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INTERFERENCE OF EXTERNAL DAMAGE CONTROL FIXATION IN DEFINITIVE OSTEOSYNTHESIS

INTERFERÊNCIA DA FIXAÇÃO EXTERNA DO CONTROLE DE DANOS NA OSTEOSSINTESE DEFINTIVA

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ABSTRACT

Introduction: Indications for provisional external fixation prior to the definitive treatment of fractures are associated with the control of local and systemic damage and the impossibility of definitive osteosynthesis in the emergency. Objective: To identify complications associated with external fixation prior to definitive internal osteosynthesis. Methods: This is a comparative, prospective study (Level II). Inclusion criteria: patients treated as emergencies (November 2019 and March 2020) who underwent provisional external correction followed by definitive osteosynthesis. We look for signs of inadequacies in external correction and correlation with infections (erythema, hyperemia, fistulae in the path of the pins or surgical scars), systemic symptoms of infection, and radiographic parameters for treatment up to eight weeks after surgery. Results: The average time for conversion to definitive osteosynthesis was 15.9 days and 47 lower limbs and three upper limbs were fixed. Of the participants who had deep infections, three (6%) showed signs during initial treatment (external fixator) and nine (18%), after definitive internal osteosynthesis. We found no correlation between provisional external correction and complications in the definitive treatment with osteosynthesis. Conclusion: The use of temporary external fixation before definitive internal osteosynthesis in fractures of the appendicular skeleton failed to increase complication rates even if the path of the implants in both procedures overlapped. ***Level of Evidence II, Comparative Prospective Study.***

Keywords: Infections. External Fixators. Fracture Fixation, Internal.

RESUMO

Introdução: As indicações para a fixação externa provisória que antecedem o tratamento definitivo das fraturas está associado ao controle do dano local e sistêmico e à impossibilidade de osteossíntese definitiva na urgência. Objetivo: Identificar complicações associadas à fixação externa precedente à osteossíntese interna definitiva. Métodos: Estudo prospectivo comparativo realizado com pacientes atendidos em situação de urgência entre novembro de 2019 e março de 2020, que sofreram a fixação externa provisória seguida de osteossíntese definitiva. Buscamos indícios de inadequações na fixação externa e correlação com: infecção (eritema, hiperemia, fístula do trajeto dos pinos ou da cicatriz cirúrgica), sintomas sistêmicos de infecção e parâmetros radiográficos da evolução do tratamento até oito semanas do pós-operatório. Resultados: O tempo médio para conversão em osteossíntese definitiva foi de 15,9 dias, e foram fixados 47 membros inferiores e 3 membros superiores. Dos participantes que apresentaram quadros de infecções profundas, três (6%) apresentaram os sinais durante o tratamento inicial (fixador externo) e nove (18%) após a osteossíntese interna definitiva. Não foi encontrada correlação entre a fixação externa provisória e complicações no tratamento definitivo com osteossíntese. Conclusão: O emprego da fixação externa temporária antes da osteossíntese interna definitiva em fraturas do esqueleto apendicular não provocou aumento nas taxas de complicações, mesmo quando houve sobreposição no trajeto dos implantes usados nos dois procedimentos. ***Nível de Evidência II, Estudo Prospectivo Comparativo.***

Descritores: *Infecções. Fixadores Externos. Fixação Interna de Fraturas.*

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INTRODUCTION

Patients who arrive at the emergency room with extensive soft tissue injuries are indicated to use external fixators to control local damage, as surgical access for internal osteosynthesis is contraindicated. A second classical condition is patients with extensive lesions who require fracture stabilization but have an overall impairment so intense that the new aggression characterized by surgery puts the patient's life at risk. Definitive implants are available for at least 48 hours after hospitalization, wasting a surgical opportunity and increasing financial costs. This reality, imposed by the health care structure, makes us

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use external fixation aiming at provisional osteosynthesis in practically all fractures of the skeleton's major bones. Even so, physicians most often stabilize exposed diaphyseal fractures , followed by polytraumas — the latter case to control systemic damage.[1]
Admittedly, the indication of provisional osteosynthesis with external fixators aims to provide stability to the bone fragments of the fractured limb and restore physiological conditions to adjacent tissues. With the understanding of the pathophysiology of the intense inflammatory process which occurs in polytraumatized patients who require fracture stabilization, the indication of osteosynthesis with external fixators, especially tube-to-tube monoliteral ones, becomes a highly indicated technique.[2]
After the time required to recover from the adversities of traumatic injuries and to restore systemic and local conditions, patients will again be surgically approached either for conversion to osteosynthesis with internal implants or for the installation of osteosynthesis with external fixators which enable definitive treatment to stabilize smaller and joint fragments.[2] Thus, this study aimed to identify the complication rates associated with the application of temporary external fixation.
This study received no financial support from public, commercial, individual or legal sources.

MATERIALS AND METHODS

A prospective study was conducted with patients treated at the Emergency Department of a quaternary School Hospital in the central region of the municipality of São Paulo between November 2019 and March 2020. Our sample consisted of patients who were treated in the emergency service and who received indication of fracture stabilization with external fixator for the following reasons: control of local muscle and skeletal conditions or control of systemic damage or appendicular bone fracture which required stabilization either by exposure or by lack of definitive internal osteosynthesis in the emergency sector. To contemplate our other inclusion criteria, these patients would need a second surgical procedure aiming at definitive osteosynthesis and undergo a new evaluation in the eighth week after the second osteosynthesis.
The informed consent form (ICF) was shown and explained to each patient. Patients who had not undergone conversion to definitive osteosynthesis for any reason and those whose skeletons were still growing were excluded from this study. Moreover, this study was submitted to and approved by the Research Ethics Committee under the opinion: CAAE 23759319.8.0000.5479.
The surgical procedures for temporary external fixation were performed by resident physicians under the supervision of an attending physician from the Orthopedics and Traumatology Department of the hospital. As stated in the introduction, the literature lacks standardization for the installation of external fixators to control damage. Thus, it was at the discretion of the head of each team to freely establish the configuration of external fixators. Although the teams knew of the research in progress, this study was observational throughout treatment, without interference from its authors.
According to the institutional protocol, these patients received postoperative antibiotic prophylaxis with the intravenous use of second-generation cephalosporin for 24 hours. Even in the interval between emergency care and the definitive surgical procedure, observations were silent, and notes were kept confidential.
As for the technique for installing the treatment pins, the conventional technique was followed with the use of a drill and manual passage of the pins. The criterion for releasing the soft tissue was the operative team's responsibility — observed by the authors in the immediate patient follow-up in the ward, at the first dressing in bed, or in a second procedure in the operating room. The documentation of this observation was made by photographs taken with cellphone cameras within 48 hours of treatment evolution. The photographs taken postoperatively were used to prove medical records and identify inflammatory or infectious processes installed in the path of the Schanz pins. In the radiographs after definitive fixation, signs of coincidence of bone borings during the emergency installation of the Schanz pins with definitive osteosynthesis implants were sought (Figures 1, 2 and 3).

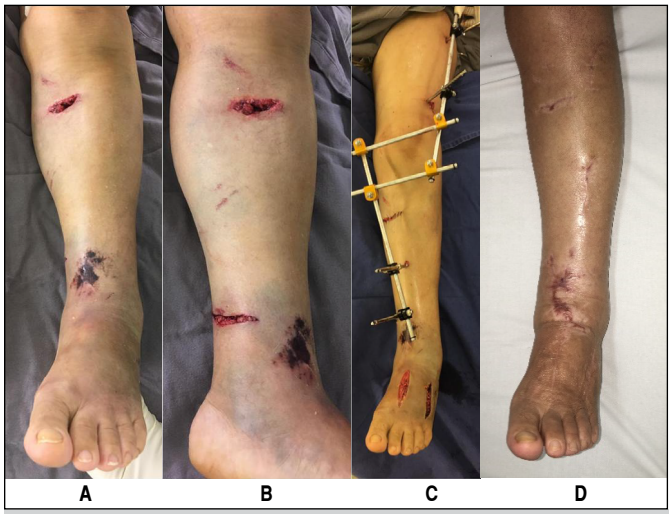

Figure 1. We can identify the exposure of the tibial plateau fracture (A and B) with clinical images after transarticular external fixation (C) and the same fracture after a two-month follow-up (D).

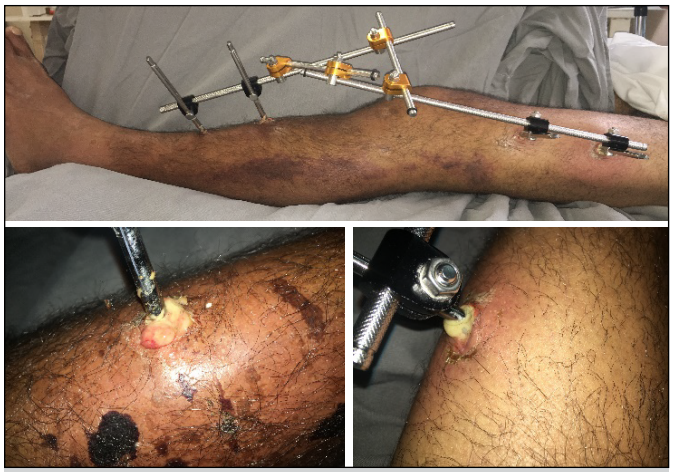

Figure 2. Images of clinical signs of infection around the Schanz pins.

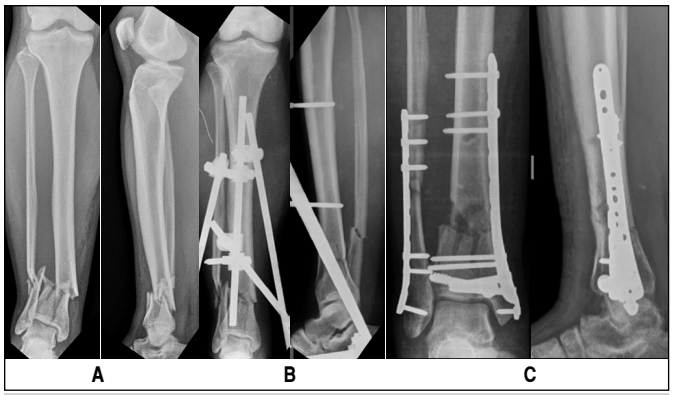

Figure 3. A tibial pylon (A) fracture was identified in the alignment after external fixation (B) and the immediate postoperative images, evincing the implant overlap with the prior port of the Schanz pin (C).

The classification of Gustilo and Anderson was performed by the team which performed the surgical procedure.[3] The indication of the need for soft tissue repair by flap rotation or other reconstructive surgery procedures was at the discretion of those responsible for conducting the treatment of patients, and no adversity was caused by the use of fixators with temporary osteosynthesis.
Post-procedure follow-up for clinical outcomes included the search for complications such as infections (erythema, hyperemia, fistula of the pin path or surgical scarring), systemic symptoms of infection, and postoperative radiographic parameters. Statistical analysis involved quantifying descriptive data via mean and standard deviations for the continuous variables and using percentages for the categorical variables via the SPSS Statistics 21 software.

RESULTS

Our sample initially consisted of 65 patients. In the established period of eight weeks for the postoperative follow-up, 16 abandoned follow-up in the institution, leaving a group of 49 participants who totaled 50 stabilized members with external fixators, 41 of which were males (83%) (Table 1).

Table 1. Descriptive data.

Characteristics	Total
Sample Size	**49 (100%)**
Age	**41.7 years (14.9)**
Days for conversion to DO	**15.9 days (10.7)**
Sex	
Male	41 (83.7%)
Female	8 (16.3%)
Energy at the time of trauma	
High energy	40 (81.6%)
Low energy	9 (18.3%)
Exposed Fractures	**28 (100%)**
Lower Limbs	25 (89.2%)
Upper limbs	3 (10.7%)

DO: definitive osteosynthesis; ±: standard deviation.

The mean time for conversion to definitive osteosynthesis was 15.9 days (± 10.7), with intervals varying between five and 69 days. Implant unavailability or the need to stabilize injured soft tissues caused the waits patients experienced for the definitive procedure. When waiting took longer than two weeks, patients had associated lesions in other devices which prevented definitive osteosynthesis (predominantly central nervous system injuries and respiratory failure). Table 2 shows that 47 lower limbs and three upper ones received fixators. Participants' mean age was 41.7 years (± 14.9) (Table 1).

Table 2. Fractured structure.

Anatomical part	Total
Leg	39 (78%)
Thigh	8 (16%)
Arm	2 (4%)
Forearm	1 (2%)

Of the total sample, 40 participants (81%) suffered high-energy trauma, whereas nine (18%) incurred in low-energy trauma. Considering the integrity of skin coverage, exposed fractures occurred 28 times, three in upper limbs and 25 in lower ones (78% of which in legs and 16%, in thighs). Regarding degree of exposure, following the classification of Gustilo and Anderson, nine were grade I, nine were grade II, and 10 were grade III (Table 3).

Table 3. Fractures with exposure.

Gustillo and Anderson Classification	Total
Grade I Classification	9 (32.1%)
Grade II Classification	9 (32.1%)
Grade III Classification	10 (35.7%)
Total	28 (100%)

Considering the 50 limbs stabilized in the emergency room, three (6%) suffered deep infection during initial treatment, i.e., between fixation in the emergency room and the wait for conversion to definitive osteosynthesis, probably as a result of bone exposure and soft tissue damage. Overall, nine segments stabilized in the emergency (18%) evolved with deep infection after definitive internal osteosynthesis (post-traumatic infection – Table 4). These patients required another hospitalization for systemic antibiotic therapy and 12% surgical debridement in this second hospitalization. In both groups, we did not find any treatment failures in the emergency room which could constitute the iatrogenic origin of the infection. Treatment of the infected followed the protocol of the institution with debridement, necessary reconstruction of the soft tissues, and specific antibiotic therapy.

Table 4. Postoperative infectious condition.

Presence of infection	Total
Infection post external fixator	
Yes	3 (6%)
No	46 (94%)
Infection post definitive osteosynthesis	
Yes	9 (18%)
No	39 (82%)

We also sought to characterize the presence of insufficient stabilization with the assembly of external fixators. In six patients, we found deviation of the fracture fragments in the radiographic controls between the intraoperative period on arrival and before the definitive surgery.
As for inadequacies in the installation of external fixators, 10 patients showed at least one inadequacy: four suffered from a coincidence of the surgical access to the fracture with the points of entry of the pins, one showed a coincidence of the entry of the pin with the incision to install the rod locking screw, two had phlogistic processes around the pin with tension of the soft tissues, and three incurred in multiple perforations for installation of the pins.
Regarding the implants used for definitive osteosynthesis, the most frequent ones were plates and screws of several models (56%), most often in the metaepiphyseal regions, intramedullary nails blocked in the diaphyseal lesions (22%), and Ilizarov circular external fixators (10%) (Table 5).

Table 5. Types of implants used.

Definitive fixation	Total
Plate and screw	28 (56%)
Intramedullary nail	11 (22%)
External fixator – Ilizarov	5 (10%)
Intramedullary nail	3 (6%)
Screw	2 (4%)
External fixator + Kirshner wires	1 (2%)

Regarding the overlap of the definitive osteosynthesis implants to the borings of the external fixation Schanz pins for provisional osteosynthesis, we found overlap in 34 fractured bones (68%), although we could observe no coincidence between the paths of the pins and the surgical accesses for definitive osteosynthesis. This coincidence occurred in 10 bones during subjection to internal osteosynthesis. we found that the Schanz pins caused tension on the soft injury tissue in 25 of the stabilized fractures (50%) (Table 6).

Table 6. Characteristics of the surgical procedure.

Characteristics	Total
Overlap of the definitive osteosynthesis pins	
Yes	34 (68%)
No	16 (34%)
Soft tissue tension	
Yes	25 (50%)
No	25 (50%)
Interference between pin and access route	
Yes	10 (20%)
No	40 (80%)
Consolidation after eight weeks	
Yes	45 (90%)
No	5 (10%)

We also observed patients eight weeks after definitive osteosynthesis, occasion in which we found delayed consolidation - in relation to what was expected - in five fractures (10%) (Table 6).

DISCUSSION

Applying monolateral external fixators in patients who arrive at the emergency room with multiple fractures or extensive local damage to soft tissues is a well-established conduct due to the low morbidity and minimal potential of the treatment to add tissue damage and consequent additional inflammatory processes. What the literature lacks is a standard assembly configuration for the external fixators used as provisional osteosynthesis, establishing the most appropriate arrangement of the Schanz pins to enable definitive osteosynthesis without coincidence of their entries and surgical access, for example. The fixation path of the Schanz pin, in particular steel ones, which is used in the emergency, determines the bacterial contamination and consequent colonization of its path. Research in the literature shows controversy regarding the higher prevalence of infections after provisional external fixation prior to definitive internal osteosynthesis.[1,2]

Our sample showed 18% of infected fractures after definitive osteosynthesis. We clinically and radiographically identified that the fracture foci were mechanically stable at the postoperative eight-week control, with neither clinical pain, functional disability nor bone lesion related to infections in the radiology exam. These patients required hospitalization for antibiotic therapy and 12% (two-thirds of the 18% group), a new surgical procedure for debridement. Studies mention postoperative infection rates of up to 30%.[4-6] In a previous study, the rate of infection after osteosynthesis was 12%.[6] We observed the overlap of definitive internal osteosynthesis with the boriongs of the Schanz pins in 43.8% of the patients. A current study has found such results in 68% of its patients.[6] The increased coincidence of surgical accesses to Schanz pin pathways was noteworthy, which seems undesirable to us, but it overlaps and the incidence of infection in definitive osteosynthesis showed no statistical significance. Some authors, when evaluating patients with fractures of the tibial plateau,[2] also reported the absence of correlation between the overlapping of the definitive implants with the infection of the definitive osteosynthesis. Another study found a rate of 16.5% of infection after internal osteosynthesis, followed by damage control with external fixation in the fractures of the tibial pylon, finding no correlation between infection and pin path overlapping to surgical accesses.[7] The overlapping correlation of the pins with surgical incisions, associated with infection, is also analyzed in a prospective study in which the external fixators installed for damage control are instruments for reducing fractures during definitive osteosynthesis.[1]

In our sample, we observed that between the accident and the definitive osteosynthesis procedure, nine patients (18%) underwent a clinically proven inflammatory and infectious process in the path of the installed Schanz pins, all with evidence of soft tissue tension against the pins. All patients underwent local debridement and antibiotics by a preoperative systemic approach to definitive surgery. Of these nine patients, two developed deep infections after osteosynthesis. We found no signs of correlation between infection of the pin path and deep infection, and we credited the association with definitive surgery. For our patients, the care with external fixators in the ward involved cleaning with a saline solution, removing crusts, and applying non-permeable dry dressings with sterile gauze around the Schanz pins. Studies suggest that specific care of pin injuries is unnecessary at follow-up, provided that the tension on the soft tissues against the Schanz pins is eliminated when installing the pins.[3]

When we seek information on the use of antibiotic therapy in the postoperative period after external fixator installation, we find that all patients received antibiotic prophylaxis with intravenous cephalosporin during the 24 hours immediately after surgery, according to hospital protocol. Studies state that this procedure shows no advantages for healthy patients, and that no significant correlation was found in relation to proven benefit or harm with the measure.[8]

Finally, we found no objective mention of the preparation for the pre-surgical planning to arrange the Schanz pins or the spatial structure of the external fixators in the damage control. In this series, we observed no association between pin arrangement, surgical access, and complications. From this observation, we should infer that it would be better to opt for a more stable conformation of the external fixators in damage control, not needing to seek atypical locations of the metal pins, avoiding the topography of the definitive implant. We were unable to find, in the literature, support which scientifically confirms this conclusion.

The clinical notes recorded by the surgical team were analyzed, seeking information on difficulties in the surgical procedure, criteria used to choose the points of insertion of the Schanz pins, existence of planning, prior to the surgical procedure, of the location of the pins, establishment of the probable surgical access for the definitive procedure, the occurrence of additional bone perforations to install the pins, and care in avoiding tension of the soft tissues against the Schanz pins. In this search for inadequacies in fixator installation, we found that ten patients showed at least one inadequacy: four had a coincidence of the surgical access to the fracture with the points of entry of the pins; one, a coincidence of the entry of the pin with the incision to install the rod locking screw; two, phlogistic processes around the pin with tension of the soft tissue; and three, multiple perforations for its installation. We sought to establish a relation between these data and the occurrence of complications but we found no significance.

In the definitive postoperative period, whenever we were unable to show the overlap of the definitive implants with the borings of the Schanz pins in postoperative radiographic images, we measured the distance from the pin boring to the extreme closest to the definitive implant in millimeters, compensating for the deformity in the digital

imaging system. We found the range of 6 to 96 millimeters (mean 42 millimeters). By subjecting this finding to the occurrence of complications in the definitive treatment, we were unable to prove a statistically significant association.

CONCLUSION

The use of temporary external fixation before definitive internal osteosynthesis in fractures of the appendicular skeleton failed to cause an increase in complication rates even if the path of the implants used in both procedures overlapped.

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