Firearm-Related Fractures: Epidemiology and Infection Rate*

Fraturas causadas por armas de fogo: Epidemiologia e taxa de infecção

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Abstract

Objective To investigate the incidence of infection in patients with gunshot-related fractures, and to correlate this finding with the occurrence of surgical debridement in the emergency room.

Methods A retrospective, observational, descriptive study that included all cases of fractures caused by firearms between January 2010 and December 2014; 245 fractures in 223 patients were included.

Results There was surgical-site infection in 8.5% of the fractures, and the mean number of debridements required to control the infectious process was of 1.273 ± 0.608. A correlation was identified between the surgical treatment chosen and the affected body segment ($p < 0.001$). The surgical treatment in the emergency room had a correlation with the occurrence of infection ($p < 0.001$; Chi-squared test).

Conclusion Patients with gunshot injuries treated non-operatively presented less severe and stable lesions; thus, the incidence of complications in this group was found to be lower. On the other hand, those patients with complex lesions underwent debridement and external fixation. Therefore, a greater number of infectious complications in patients submitted to external fixation was found, as expected.

Keywords

- Wound infection/epidemiology
- wounds, gunshot/epidemiology
- fractures, bone

Resumo

Objetivo Investigar a incidência de infecção em pacientes com fraturas por arma de fogo, e correlacionar esse achado com a ocorrência de desbridamento cirúrgico na sala de emergência.

Métodos Estudo retrospectivo, observacional e descritivo, que incluiu todos os casos de fraturas causadas por armas de fogo entre janeiro de 2010 e dezembro de 2014; foram incluídas 245 fraturas em 223 pacientes.

* The data was collected in Hospital Risoleta Tolentino Neves, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

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Resultados Houve infecção do local cirúrgico em 8,5% das fraturas, e a média de desbridamentos necessários para controlar o processo infeccioso foi de 1,273 ± 0,608. Foi identificada correlação entre o tratamento cirúrgico escolhido e o segmento corporal afetado ($p < 0,001$). O tratamento cirúrgico na sala de emergência teve correlação com a ocorrência de infecção ($p < 0,001$; teste do qui-quadrado).

Conclusão Pacientes com ferimentos à bala tratados de forma não operatória apresentaram lesões menos graves e estáveis; portanto, a incidência de complicações nesse grupo foi menor. Por outro lado, os pacientes com lesões complexas foram aqueles submetidos a desbridamento e fixação externa. Portanto, como esperado, foi encontrado um maior número de complicações infecciosas em pacientes submetidos à fixação externa.

Palavras-chave
- infecção dos ferimentos/ epidemiologia
- ferimentos por arma de fogo/ epidemiologia
- fraturas ósseas

Introduction

Nonfatal injuries caused by firearm projectiles (FAPs) affect over 60 thousand people annually in the US, and the extremities are the most affected anatomical regions.[1] In addition, they represent the second cause of death in the US, accounting for 30 to 50 thousand victims each year.[2]

In Brazil, according to the "2015 Violence Map" ("Mapa da Violência 2015,"[3] in Portuguese), it is estimated that between 1980 and 2014 more than 1 million deaths secondary to gunfire occurred; 8.710 in 1980 and 44.861 in 2014, which represents a 415.1% increase.[3]

The best approach to treat fractures caused by FAPs is still under debate. Some authors consider that they should be addressed as open fractures. On the other hand, other authors argue that not all FAP fractures require urgent surgery and debridement. Similar infection rates were identified in stable fractures caused by low-energy FAPs, with the administration or not of prophylactic antibiotics, either orally or intravenously, to the patients.[4,5]

Our main objective was to investigate the incidence of infection in patients with gunshot-related fractures and to correlate this finding with the occurrence of surgical debridement in the emergency room.

Patients and Methods

The present was a retrospective, observational, descriptive study that included all cases of fractures caused by FAPs at the Orthopedics and Traumatology Service of our hospital between January 2010 and December 2014. Patients who died were excluded because there was no record of their evolution or not to infection during the outpatient follow-up.

The variables evaluated were: age, body segment affected, first-aid treatment, operating-room time, prophylactic antibiotic scheme, incidence of surgical-site infection, number of debridements, and complications.

The statistical analysis was performed using the Wizard Pro for Mac application, version 1.9.24, and the StatPlus (StatPlus, Inc., Taipei, Taiwan) software, version 6.7.03. The continuous variables were submitted to the evaluation of distribution, and were later compared using the appropriate statistical tests. The categorical variables were compared using the Chi-squared test. Values of $p < 0.05$ were used to indicate a statistically significant difference.

Results

A total of 245 fractures in 223 patients were included, and 9 patients (4%) with 10 fractures were excluded from the study because there was incomplete information in their medical records.

Most patients were male (93.9%; $n = 230$), and the mean age of the sample was 26.0 ± 1.2 years. The upper limbs were affected in 55.7% of the cases, the lower limbs, in 43%, and multiple sites accounted for 1.3% of the cases. The distribution by anatomical segment affected is shown in ►**Table 1**.

Regarding the medical management at admission, 28.1% of the patients were not operated on, and 71.9% underwent a surgical procedure with the following distribution: 36.2% ($n = 85$), debridement alone; 24.3% ($n = 57$), debridement and osteosynthesis; 11.5% ($n = 27$), debridement and external fixation. In total, 95.9% of the surgical procedures were performed in the first 24 hours after the trauma. The mean time for conversion between the external fixator and the osteosynthesis was of 14.37 ± 2.7 days. Antibiotic prophylaxis for the mean time of 2.779 ± 0.214 days was administered to all of the patients.

Table 1 Distribution of fractures by anatomical segment

Segment	% (n)
Leg	17.9 (42)
Hand	17 (40)
Forearm	15.3 (36)
Arm	14 (33)
Thigh	11.1 (26)
Shoulder	9.4 (22)
Foot	8.5 (20)
Hip	5.5 (13)
Multiple	1.3 (3)

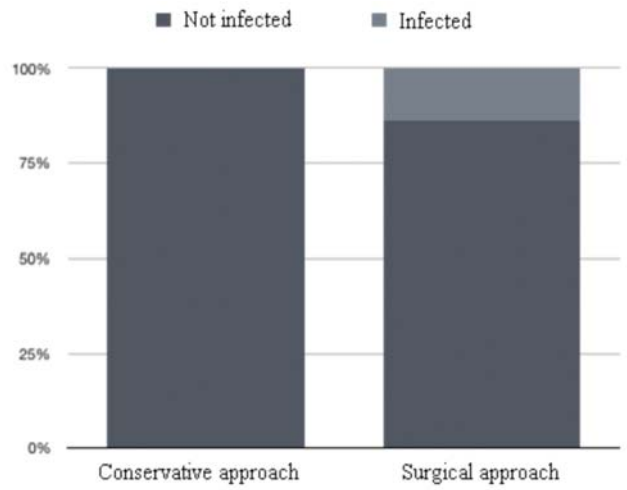

Fig. 1 Correlation between infection and conduct in the emergency room (Chi-squared test; $p < 0.001$).

There was surgical-site infection in 8.5% of the fractures, and the mean number of debridements required to control the infectious process was of 1.273 ± 0.608.

A correlation was identified between the surgical treatment chosen and the affected body segment ($p < 0.001$). When evaluating the conduct and its relationship with the affected segment, we found that: 1) there is a preference for not operating proximal umeral and hip fractures compared with fractures of other segments ($p = 0.004$ and $p < 0.001$ respectively; Chi-squared test); 2) the external fixator was not used in hip fractures; and 3) all patients with foot fractures were operated.

The surgical treatment in the emergency room had a correlation with the occurrence of infection ($p < 0.001$; Chi-squared test) (►**Fig. 1**).

The subgroup analysis showed that patients submitted to debridement and external fixation were responsible for 57.1% of the cases that evolved to infection (Z-score; $p < 0.001$) (►**Fig. 2**).

The proportion of infectious complications was higher among patients submitted to debridement and external fixation (Chi-squared test; $p = 0.04$).

External debridement and fixation in the emergency room was associated with the occurrence of noninfectious complications such as non-union, vicious consolidation, and neurological injury (Chi-squared test; $p = 0.002$).

Discussion

According to the literature, FAP lesions are frequent among males (94.4%) aged between 15and 29 years.[3] The segments most affected are: the spine, the femur, the tibia, the fibula, the hand and the forearm.[6,7] Our findings are congruent with those of the literature: 93% of our patients were male; the mean age was 26 years; and the topographic distribution showed that the long bones were the most affected. The present article is relevant for the study of the complications related to FAP lesions in an urban Brazilian population.

The number of 245 fractures in 223 patients is relevant, since there are numerous retrospective studies[8–10] on the subject with smaller samples. Nguyen et al.,[8] in a retrospective study that evaluated the results of the treatment of joint fractures by FAPs, included 55 lesions in 53 patients. Kaim Khani et al.[9] evaluated 90 isolated lesions to compare the outcomes of high and low-velocity FAPs. Mehta et al.[10] studied forearm fractures caused by FAPs for 5 years, and included 56 lesions in 55 patients. The retrospective design of the study is justified by the incidence of FAP lesions and the time required for treatment-related complications to be identified.

Lesions caused by FAPs are classified according to the projectile speed as low or high. High-speed FAP injuries are caused by weapons whose projectile is launched at speeds exceeding 600 m/s. Low-speed injuries are caused by handguns common to the civilian population, while high-speed injuries are typical of military-grade weapons.[9] In this study, we assumed that the injuries studied were caused by guns with low-speed projectiles, since this those the most used firearms in the urban confrontations in our city. It is noteworthy that in the present study we excluded the patients who died, since the evaluation of the primary outcome (infection) required the outpatient follow-up of the patients.

The severity of the lesions that a FAP produces depends on the energy transmitted to the tissues, which, in turn, varies with the velocity, diameter, shape, stability in the trajectory and weight of the projectile.[6] Increased tissue damage is associated with multiple FAPs, close-range shots, high-velocity projectiles and hollow-tipped ammunition.[7] In the present

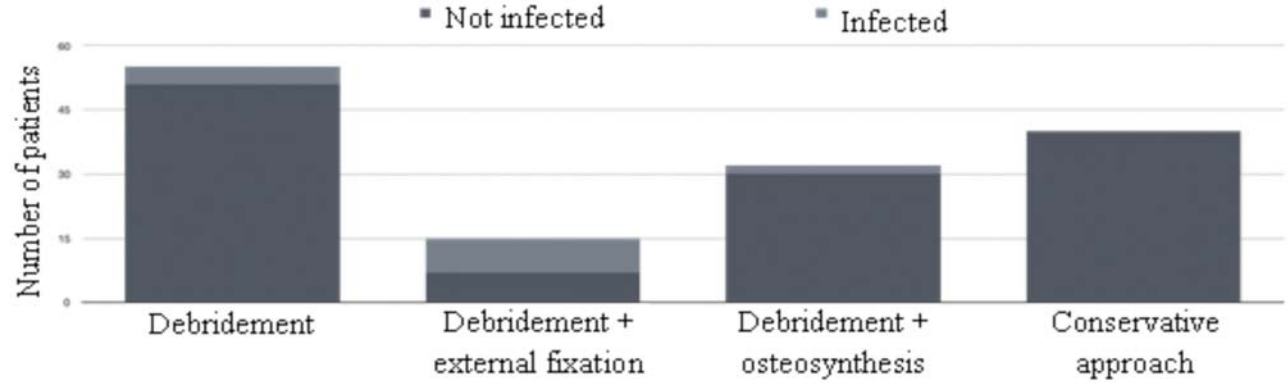

Fig. 2 Subgroup analysis to identify the group with the highest incidence of infection.

paper, because of its retrospective character, it was not possible to correlate the characteristics of the projectile or the lesions produced with the infectious outcome. We can infer that the non-operated patients presented less severe and stable lesions in the orthopedic judgment, thus, the incidence of complications in this group was found to be lower. On the other hand, patients with complex lesions underwent debridement and external fixation. Therefore, the greater number of infectious complications in patients submitted to external fixation in the first care is explained.

Stable low-energy fractures of the tibia and humerus, for example, may be suitably treated by splint or cast with a window for wound care and closure by secondary intention. Unstable fractures are treated surgically with the same principle of stability and implant that would be used in closed fractures.[1]

In fractures caused by high- or low-energy FAPs in subcutaneous bones such as the tibia or the clavicle, surgical debridement of the wound is recommended. As for antibiotic prophylaxis, in fractures caused by high-speed weapons, 24 to 72 hours of intravenous antibiotics are recommended; in fractures caused by low-speed FAPs, there is no evidence for the use of antibiotics. The choice of antimicrobial regimen is also variable.[7,11] In the present study, 40 patients (28%) were not submitted to an emergency surgical approach, and received prophylactic antibiotics for 24 hours. The decision not to take the patient to the surgical center was taken by the on-call staff based on a personal assessment of the severity of the case. This strategy, although subjective, managed to ensure for this group of patients a lower incidence of infectious and non-infectious complications. Therefore, the severity of the initial lesion seems to be a factor that justifies a higher incidence of complications, despite the initial approach offered. The evaluation by the emergency team was also the criterion used to define the treatment in other works. Nguyen et al.[8] reported that, in 43.6% of the cases, non-surgical treatment was the option, and there were no reports of infectious complications in this group. However, the two cases of infection reported by these authors are of patients who underwent emergency surgical debridement,[8,9] and the authors correlated the occurrence of deep infection with the energy of the initial trauma. In the series of cases analyzed by these authors, all 90 patients were taken to the surgical center and received antibiotic prophylaxis. The lesions caused by high-energy FAPs had a higher incidence of infection, and cases of multiple FAP lesions were excluded.[9]

Recent studies[8] do not consider that the classification recommended by Gustilo et al.[4] should be used in the evaluation of fractures caused by FAPs. The authors argue that the size of the post-debridement lesion does not correspond to the damage caused internally by the FAPs, and that the energy dissipated in the tissues would be the main prognostic factor.[6] We did not use the aforementioned classification as a parameter for the stratification of gravity. We chose to rely on the judgement of the on-call staff regarding the degree of contamination and bone instability, since we believe that this includes other subjective elements that cannot be simplified by scores.

Conclusion

Patients with gunshot injuries treated non-operatively presented less severe and stable lesions; thus, the incidence of complications in this group was found to be lower. On the other hand, the patients with complex lesions underwent debridement and external fixation. Therefore, a greater number of infectious complications in patients submitted to external fixation was found, as expected.

Conflict of Interests
The authors have none conflict of interests to declare.

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