loss, whereas RINF may be advantageous for quicker fusion. Further studies are needed to optimize patient selection for each fixation method. To compare the clinical efficacy of retrograde intramedullary nail fixation (RINF) and locking plate fixation (LPF) for TTCA. To measure the incidence of complications associated with each fixation method.

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Key Words
LPF, RINF, TTCA

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INTRODUCTION

The tibiotalar and subtalar joints are fundamental elements of the ankle and hindfoot complex, playing a pivotal role in preserving ankle mobility and flexibility, essential for weight-bearing activities and ambulation. Secondary lesions in these joints, resulting from injury, developmental abnormalities, or chronic tendon dysfunction affecting the ankle or hindfoot, can lead to significant pain, deformity and gait impairment. For patients who do not achieve satisfactory outcomes with conservative treatments, surgical intervention may offer pain relief and functional restoration. While combined tibiotalar joint replacement and subtalar fusion have been suggested this approach is technically complex and associated with uncertain long-term results[1]. In contrast, tibiotalocalcaneal arthrodesis (TTCA) has demonstrated favorable outcomes, enabled the resumption of normal daily activities and remained the gold-standard surgical option for advanced disease in the tibiotalar and subtalar joints[2]. Tibiotalocalcaneal arthrodesis (TTCA) was first introduced by Lexer in 1906[3]. With advancements in implant technology and refinements in surgical methods, the fusion rates of TTCA have progressively improved, while complication rates have declined[4]. Surgical fixation techniques employed in TTCA include screws, external fixators and angle plates. TTCA can be accomplished through various fixation methods, such as pressure screw fixation, angle plate fixation, retrograde intramedullary nail fixation (RINF) and locking plate fixation (LPF). Retrograde intramedullary nail fixation offers simplicity in application and procedural efficiency, with reported fusion rates ranging from 71-95%[5]. However, the reaming process required in RINF may increase risks of systemic inflammation, pulmonary embolism and infection. The recent development of LPF has enhanced its utility in managing complex orthopaedic trauma. Compared to conventional plate fixation, LPF offers distinct benefits for managing severely comminuted fractures, peri articular fractures and osteoporosis fractures. In cases involving peri articular and intra articular fractures, locking plates and screws with an angle-stable design provide enhanced structural stability, significantly improving resistance against shear and pull-out forces[6]. Despite the growing application of locking plate fixation (LPF) due to its relative simplicity and reliable fixation strength in tibiotalocalcaneal arthrodesis (TTCA), the optimal approach whether LPF or retrograde intramedullary nail fixation (RINF) remains a topic of debate. This study retrospectively analyzed the clinical outcomes of 30 patients who underwent TTCA with either RINF or LPF. The objective was to assess and compare the clinical efficacy and complication profiles associated with each fixation technique.

MATERIALS AND METHODS

This retrospective comparative study, conducted at a tertiary care hospital in Ahmedabad (2021-2023), evaluated the outcomes of tibiocalcaneal arthrodesis (TTCA) using retrograde intramedullary nailing (RINF) versus lateral plate fixation (LPF). A convenience sample of 30 patients undergoing TTCA with either RINF or LPF was enrolled, following strict eligibility criteria: patients aged >18 years with severe tibiotalar and subtalar joint lesions confirmed by imaging modalities (X-ray, CT and/or MRI) and failure of conservative therapy who give consent were included, Exclusions included active infections, severe congenital bone defects, revision surgery and incomplete follow-up (<12 months). Data collection involved analyzing surgical records, electronic and physical medical records and a pre-designed questionnaire assessing demographics, indications, smoking status, comorbidities and complications. Statistical analysis was performed using Microsoft Excel 2019. This study received Institutional Ethics Committee approval.

RESULTS AND DISCUSSIONS

Table 1: Demographic Profile of Patients

Characteristic	RINF(n=18)	LPF(n=12)	p value
Age (Mean ± sd)	48±11	51±12	0.337
Gender n (%)			
Male	10(55.55)	8(66.66)	0.816
Female	8(44.44)	4(33.33)	
Side of lesion n (%)			
Left	10(55.56)	8(66.67)	0.820
Right	8(44.44)	4(33.33)	
Comorbidities n (%)			
Diabetes Mellitus	3(16.67)	0	0.875
Osteoporosis	10(55.55)	7(58.33)	
Obesity	5(27.78)	3(25)	
Smoking	5(27.78)	3(25)	

(Note: Statistically significant at the p value <0.05 level).

(Table 1) shows demographic and clinical profile of pts. A comparative analysis of demographic and clinical profiles was conducted between patients undergoing Retrograde Intramedullary Nailing (RINF, n=18 male 10 (55.55) and female 8(33.33)) and Lateral Plate Fixation (LPF, n=12 male 8(66.66) and female 4(33.33). The mean age at surgery was found to be statistically similar between the two groups (48±11 vs. 51±12 years, P=0.337). Additionally, no significant intergroup differences were observed in gender and terms of lesion laterality (P=0.820). The prevalence of comorbidities, including osteoporosis (55.55% RINF, 58.33% LPF), diabetes mellitus (16.67% RINF, 0% LPF, P=0.875), obesity (27.78% RINF, 25% LPF) and smoking (27.78% RINF, 25% LPF), was also comparable. These findings suggest that the RINF and LPF cohorts exhibited analogous baseline characteristics, thereby validating the comparability of the study groups. (all p value >0.05).

Table 2: Indication for Surgery

Indication	RINF (n=18) (%)	LPF(n=12) (%)	p value
Traumatic arthritis	10(55.56)	5(41.67)	0.972
Osteoarthritis	4(22.22)	3(25)	
Rheumatoid arthritis	2(11.11)	2(16.67)	
Charcot arthritis	1(5.56)	1(8.33)	
Talar necrosis	1(5.56)	1(8.33)	

(Note: Statistically significant at the p value <0.05 level).

(Table 2) outlines the surgical indications. The results showed that traumatic arthritis was the predominant etiology (55.56% RINF, 41.67% LPF), followed by osteoarthritis (22.22% RINF, 25% LPF) and rheumatoid arthritis (11.11% RINF, 16.67% LPF). Charcot joint disease and talar necrosis were additional contributing factors. Statistical analysis revealed no significant difference in disease causes between the groups (p=0.972).

Table 3: Surgical Outcome and Complication

Outcome and complication	Mean±Sd		
	RINF n (18)	LPF n (18)	P Value
Operation time (minutes)	102.61±12.82	76.16±6.16	< .00001*
Blood loss (ml)	160.17±20.62	83±18.28	< .00001*
Postoperative fusion time (week)	17±3	19±4	0.0029*
VAS Score			
Pre operative	6.17±1.21	6.83±1.43	0.378
Post operative	1.61±1.11	1.83±1.14	0.306
AOFAS			
Pre operative	37.11±8.15	42.41±8.57	0.00213*
Post operative	72.22±7.11	74.41±6.42	0.00213*
Postoperative total fusion rate %	90.60%	94.54%	0.638
Surgical complication total n (%)	4(22.22)	4(33.33)	0.80
Infection	2(50)	1(25)	0.709
Non union	2(50)	1(25)	0.709
Wound skin necrosis	0	2(50)	0.357

(Note: * indicate significance, statistically significant at the p value <0.05 level).

(Table 3) outlines surgical outcome and complication of RINF and LPF. The RINF procedure required significantly longer operation times (102.61±12.82 minutes) compared to LPF (76.16±6.16 minutes, P<0.001). Additionally, RINF patients experienced greater blood loss (160±20.62 ml) than LPF patients (83.0±18.28ml, P<0.001). However, RINF demonstrated a shorter postoperative fusion time (17±3 weeks) compared to LPF (19±4 weeks, P<0.0029). Both groups achieved high fusion rates, with 90.6% in RINF and 95.4% in LPF. Pain and functional assessments revealed significant improvements in both groups post-surgery: VAS scores decreased from 6.17±1.21-1.61±1.11 (RINF) and 6.83±1.43-1.83±1.14 (LPF). AOFAS scores increased from 37.11±8.15-72.22±7.11 (RINF) and 42.41± 8.57-74.41±6.42 (LPF). Intergroup comparisons revealed no significant differences in preoperative or postoperative VAS scores (P>0.05). However, significant differences were observed in preoperative and postoperative AOFAS scores between the two groups (P<0.00213). This study highlights Except for postoperative fusion time, LPF patients showed significant advantages in all other aspects over RINF patients. Superficial wound infections occurred in two RINF and one LPF patient, managed with dressing changes and intravenous antibiotics. Bone non-union required revision surgery in two RINF and one LPF case. Notably, wound skin flap necrosis was observed in two LPF patients, resolving after debridement and re-suture, whereas no cases were reported in the RINF group. Despite varying individual complications, statistical analysis revealed no significant difference in overall complication rates between the groups (p=0.80), indicating comparable morbidity profiles.

The present study retrospectively analyzed the outcomes and complications of 30 patients with severe tibiotalar joint lesion combined with subtalar joint lesion, which failed to respond to a fair trial of conservative therapy and who received TTCA surgery with RINF or LPF. Compared with LPF, RINF surgery required longer operative time and more blood loss, although it had less postoperative fusion time than LPF. The complication rates in the both groups similar. These results suggest that LPF may be a better option for TTCA treatment than RINF. TTCA surgery is usually indicated for the treatment of severe tibiotalar joint lesion combined with subtalar joint lesion, which is not satisfactory due to its low fusion rate compared with normal ankle joint arthrodesis. That is because the lesions treated using TTCA are generally more severe and with a higher incidence of inflammatory joint disease and severe osteoporosis. TTCA is a difficult surgery requiring stronger fixation methods to increase the fusion rate[7]. RINF and LPF were considered as potentially good methods for TTCA. Tavakkolizadeh et al. used RINF to treat 26 patients with tibiotalar joint and subtalar joint lesions and obtained good postoperative AOFAS scores of 66[8]. Kamath *et al.* achieved 74.6 postoperative AOFAS for their patients with rheumatoid arthritis, which was comparable to the scores we obtained in the present study[9]. Mendicino *et al.* reported that 25% of patients who received TTCA using RINF had severe complications such as osteomyelitis, non-union and pulmonary embolism and that 55% of patients had complications such as wound skin necrosis and superficial skin infection[10]. The mechanical stability of integration area of RINF is relatively limited, which might affect fusion. Bennett *et al.* 20 found that RINF had limited antirotation stability and needed auxiliary straddle nail for fixation. In addition, the RINF method is only suitable for patients with co-existing degeneration the of tibiotalar and subtalar joints. In recent years, RINF was used for patients with ankle arthritis combined with subtalar arthritis and achieved good results.

Ahmad *et al.* reported a group of 18 patients treated for TTCA with LPF at proximal humerus and 17 out of 18 patients (94.4%) achieved fusion with no obvious complications[11]. Several biomechanical studies confirmed that compared with RINF, using cannulated compression screw nail and angle plate methods, LPF had the best biomechanical fusion strength for TTCA surgery, especially for patients with osteoporosis, as well as in other population of patients[12-16]. We used a sufficient number of locking screws to fix the tibia-talus and calcaneus, which should result in a stronger fixation and improved compression on fused bone to provide excellent stability for TTCA and increased fuse rate, as previously shown[13-16]. However, the plates were not designed specifically for TTCA. The position and orientation of the screws for fixing tibia, talus and calcaneus were not optimal in some patients. In these cases, light shaping had to be performed to fit the specific regional anatomic structure of these patients. However, the shaping was very light and did not compromise the solidity of the plate[17]. Some studies reported that RINF achieved better fusion rates and less surgeon-associated complications[18,19]. We found that the LPF method needed less operation time, had less intraoperative blood loss and required less surgical perspective examinations. Previous studies showed that shorter surgical time and nonreaming operation also reduced the incidence of postoperative wound infection, both groups had good joint fusion rates[20,21].

Limitation of Study: This study has several limitations that warrant consideration. Firstly, the convenience sampling method employed in this research may introduce selection bias, as participants were not randomly selected from the population, potentially compromising the generalizability of the findings. Moreover, the relatively small sample size (n=30) may limit the statistical power and precision of the results, increasing the risk of type II errors. Furthermore, the retrospective design of this study may have introduced information bias due to the reliance on existing medical records, potentially leading to incomplete or inaccurate data. The lack of randomization and control group also precludes causal inferences about the treatment outcomes. Future studies should address these limitations by employing prospective, randomized controlled trial designs with larger sample sizes to enhance the validity and reliability of the findings.

CONCLUSION

This study's findings indicate that LPF may be a superior option for TTCA treatment due to its shorter operative time, reduced blood loss and comparable complication rates to RINF. Future research should further explore the clinical implications of these results.

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