



## Original Article

## Results of Primary Intramedullary Nailing After 6 hours of Open Diaphyseal Gustilo I and II Fracture of the Femur and Tibia: A Retrospective Study

*Résultats de l'Enclouage Intramédullaire Primaire Après 6 Heures de Fracture Diaphysaire Ouverte de Gustilo I et II du Fémur et du Tibia : Une Étude Rétrospective*

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**ABSTRACT**

**Introduction.** The annual incidence of open long-bone fractures is estimated to 11.5 per 100,000 habitants; and they occur in tibial diaphysis for a quarter of cases [1,2]. Their management is a challenge for the orthopedic surgeon. In order to avoid infection, the treatment of open limb fractures is a surgical emergency. **Objective.** The aim of this study was to assess the results of primary intramedullary nailing after 6 hours of open Gustilo I and II diaphyseal fractures of femur and tibia. **Materials and methods.** Between January 2021 and December 2023, a retrospective study was conducted. Patients over 15 years admitted for open Gustilo I and II diaphyseal fracture of the femur and/or tibia in whom locked intramedullary nailing had been performed after initial debridement were included. The study involved 35 patients, 26 (74.3%) men and 9 (25.7%) women. The mean age was 35.4 (17-56) years. There were 30 (85.7%) tibial diaphyseal fractures and 5 (14.3%) femoral fractures. The wound was classified as Gustilo II in 23 (65.7%) cases and Gustilo I in 12 (34.3%). Debridement was performed in 37.1% of cases between 12 and 24 hours. An unreamed intramedullary nailing was performed after debridement. All patients were followed up for an average w of 20 (12 - 24) months. **Results.** Wound healing was achieved in 24 (68%) patients after 21 days. We observed 2 skin necrosis. Bone healing was achieved in 33 (94.3%) patients within an average of 110 (100-150) days. We observed 2 (5.7%) septic pseudarthrosis. **Conclusion.** Primary intramedullary nailing of open Gustilo I and II fractures of the tibia and femur provide consolidation with a low rate of infectious complications.

**RÉSUMÉ**

**Introduction.** L'incidence annuelle des fractures ouvertes des os longs est estimée à 11,5 pour 100 000 habitants ; elles concernent la diaphyse tibiale dans un quart des cas [1,2]. Leur prise en charge est un défi pour le chirurgien orthopédiste. Afin d'éviter l'infection, le traitement des fractures ouvertes est une urgence chirurgicale. **Objectif.** Le but de cette étude était d'évaluer les résultats de l'enclouage intramédullaire primaire après 6 heures de fractures diaphysaires ouvertes de Gustilo I et II du fémur et du tibia. **Matériels et méthode.** Entre janvier 2021 et décembre 2023, une étude rétrospective a été réalisée. Les patients de plus de 15 ans admis pour une fracture diaphysaire ouverte de Gustilo I et II du fémur et/ou du tibia chez qui un enclouage intramédullaire verrouillé avait été réalisé après débridement initial ont été inclus. L'étude a porté sur 35 patients, 26 (74,3 %) hommes et 9 (25,7 %) femmes. L'âge moyen était de 35,4 ans (17-56). Il y avait 30 (85,7%) fractures diaphysaires tibiales et 5 (14,3%) fractures fémorales. La plaie a été classée comme Gustilo II dans 23 (65,7%) cas et Gustilo I dans 12 (34,3%) cas. Un débridement a été effectué dans 37,1% des cas entre 12 et 24 heures. Un enclouage intramédullaire non fraisé a été réalisé après le débridement. Tous les patients ont été suivis pendant une durée moyenne de 20 (12 - 24) mois. **Résultats.** La cicatrisation a été obtenue chez 24 (68%) patients après 21 jours. Nous avons observé 2 nécroses cutanées. La guérison osseuse a été obtenue chez 33 (94,3 %) patients dans un délai moyen de 110 (100-150) jours. Nous avons observé 2 (5,7%) pseudarthroses septiques. **Conclusion.** L'enclouage intramédullaire primaire des fractures ouvertes de Gustilo I et II du tibia et du fémur permet une consolidation avec un faible taux de complications infectieuses.

**INTRODUCTION**

The annual incidence of open long-bone fractures is estimated to 11.5 per 100,000 habitants; and they occur in tibial diaphysis for a quarter of cases [1,2]. Their management is a challenge for the orthopedic surgeon. In order to avoid infection, the treatment of open limb fractures is a surgical emergency. Open fracture require careful debridement and irrigation, bone fixation and skin coverage. Since Friedrich's work [3,4] many teams including our, preferably treat these injuries in operating room within 6 hours. However, everyone don't agree this principle [5]. Moreover, the results of immediate intramedullary nailing after initial debridement seems similar to external fixation concerning infection and healing incidence [6]. In our context, initial debridement is often delayed from several hours to days due to various management problems. Moreover, primary intramedullary nailing after debridement is preferred by patients and cheaper than external fixation. The objective of this study was to assess the results of primary intramedullary nailing after 6 hours of open Gustilo I and II diaphyseal fractures of femur and tibia. Did intramedullary nailing in this setting achieve bone healing with few complications?

**MATERIALS AND METHODS**

A retrospective study was carried out between January 2021 and December 2023 in the Orthopedic Department of Treichville University Hospital in Abidjan. Patients of age 15 and above admitted for Gustilo I and II open diaphyseal fracture of the femur and/or tibia; and treated beyond 6 hours from accident using intramedullary locked nailing after debridement were included in the study. Were not included patients in whom an external fixator was used after initial debridement; patients operated on before 6 hours from accident; and patients who refused to take part in the study. Patients lost to follow-up before the end of the study were excluded. The study included 35 patients, 26 (74.3%) men and 9 (25.7%) women. Average age was 35.4 (17-56) years. In 89% of cases, the injuries were the result of a road traffic accident. Emergency admission time was less than 6 hours in 79% of patients. Fractures of the tibial and femoral shaft

occurred in 30 (85.7%) and 5 (14.3%) cases respectively. The skin opening was classified as Gustilo II in 23 (65.7%) cases and Gustilo I in 12 (34.3%). Irrigation with saline and antiseptics, followed by a sterile dressing, was performed after admission. Antibiotherapy was started after admission and continued for at least 8 days. The fracture line was simple in 22 (63%) cases and complex in 13 (37%). Debridement and irrigation were performed in 37.1% of cases between 12 and 24 hours (Table I). An unreamed locked intramedullary nailing was performed after initial debridement. Patients were followed up after surgery for an average of 20 (12 - 24) months. Clinical monitoring concerned the evolution of skin healing. Healing was considered delayed if it occurred after 21 days. Biological monitoring included blood counts for hyperleukocytosis and bacteriological samples.

Orthogonal radiographs of the femur and tibia were used to assess bone consolidation. Consolidation was considered complete if it involved at least 3 bone cortices. We conduct this study in compliance with the principles of the declaration of Helsinki.

**RESULTS**

The average hospital stay after surgery was 5 (3-10) days. Wound healing was achieved after 21 days in 24 (68%) patients. For the remaining 14, wound healing occurred within 30 to 60 days. Two skin necrosis were observed in subjects with open Gustilo II fractures operated on between 24 and 48 hours. Treatment of necrosis consisted of local care, with a favorable outcome.

**Table I : Distribution according first debridement time**

Time (Hours)	Frequency : n (%)		Total :n (%)
	Gustilo I	Gustilo II	
6 - 12	2 (5,7)	0 (0)	2 (5,7)
12 - 24	5 (14,2)	8 (22,9)	13 (37,1)
24 - 48	2 (5,7)	6 (17,2)	8 (22,9)
48 - 72	1 (2,8)	3 (8,6)	4 (11,4)
>72	1 (2,8)	7 (20,1)	8 (22,9)

No secondary flap coverage was required. Bone healing was achieved in 33 (94.3%) patients in an average time of 110 (100-150) days. We observed 3 (8.5%) early infections in patients with complex fractures (Table II).

**Table II : Cross distribution according fracture characteristics and complications**

Characteristics		Infection		Pseudarthrosis		Total
		Yes	No	Yes	No	
Gustilo	I	1	11	1	11	12
	II	2	21	1	22	23
Fracture line	Simple	0	22	1	21	22
	Complex	3	10	1	12	13
Time to Surgery (Hours)	6 - 12	0	2	0	2	2
	12 - 24	2	11	2	11	13
	24 - 48	0	8	0	8	8
	48 - 72	0	4	0	4	4
	>72	1	7	0	8	8

Their treatment consisted of revision surgery for excision, bacteriological sampling and antibiotherapy. The outcome was favorable in 1 case, with wound healing obtained in 1 month without nail removal, and bone healing in 4 months. The last 2 cases progressed, one to osteitis and the other to aseptic pseudarthrosis, requiring revision. We observed 2 (5.7%) at distance septic pseudarthrosis.

## DISCUSSION

This study showed that primary intramedullary nailing after 6 hours of open Gustilo I and II diaphyseal fractures of femur and tibia, resulted in wound and bone healing with a low complication rate. In this series, bone healing was achieved in 94.3% of cases, with an early infection rate of 8.5%.

Gianoudis [7], in a meta-analysis of 666 open tibial fractures, confirms the efficacy of unreamed intramedullary nailing, with 95% of bone consolidation and a 7% rate of deep infection. Moreover, he observed no difference between external fixator and unreamed nailing concerning consolidation and the occurrence of infection. Other authors [6,8,9] confirm efficiency and safety of primary unreamed intramedullary nailing in the treatment of open limb fractures. Compared with external fixation, nailing not only provides a better rate of bone healing. Intramedullary nailing also requires fewer surgical interventions before healing, and results in a better patient compliance with treatment. These latter arguments are important in our context, because patients don't have health coverage and often see bonesetters for fracture treatment.

Concerning time of first debridement, 57.1% of patients in the series underwent surgery after 24 hours. This delay is beyond the gold standard of 6 hours currently matter of debate. Several studies maintain that even if debridement must be performed as soon as possible, the 6-hour time limit is not imperative [10,11,12,13].

For these authors, rather than the delay in initial debridement, early antibiotic administration and careful surgical management are the most important factors in preventing infection in open fractures.

Finally, although our study has limitations due to the small sample size and descriptive nature of the series, few complications occurred in post-operative follow-up. The 3 patients who developed post-operative infection were treated for complex fractures, including 2 Gustilo II open fractures. It seems that soft tissue attrition and extensive bone damage contributed significantly to the occurrence of infection in these patients.

## CONCLUSION

Primary Intramedullary nailing of open diaphyseal Gustilo I or II fractures of the tibia and femur is a safe and effective first-line solution. In our context, marked by a delayed treatment intramedullary nailing is an alternative solution to external fixators. But before nailing early administration of antibiotics and careful debridement must be carried out.

## ETHICS STATEMENT

Informed consent from all patients was obtained

## CONFLICT OF INTEREST

None

## CONTRIBUTION OF AUTHORS

**Armand Yepie:** Study design, data collection, data analysis, article writing.

**Moctar Traore:** Study conception and design, data analysis.

**Stephane Sainy:** Data collection

**Maurice Kouame:** Article revision, Final approbation

**Michel Anoumou:** Approval of final version for submission

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