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THE CHALLENGE OF OPEN TIBIAL SHAFT FRACTURES: WHEN TOMANAGE WITH EXTERNAL FIXATION AND WHEN TO USEINTRAMEDULLARY NAILING?

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ABSTRACT

Treatment of open tibial shaft fractures is challenging. External fixation (EF) is comparatively safe in treating these open injuries with the main advantages of easy application, minimal additional disruption, and convenient subsequent soft tissue repair. Tibial intramedullary nailing (IM) is optimal for the treatment of open tibial fractures. This study aims to report the outcomes of our multi-center experience in the management of open tibial shaft fractures, evaluating the efficacy and safety of using either the external fixation (EF) or intramedullary nailing (IM).In this study, clinical-radiographic results were evaluated in 26 cases of open fractures treated with an external fixator and intramedullary locking nail for the period from January 2012 to December 2016 at Level 1 trauma centers. Patients were evaluated for an average period of 12 months, observing the healing of the fracture at 1 month, 3 months, 6 months and 12 months. General assessment indicators included the direct cost of hospitalization and the times of the first surgery, full weight-bearing, and complete union. Infections and complications in union or limb alignment were compared as primary outcomes. Additionally, the number of patients who switched fixation system for various reasons was analyzed. The population we studied was predominantly male. The predominant etiology was due to traffic accidents. The type of fracture exposure was mostly type I. We mainly observed fracture healing with EF and had low complication rates. However, hospitalization health costs were high. In view of the obtained results from this study, it is clear that the type of treatment for open tibia diaphyseal fractures depends on the extent of the lesion and on the surgical manual skills of the surgeon, but in general, external fixation (EF) is a good method for preventing complications in cases of polytrauma and prevention of infection in open fractures.

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1. Introduction

Open tibial fractures, due to their reduced tissue coverage, represent the widestcategory of open fractures. They occur more often at the tibial shaft level in 19.1% of cases and at the distal and proximal end, respectively, in 1.3% and 1.2% of cases.

Generally, these fractures occur predominately in males, mainly resulting from high energy trauma (falling from heights or road accidents) and sometimes associated with other fractures [1-3]. The exposure of the tibia in fractures has a decisive influence on their management because they can lead to numerous complications, such as infection, non-union and delay of consolidation, which weigh on health costs and the prognosis of the patient [4-7].

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The classification system of Gustilo and Anderson is used for exposed fractures. Following this classification, 3 different types of open fractures are described: type 1 (wound<1 cm), type 2 (wound>1 cm) and type 3 (wound with consequent involvement of deep tissues). Type 3 includes three different subgroups of soft tissue damage: subgroup A when it is possible to cover the periosteum with the overlying soft tissues, subgroup B when the bone covering needs the aid of tissue flaps, and subgroup C when the vasculature-nerve structures are involved. The surgical treatment of these fractures aims to restore the lower limb axis, length and rotation, and aims at obtaining adequate stability for the patient's early recovery of daily activities [8-10]. However, the best approach regarding the treatment of open tibial fractures with soft tissue impairment remains controversial.
The aim of this study was to evaluate the clinical-radiographic outcomes of consecutive patients surgically treated for open tibial shaft fractures with external fixation (EF) or intramedullary nail (IM).

2. Material and methods

This article refers to a retrospective study conducted on 52 patients surgically treated for open fracture tibia diaphyseal fracture from January 2012 to January 2018 at Level I trauma centers. Case analysis began with access to our orthopedic emergency room, where remote history, proximal anamnesis, objective examination, and radiological evaluation were performed. All fractures were divided into 3 segments: proximal third, middle third and distal third and were subsequently evaluated on the basis of the extent of exposure according to the Gustilo & Anderson classification [8]. Inclusion criteria were: patients aged ≥18 years with an open tibia diaphyseal fracture and who were clinically stable. The exclusion criteria were: patients <18 years old, unstable patients, patients with pathological fractures, and tibia fractures treated with plate and screws. Patients received an antibiotic prophylaxis that included Ampicillin/Sulbactam (3g x 4 i.v.) + Amikacin (1g i.v./die) for 7 days ± Metrodazole (500mgi.v. x 3/day in case of risk of tetanus infection). Patients were also administered an anti-thrombotic prophylaxis. All enrolled participants were surgically treated within 24 hours of hospital admission with initial irrigation and debridement. Following debridement, the surgeon determined if the wound was amenable to immediate or delayed primary closure. Patients were evaluated for an average period of 12 months, evaluating the fracture's healing at 1 month, 3 months, 6 months and 12 months. General assessment indicators included the direct cost of hospitalization and the times of first surgery, full weight bearing, and complete union. Infections and complications in union or limb alignment were compared as primary outcomes. Additionally, the number of patients who switched their fracture fixation system for various reasons was analyzed.

3. Results

Out of 52 patients, 82% were male(n=42) and 18% were female (n= 10). The average age was 31.8. The main injury mechanism was a traffic accident for 65.3% (n=34), followed by work-related accidents for 23% (n=10), and finallya fall from heights for 11.5 % (n= 6).

The predominantly affected fracture site was the diaphysis in 69.2% of cases (n=36), followed by the proximal diaphysis in 11.5% (n=6) and the distal diaphysis in 19.2 % of cases (n=10). Regarding the extent of exposure, we found that 38.4% of the fractures were type 1 (n=20), 53.8% type 2 (n=28), 5.8% type 3 A (n=3) and type 3 B 1.8%(n=1) according to the Gustilo and Anderson classification (Figure 1). We found no cases of open fractures belonging to type 3 C. Regarding the surgical approach, the fractures were treated in 76.9% of cases (n=40) with an external fixator, while in 23.1% of the cases (n=12) bone synthesis was obtained with a locked intramedullary nail (Figure 2 and 3).

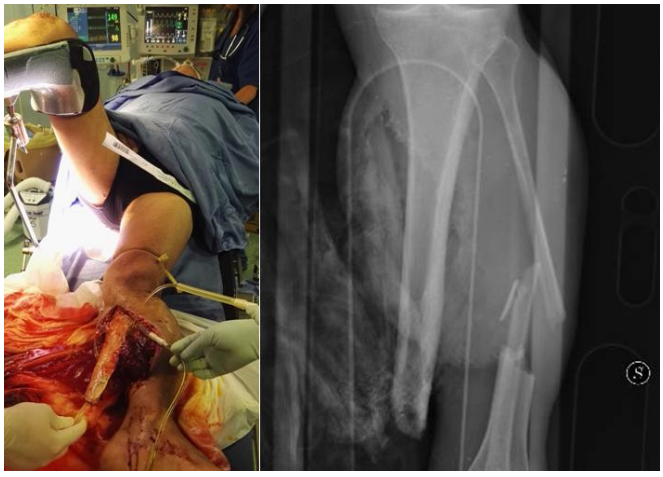

Figure 1. 56year-old man, pawn invested. Injury score of 26 points. Left leg sub-amputated, lesion of the external popliteal sciatic nerv. Mangled Extremity score of 3 points (Fig.1A). Figure B shows the X-ray of trauma with abundant loss of bone substance.

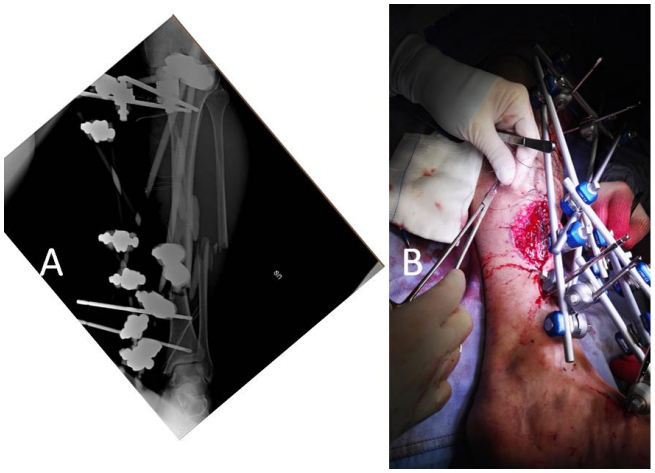

Figure 2. Damage control with external fixation to save the limb and antibiotic cemented beads put inside (2A). Closed the Wound (2B).

In 10 patients (19.2%) initially treated with external fixation, after three months, the synthesis was changed to an IM due the delayed bone union. The total cost of the first surgery was 8,171 Euro (±1,234; range 2,704 to 17,037).The total cost of the second surgery with an IM implantation was 4,232(±1,167.87; range 210to 8,414).First surgery time (hours) was 1.02(±0.34; range 0.35 to 2.41) where asthe time to install the new synthesis device was 1.42(±0.248; range 0.48 to 2.32). Time to full weight bearing (months) 4.62 (±1.27; range 3.23 to 6.54). Time to complete union (months) 5.41 (±1.27; range 3.96 to 22.17). Finally, with regard to the complications found, we noticed that in all of the cases analyzed, 29.9% reported some sequelae. In particular, infection occurred in 5.7% of cases (n=3), nonunion occurred in 5.6% patients(n=3) and 11.5% of patients (n = 6) presented with deep vein thrombosis (n=6).

Figure 3. After 6 months of Vacuum Therapy and with signs of infection, we performed the shaft fibular osteotomy and nailing of tibia.

4. Discussion

Numerous scientific papers have focused on the best possible approach in the treatment of these types of fractures, taking into account lesion size (clinical conditions of the patient, type of fracture and soft tissue impairment) and the surgeon's experience. In the treatment of open tibial fractures, there are two surgical options: external fixation (definitive or deferred) or internal fixation (osteosynthesis with intramedullary locking nail or plate) [11,12-16]. Both surgical options have advantages and disadvantages. External fixation is adopted in most cases as a temporary option for minimally invasive emergency fracture stabilization within the DCO (damage control orthopedic) [17-27]. The advantage of this method is it being minimally invasive, which is safe for the soft tissues, allowing it tobe used to correct any deformity or bone resection in case of infection [22-26]. On the contrary, external fixation is disadvantageous because it can lead to pin infection and consequently result in mal-union or non-union [19,23-25].As for internal fixation, there are two surgical methods: osteosynthesis with intramedullary locking nail or plate. The first method is advantageous because it allows greater stability, better reduction of the fracture site, early loading by the patient [7-8-9].

This method also provides for the reaming or no-reaming of the intramedullary canal, a technique discussed in the scientific literature on the advantages or disadvantages [20-21].Concerning osteosynthesis with plate, it is used in multi-segmentation fractures and in articular fractures where a better anatomical reduction is required. However, the use of plaques leads to greater aggression of the soft tissues and of the periosteum, compromising the tissue vascularization and the final consolidation of the fracture [13-22].The biomechanical limitations of external fixation for adequate reduction and stability and premature removal of the fixator in the healing process were believed to be the leading causes [13-23].Early (<5 days) closure is recommended for soft tissue injuries in open fracture. Gastrocnemius flap is suggested for fractures of the proximal third of the tibia, a soleus flap for middle third tibial fractures, and fasciocutaneous flap or free tissue transfer for distal third tibial fractures. The majority of the patients stated that they had had assistance with soft tissue reconstruction[24].Additionally, there are some inherent limitations of external fixation. A high pin-track infection rate is the most common problem. The pin-site infection rate was as low as in our study, but this did not result in an increased deep tissue infection risk. With our pin-site care protocol and detailed guidance in the discharge instructions, patients with pin-track infections received timely and successful treatment with oral antibiotics. For this reason, we believe that this is a ‘local problem’ rather than an obstacle or a true complication. In addition, the cumbersome nature of the external fixator is another drawback, leading to inconvenience in daily activities, and the need for an additional procedure to change the fixation device has a tendency to occur in some non-compliant patients. Therefore, we believe a mature discussion of the risks and benefits with patients is necessary; this may decrease the incidence of secondary operations to change the fixation system[13].Based on our results, we are in line with the literature regarding the epidemiology and incidence of tibial fractures. In fact, we have found that these injuries prevail in males aged thirty to forty, and that the main traumatic mechanism turns out to be a traffic accident trauma. We also confirm that these fractures are, in most cases, the result of high-energy trauma. Because of the anatomical features of the tibia, fractures can go against exposure of the bone stumps, a condition that weighs on the treatment and prognosis of the clinical case. The worst and most feared complications in orthopedic surgery are therefore infections, which in turn not only can compromise the patient's clinical condition, but can alter the consolidation process of the fracture in question. It is, therefore, very important to administer a broad-spectrum antibiotic prophylaxis at the time of first aid, sometimes targeting it as much as possible on potential microbial agents based on the environment in which the trauma occurred. Regarding the treatment, it always comes from the extent of the injury and the experience of the surgeon. The external fixator represents an effective surgical option to be adopted above all as damage control in cases of polytrauma, and in the correction ofdeformity or distraction osteogenesis following bone resections by the Ilizarov technique [25-28].

Under such conditions, this technique of osteosynthesis involves the reduction and stabilization of the fracture site by reducing the stress on the soft tissues, therefore not compromising the clinical condition of the unstable patient. External fixation, however, can be used as a transient surgical option, then converted into a definitive osteosynthesis by introducing an intramedullary locking nail or plate placement. In other cases, the external fixation can be considered as definitive treatment, thus avoiding a second surgical step. This last choice could result in the non-consolidation of the fracture or the clinical instability of the patient, a condition that contraindicates a definitive surgical treatment. However, a possible conversion of the external fixator into internal osteosynthesis is not without complications, such as an increase in the risk of infection and consequent increase in health care costs. The limit of this study appears to be the small sample size of patients, but despite this, we conclude that external fixation is an excellent method of osteosynthesis regarding the management of open fractures, preventing local and general complications of the patient, but also because it avoids s prolonged hospitalization, saving health care costs.

5. Conclusions

In view of what can be inferred from the reported literature and from the results of our study, the treatment of tibia fractures is subordinated to the type of clinical case in question. Therefore, it is important to perform a correct medical history of the patient and to analyze the extent of the injury. From our results, it is clear that the characteristics of the fracture are crucial in determining the type of surgical approach. We have used both osteosynthesis with external fixation and internal osteosynthesis with the introduction of intramedullary locking nails, evaluating the advantages and disadvantages of both surgical techniques. Regarding internal fixation, in our study we evaluated the results obtained with intramedullary locking nail. This method is characterized by a higher invasiveness, so it involves a major aggression of the soft tissues and a consequent greater probability of infection, especially if it constitutes an intervention following the external fixation, but it guarantees a better reduction and stability of the fracture site, allowing an early loading by the patient. The advantages of external fixation are related to a quick and simple technique of execution without excessively affecting the soft tissues in the case of open fractures. As for the disadvantages, infections of the screws can be found with consequent loosening of the same and alterations of consolidation of the fracture. These conditions can lead the surgeon to convert external fixation into an internal osteosynthesis. Finally, external fixation can be adopted both as a definitive treatment and as an emergency treatment and subsequently converted with internal osteosynthesis.

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