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# TEMPORARY STABILIZATION OF TIBIA FRACTURES: DOES EXTERNAL FIXATION OR TEMPORARY PLATE FIXATION RESULT IN BETTER OUTCOMES?

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## ABSTRACT

**Background: Provisional stabilization of high-energy tibia fractures using temporary plate fixation (TPF) or external fixation (ex-fix) prior to definitive medullary nailing (MN) is a strategy common in damage control orthopaedics. There is a lack of comprehensive data evaluating outcomes between these methods. This study compares outcomes of patients stabilized with either TPF or ex-fix, and with early definitive MN only, assessing complications including nonunion and deep infection.**

**Methods: A retrospective review was performed on adult patients with tibia fractures treated with MN followed until fracture union (≥3 months) at a single level-1 trauma center from 2014 to 2022. Medical records were evaluated for nonunion and deep infection. Demographics, injury characteristics, and fixation methods were recorded. Significance between patients who underwent TPF and ex-fix was compared with a matched cohort of early MN using Pearson's exact tests, independent t-tests, and one-way ANOVA, depending on the appropriate variable..**

**Results: 81 patients were included; 27 were temporized with TPF (n = 12) or ex-fix (n = 15). 54 early MN cases defined the matched cohort. All groups had similar patient and fracture characteristics. The difference in rates of nonunion between groups was significant, with TPF, ex-fix, and early MN groups at 17, 40, and 11% respectively (p = 0.027). Early MN had lower rates of nonunion (11% vs. 40%, p = 0.017) and deep infection (13% vs. 40%, p = 0.028) compared to ex-fix.**

**Conclusion: Temporary ex-fix followed by staged MN was associated with higher rates of nonunion and deep infection. There was no difference in complication rates between TPF and early definitive MN. These data suggest that ex-fix followed by MN of tibia fractures should be avoided in favor of early definitive MN when possible. If temporization is needed, TPF may be a better option than ex-fix.**

**Level of Evidence: IV**

**Keywords: tibia fracture, external fixation, temporary plate fixation, open fracture, outcomes**

## INTRODUCTION

Provisional stabilization of tibia fractures is sometimes performed for high energy fractures. Often this is performed in the setting of a severe soft tissue injury or open fracture, compartment syndrome, or a vascular injury.[1] In these situations, a two-stage approach beginning with temporary stabilization and ending with definitive medullary nailing (MN) can be employed. This method of temporary fracture stabilization is used in damage control orthopedics and aims to limit infections and expedite conversion to definitive fixation.[1-5]

External fixation (ex-fix) and temporary plate fixation (TPF) are two methods currently used by surgeons to provisionally stabilize and improve axial alignment for open tibia shaft fractures. Historically, external fixation has been the predominant method of temporary fixation for fractures of the tibia, but more recently, TPF has been used to achieve the same goal.[6] Previous work has suggested that both temporizing methods are safe when immediate definitive fixation is not an option, but it remains unclear whether there is a difference in long term clinical outcomes between the two techniques.[7,8]

Some surgeons have suggested that immediate definitive fixation of tibia shaft fractures with MN is safe in most circumstances and that temporary fixation of these injuries is rarely necessary. Recent studies found

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that tibia fractures definitively or temporarily treated with ex-fix may be associated with increased rates of complication when compared to early definitive MN.[9,10]

The purpose of this study was to compare complication rates among patients who underwent temporization surgery with either TPF or ex-fix for tibia fractures that were later definitively treated with MN, which then included a third group that was established as a matched cohort of similarly classified tibia fractures treated with early definitive MN only. The authors hypothesize that there would be no difference in complications between the TPF or ex-fix groups, but that the early definitive MN would result in fewer complications than ex-fix or TPF, defined by nonunion and deep infections rates.

## METHODS

After receiving institutional review board approval, a retrospective review of all patients who underwent medullary nailing for a tibia fracture at a single Level-1 trauma center from 2014 to 2022 was conducted. Operative notes were used to determine whether patients received temporary stabilization with TPF or ex-fix prior to MN, and radiographs were used for confirmation. Patients under the age of 18, who had a pathologic fracture, were followed for less than 3 months (unable to assess fracture union), or that underwent both TPF and ex-fix simultaneously for provisional management were excluded from the study.

Once all temporary fixation cases from the initial search were identified, another cohort from the remaining cases that received early definitive MN was created by splitting cases into two groups: open or closed. These were then randomly arranged and sequentially reviewed to construct a matched cohort that mirrored the proportions of open versus closed fractures seen in the TPF and ex-fix groups. Importantly, these also maintained a comparable distribution of AO/OTA and Gustilo-Anderson fracture characteristics as seen in the TPF and ex-fix groups. The total number of cases in this matched cohort was determined by doubling the number of cases in the TPF and ex-fix groups combined, while using the same exclusion criteria.

Patient demographic and case-specific data including age at operation, sex, substance use history, diabetic status, smoking status, injury mechanism, and duration of temporary fixation and follow-up were recorded. Fracture characteristics including comminution and AO/OTA classification were documented for every fracture, along with Gustilo-Anderson type for open fractures. Recorded complications of interest included tibial nonunion and deep infection.

### Statistical Analysis

Descriptive statistics were calculated for all continuous data in the TPF, ex-fix, and early MN groups, including age, follow-up duration, and duration of temporary fixation. These were compared using one-way ANOVA tests and significance was calculated with independent t-tests. All other categorical variables were described with percentages and compared using the Freeman-Halton extension of the Pearson's exact test for significance level. Statistical analysis was completed with commercially available software.

### Nonunion

The determination of nonunion relied on clinical and/or radiographic evidence, or the diagnosis of nonunion charted by the attending surgeon following the patient. The criteria for diagnosis of nonunion were as follows: At ≥3 months post definitive fixation, (1) patients experienced motion or pain while stressing or fully weight bearing on the injured extremity; and (2) radiographs demonstrated the presence of fracture lines or absence of bridging callus.

### Deep Infection

Deep infections were defined as those occurring anytime during follow-up that related to the inciting tibial injury or subsequent corrective surgery, which resulted in corrective surgery necessitating debridement, removal of hardware, revision, or amputation. At least one of the following criteria had to be met for diagnosis of deep infection: (1) abscess or sinus tract with direct communication to bone; (2) radiographs concerning for osteomyelitis; (3) positive deep tissue culture.

### Temporary Fixation

Temporary fixation (stage 1) was the first of a two-stage operation that began with either TPF or ex-fix and ended with definitive MN (stage 2). For open fractures with extensive contamination and soft tissue or vascular damage, initial debridement, vascular repair, and plan for soft tissue coverage were completed by an interdisciplinary team of orthopedic, vascular, and plastic surgeons at stage 1 of the operation. Some tibia shaft fractures with severe comminution or extension into the proximal or distal metaphysis required supplemental fixation with dynamic compression plates (DCP) in addition to MN at stage 2 of the operation.

### External Fixation

Ex-fix was performed >24 hours prior to definitive fixation with MN. The reasons for ex-fix included hemodynamic instability, comminuted open fractures, and soft tissue injury. Two patients underwent external fixation at an outside hospital. In all cases, at least one pin was inserted on each side of the fracture, and all fractures underwent definitive MN at the authors' home institution.

### Temporary Plate Fixation

TPF was completed >24 hours prior to definitive fixation via MN. The reasons for performing TPF included hemodynamic instability, soft tissue swelling, or need for extensive wound exploration. TPF involved spanning the fracture with either a small or large fragment plate of appropriate length, grossly re-aligning the fracture, and subsequently securing the plate to the tibia in temporary bridge mode. The approach for open fractures utilized existing traumatic wounds whenever possible. All temporary plates were removed prior to definitive MN.

Exhibit 1 depicts a typical example of TPF followed by MN. The patient underwent temporary fixation due to hemodynamic instability and was found to have bilateral segmental pulmonary emboli. For TPF of the right tibia, small percutaneous incisions were made to pass a 4.5 mm 12-hole plate. The tibia was grossly realigned, and the plate was wired in the appropriate position and used as a reduction aid to control coronal translation. The right extremity wounds were closed primarily before transfer back to the ICU. After further resuscitation and stabilization, the provisional plate was removed, and definitive MN was performed.

## RESULTS

485 patients were identified based on our criteria. After initial screening, we identified 30 patients who received temporary fixation. Two were treated with both TPF and ex-fix simultaneously and one had inadequate follow-up, so these patients were excluded (Figure 1). Of the remaining 27 patients, 12 were temporized with TPF and 15 with ex-fix. The remaining 455 MN cases consisted of 114 open fractures and 341 closed fractures. Of these, 54 were selected to define the early MN matched cohort.

A total of 81 patients were included for analysis. The mean age was 43±20 years. 78% were male (63/81), 26% were smokers (21/81), 7% were diabetic (6/81), and 27% endorsed substance abuse history (22/81). Mean duration of temporary fixation for the TPF and ex-fix groups were 13.2±10.6 and 10.5±12.6 days (range: 1-53) and there were no statistical differences for baseline characteristics in the three groups. All three groups had statistically comparable patient and injury characteristics (Tables 1 and 2), however, the mean follow-up duration of the TPF, ex-fix, and early MN groups was13.2±12.7, 26.2±23.7, and 12.7±12.3 months (range: 3-66, p=0.01), respectively.

Of all tibia fractures, 84% were comminuted (68/81) and 70% were open (57/81) (Table 2). At 84%, the most common AO/OTA fracture classification encountered was 42C. 19% of the open fractures were classified as

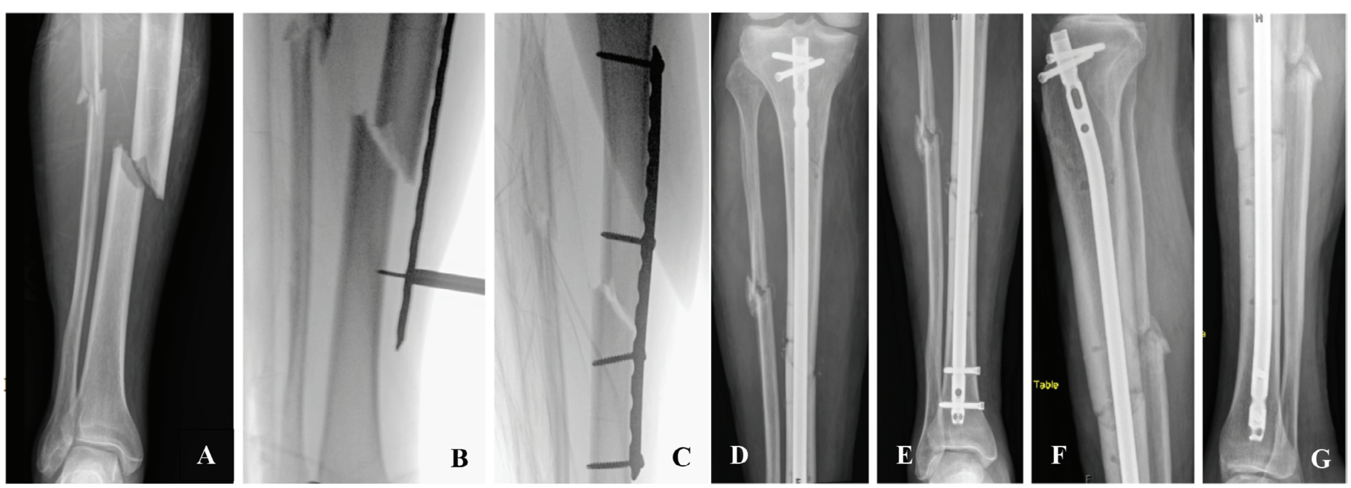


**Figure 1A to 1G. Case example. The use of temporary plate fixation for stabilization of tibia fractures. These radiographs were obtained from a 72-year-old male who suffered a polytraumatic event after a high-speed motor vehicle collision. He sustained an aortic injury resulting in retroperitoneal hemorrhage in addition to multiple orthopedic injuries including open left femur, tibia, and fibula fractures as well as closed right tibia and fibula fractures. The preoperative anteroposterior (AP) radiograph (1A) depicts acute comminuted transverse fractures of the tibia and fibula. Intraoperative fluoroscopic images show positioning of the temporary plate (1B) followed by achievement of satisfactory alignment and attachment of plate with four bicortical screws (1C). Twenty-nine days later, the temporary plate was removed, and the tibia fracture was definitively treated with MN. Postoperative AP (1D, 1E) and lateral (1F, 1G) radiographs demonstrate interval healing and improved alignment of the proximal (1D, 1F) and distal (1E, 1G) tibia.**

**Table 1. Patient Characteristics by Fixation Method**

| | | TPF (n = 12) | Ex-fix (n = 15) | Early MN (n = 54) | p-value |
|---|---|---|---|---|---|
| Age | | 44 ± 20 | 42 ± 9 | 43 ± 18 | 0.951 |
| Male Gender | | 11 (92%) | 10 (67%) | 42 (78%) | 0.340 |
| Diabetes | | 1 (8%) | 1 (7%) | 4 (7%) | 0.999 |
| Smoking Status | Never | 4 (33%) | 5 (33%) | 26 (48%) | |
| | Former | 4 (33%) | 6 (40%) | 10 (19%) | 0.074 |
| | Current | 2 (17%) | 2 (13%) | 17 (31%) | |
| Substance Use | | 3 (25%) | 5 (27%) | 14 (26%) | 0.871 |
| Temporary Fixation Duration | (days) | 13.2 ± 10.6 | 10.5 ± 12.6 | - | 0.523 |
| Follow-up Duration | (months) | 13.2 ± 12.7 | 26.2 ± 23.7 | 12.7 ± 12.3 | 0.010 |

TPF = temporary plate fixation, Ex-fix = external fixation, MN = medullary nailing.

**Table 2. Injury Characteristics by Fixation Method**

| | | TPF (n = 12) | Ex-fix (n = 15) | Early MN (n = 54) | p-value |
|---|---|---|---|---|---|
| Mechanism | Ground level fall | - | 1 (7%) | 5 (9%) | 0.335 |
| | | | | | |
| | Fall from height | - | 1 (7%) | 5 (9%) | |
| | MVC | 1 (8%) | 5 (33%) | 9 (17%) | |
| | MCC/ATV | 1 (8%) | 4 (27%) | 15 (28%) | |
| | Auto vs. Peds | 7 (58%) | 4 (27%) | 14 (26%) | |
| | Ballistic | 1 (8%) | - | 1 (2%) | |
| | Other | 2 (17%) | - | 5 (9%) | |
| Comminution | | 12 (100%) | 12 (80%) | 44 (81%) | 0.306 |
| Open Fracture | | 9 (75%) | 10 (67%) | 38 (70%) | 0.877 |

TPF = temporary plate fixation, Ex-fix = external fixation, MN = medullary nailing, MVC = motor vehicle collision, MCC = motorcycle crash, ATV = all-terrain vehicle.

Gustilo-Anderson Type I (11/57); 11% were Type II (6/57), and 70% were Type III (40/57). All three groups were statistically similar with respect to fracture characteristics (Table 3).

In total, 17% of patients (14/81) resulted in nonunion. The difference in rates of nonunion between groups was significant, with TPF, ex-fix, and early MN groups at 17, 40, and 11%, respectively ($p = 0.027$, Table 4). A total of 20% of patients developed deep infections including 25% in the TPF group, 40% in the ex-fix group, and 13% in the MN group ($p = 0.053$, Table 4). The early MN group had significantly lower rates of nonunion (11% vs. 40%, $p = 0.017$) and deep infection (13% vs. 40%, $p = 0.028$) compared to the ex-fix group (Table 5). There was no significant difference in nonunion or deep infection between the TPF and ex-fix groups, or in complication rates between the early MN and TPF groups (Table 5).

## DISCUSSION

In this single-center retrospective study, the authors compared complication rates between temporary external fixation or temporary plate fixation versus early definitive medullary nailing in the management of high energy tibia fractures. The major findings were that external fixation followed by later medullary nailing was associated with a higher risk of nonunion and deep infection when compared to early definitive medullary nailing. There was no difference in complication rates between temporary plate fixation and early definitive nailing.

Temporary plate fixation has been described more recently in the literature, but information regarding its safety and efficacy is sparse. Some studies suggest TPF may be superior to ex-fix,[7,8] but it remains unclear whether ex-fix or TPF is the better method of temporary stabilization, or if these temporizing methods result in significantly worse outcomes when compared to early definitive MN of tibia fractures.

**Table 3. Fracture Classification by Fixation Method**

| | | TPF | Ex-fix | Early MN | p-value |
|---|---|---|---|---|---|
| AO/OTA | 42A | 1 (8%) | 1 (7%) | 9 (17%) | 0.632 |
| | 42C | 11 (92%) | 13 (87%) | 44 (81%) | |
| | 43B | - | 1 (7%) | 1 (2%) | |
| Gustilo-Anderson | Type I | 2 (22%) | 1 (10%) | 8 (21%) | 0.883 |
| | Type II | - | 1 (10%) | 5 (13%) | |
| | Type III | 7 (78%) | 8 (80%) | 25 (66%) | |
| | IIIA | 3 (43%) | 5 (63%) | 20 (80%) | 0.118 |
| | IIIB | 3 (43%) | 1 (13%) | 4 (16%) | |
| | IIIC | 1 (14%) | 2 (25%) | 1 (4%) | |

TPF = temporary plate fixation, Ex-fix = external fixation, MN = medullary nailing.

**Table 4. Complication Rates Compared to Fixation Method Overall**

| | Fixation method(s) | Rate | p-value |
|---|---|---|---|
| Non-union | Early MN | 6 (11%) | 0.027 |
| | Ex-fix | 6 (40%) | |
| | TPF | 2 (17%) | |
| | Overall | 14 (17%) | |
| Deep infection | Early MN | 7 (13%) | 0.053 |
| | Ex-fix | 6 (40%) | |
| | TPF | 3 (25%) | |
| | Overall | 16 (20%) | |

TPF = temporary plate fixation, Ex-fix = external fixation, MN = medullary nailing.

**Table 5. Complication Rates Compared to Fixation Method by Pairing**

| | Fixation method(s) | Rate | p-value |
|---|---|---|---|
| Non-union | Early MN vs. ex-fix | 12 (17%) | 0.017 |
| | Early MN vs. TPF | 8 (12%) | 0.449 |
| | Ex-fix vs. TPF | 8 (30%) | 0.186 |
| Deep infection | Early MN vs. ex-fix | 13 (19%) | 0.028 |
| | Early MN vs. TPF | 10 (15%) | 0.259 |
| | Ex-fix vs. TPF | 9 (33%) | 0.343 |

TPF = temporary plate fixation, Ex-fix = external fixation, MN = medullary nailing.

In a 2017 retrospective study, Whiting et al. compared complication rates between a cohort of patients receiving damage control plating (n = 9) or ex-fix (n = 11) for temporary fixation of open tibia fractures. They found no difference in complication rates and determined that TPF was quicker and less expensive than ex-fix.[7] Another retrospective study conducted by Fowler et al. in 2019 concluded that TPF was at least as safe as ex-fix and may even reduce the long-term rates of deep infection in their cohort of Gustilo-Anderson type IIIB tibia fractures.[8] Similar to present literature, our study demonstrated that TPF had less complications compared to ex-fix for temporary stabilization.

More recently, Bunzel et al. observed an infection rate of 32% for tibia fractures treated with ex-fix prior to MN in a 2023 retrospective study. They recommended avoiding the use of ex-fix for temporary fixation whenever possible and limiting time spent in ex-fix to the shortest duration necessary.[9] Furthermore, a systematic review of 17 studies by Turley et al. found that the rates of tibial nonunion (9.7%) and infection (8.1%) were low in their cohort of 1850 patients receiving early MN for open tibia shaft fractures.[11] These results are agreeable with our study findings. Our study adds supporting data to a growing body of evidence suggesting that TPF may be the better alternative to ex-fix for temporary stabilization of tibia fractures and that early definitive medullary nailing should be considered whenever possible.

This study is limited by the nature of it being retrospective. Some patients did not attend all follow-up visits unless they were symptomatic. However, the authors of this study used adequate follow-up approaches for accurately reporting outcomes, aligning with established standards for orthopedic trauma follow-up protocols.[12,13] Secondly, some cases involving severely comminuted tibia shaft fractures with extension into the metaphysis were treated with MN and supplemental DCP. It was not possible to control for this treatment approach in our study. Finally, the sample sizes for the TPF and ex-fix groups were relatively small; consequently, the study may lack the statistical power to discern differences between the two temporary techniques. This limitation is mitigated by the positive results observed when separately comparing the TPF and ex-fix groups to the matched early MN cohort. Further prospective and larger comparative multi-center studies may be beneficial in providing more robust insights into the superiority of a particular treatment approach.

## CONCLUSION

In this present study, temporary external fixation of high energy tibia fractures followed by staged medullary nailing was associated with a higher risk of nonunion and deep infection compared to early definitive medullary nailing. There was no difference in complication rates between temporary plate fixation and early definitive medullary nailing. These data suggest that external fixation followed by medullary nailing of tibia fractures should be avoided when possible. In cases requiring temporization, damage control plating may be a better option than external fixation. Early definitive intramedullary nailing should also be considered as a viable treatment option.

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