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High Rate of Postoperative Complications in Ballistic Distal Femur Fractures

Alta tasa de complicaciones posoperatorias en fracturas balísticas de fémur distal

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Abstract

Introduction Femur fractures are among the most common injuries caused by gunshots. However, distal femur fractures due to gunshots are scarcely studied in the literature.

Objective To present a cohort of patients with distal femur fractures caused by gunshots treated surgically and to analyze their complications.

Materials and Methods A retrospective cohort study of patients operated on for distal femur fractures caused by gunshots in a public hospital in an area with a vulnerable population, from 2011 to 2015. Demographic variables, days from admission to definitive surgery, intraoperative time, type of definitive osteosynthesis, complications, and one-year mortality were recorded.

Results In total, 39 patients met the inclusion criteria; they had a mean age of 30 (range: 16–53) years, and 85% were men. The mean latency until the definitive osteosynthesis was of 9.8 (range: 1–33) days. The overall complication rate was of 25.64%, with a reintervention rate of 23.08%. The main complication was infection (12.82%). There were no statistically significant factors associated with complications. There were no deaths at the one-year follow-up.

Conclusion Patients with distal femur fractures caused by gunshots present a high rate of complications, especially infections, with a high rate of reinterventions.

Level of Evidence: Type IV, retrospective study.

Keywords
- distal femur
- gunshot fracture
- complications

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Resumen

Introducción Las fracturas de fémur están dentro de las lesiones más frecuentes por bala. Sin embargo, las fracturas de fémur distal por bala están escasamente estudiadas en la literatura.

Objetivo Presentar una cohorte de pacientes con fractura de fémur distal por bala tratados quirúrgicamente y analizar sus complicaciones.

Materiales y Métodos Estudio de cohorte retrospectiva, con pacientes operados por fractura de fémur distal por bala, en un hospital público de una zona con población vulnerable, de 2011 a 2015. Se constataron variables demográficas, días desde el ingreso a la cirugía definitiva, tiempo intraoperatorio, tipo de osteosíntesis definitiva, complicaciones y mortalidad al año.

Resultados En total, 39 pacientes cumplieron los criterios de inclusión; tenían promedio de edad de 30 (rango: 16–53) años, y 85% eran hombres. El promedio de latencia a osteosíntesis definitiva fue de 9,8 (rango 1–33) días. La tasa global de complicaciones fue de 25,64%, y la tasa de reintervenciones, de 23,08%. La principal complicación fue la infección (12,82%). No hubo factores estadísticamente significativos asociados a complicaciones. No hubo fallecidos al año de seguimiento.

Conclusión Los pacientes con fracturas de fémur distal por bala presentan una alta tasa de complicaciones, especialmente de infecciones, con una alta tasa de reintervenciones.

Nivel de evidencia: IV, estudio retrospectivo

Palabras clave

- fémur distal
- fractura por bala
- complicaciones

Introduction

Injuries from firearms within the civilian population have been increasing in both European countries and the United States.[1,2] Fractures caused by gunshots in the civilian population occur mainly from low-velocity projectiles, in contrast to firearms in the context of war. Ballistic fractures have been associated with higher rates of complications, such as infections, neurovascular injuries, compartment syndromes, or non-union.[3,4]

Regarding ballistic fractures, the lower extremities are the most frequently affected, corresponding to around half of the cases.[2] Femur fractures represent 12 to 13% of the total cases of gunshot injuries. Although it has been reported that distal femur fractures correspond to 4 to 6% of those,[5] these data correspond to fractures due to mechanisms that exclude ballistic injuries. The truth is that the incidence of distal femur fractures due to bullets is unknown.

Among the most frequent complications of distal femur fractures, non-union has a prevalence of approximately 6%.[6,7] Again, these data exclude ballistic injuries, which would be expected to result in a higher risk of complications than that described in closed fractures. Although the scientific literature regarding distal femur fractures is extensive, to our knowledge, there are no reports that exclusively describe the subgroup of gunshot fractures, nor that refer to the rate of complications and the possible factors involved.

Therefore, the objective of the present study is to present a cohort of patients treated surgically for distal femur fractures by gunshot and analyze their complications.

Materials and Methods

We conducted a retrospective cohort study that involved patients with a distal femur fracture due to a gunshot who underwent surgery in a tertiary public hospital center, which mainly serves a socioeconomically vulnerable population. The study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[8] All procedures were performed in accordance with the ethical standards described in the Declaration of Helsinki.

The inclusion criteria were:[1] patients $\geq$ 18 years old at the time of surgery,[2] complete epidemiological data,[3] follow-up $\geq$ 1 year,[4] and surgeries performed between 2011 and 2015.

An exhaustive review of the clinical records of each patient was carried out, and we collected the following information: age, gender, type of surgery, time from admission until definitive surgery (surgical latency), osteosynthesis used, intraoperative time, and postoperative complications. Death certificates were obtained from the national civil registry, where applicable, with the cause and date of death. The choice of the type of osteosynthesis was left at the discretion of the main surgeon.

Statistics

The numerical variables were expressed through average range values, and the categorical variables, through absolute and relative frequencies. To analyze possible factors involved in the occurrence of postoperative complications, the Mann-Whitney U test was performed.

All analyzes were performed using the Stata software (StataCorp LLC, College Station, TX, United States), version

13.0. For all analyzes, values of $p < 0.05$ were considered significant.

Results

Out of a total of 63 patients operated on for distal femur fractures in the study period, 39 met the inclusion criteria. The etiology of 61.9% of all distal femur fractures in our center corresponded to ballistic impact.

In total, 84.61% (33 patients) of the sample corresponded to male patients. The ratio of men to women was of 5.5:1. The average age was of 30 (range: 16–53) years. ►**Figure 1** shows the age distribution of the cases; the age group with the highest incidence was that between 16 and 20 years old.

In 82.05% of the cases (32 patients) the initial surgery consisted of surgical cleansing and placement of an external fixator, while in the remaining cases it only consisted of surgical cleansing. None of the patients were treated with definitive osteosynthesis in their initial surgery. In 95% of the cases (37 patients) the initial surgery was performed within 24 hours. In the remaining cases, the initial surgery was performed between 24 and 48 hours. The surgical latency averaged 9.8 (range: 1 to 33) days. ►**Figure 2** shows the distribution by the ranges of surgical latency time of the cases.

Regarding definitive surgery, 46.15% (18 patients) of the cases were treated with a retrograde intramedullary nail (RIN), 38.45% (15 patients), with a dynamic condylar screw (DCS) plate, and 15.40% (6 patients), with a locking compression plate (LCP).

Furthermore, 10 patients (25.64%) developed postsurgical complications, 9 of whom required some type of surgical reintervention, with an overall reintervention rate of 23.08%. Of the total of complications, 50% were secondary to infection (5 patients), 30% were due to failure of osteosynthesis (3 patients), 10%, due to aseptic non-union (1 patient), and 10%, due to surgical wound dehiscence (1 patient).

Of the total number of reoperated patients, 62.5% were treated with a DCS plate (3 osteosynthesis failures and 2 infections) and 37.5%, with an LCP (2 infections and 1 non-union) in their definitive surgery. The RIN group did not undergo reinterventions. There were no complications due to compartment syndrome, fat embolism or thromboembolic disease, neither were there patient deaths, after one year of follow-up.

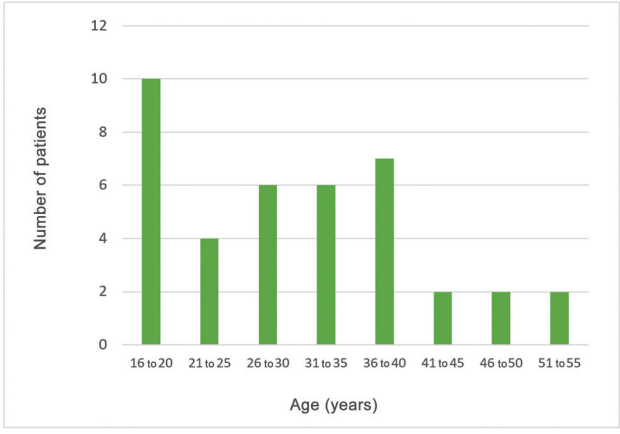

Fig. 1 Distribution of patients according to age in ranges.

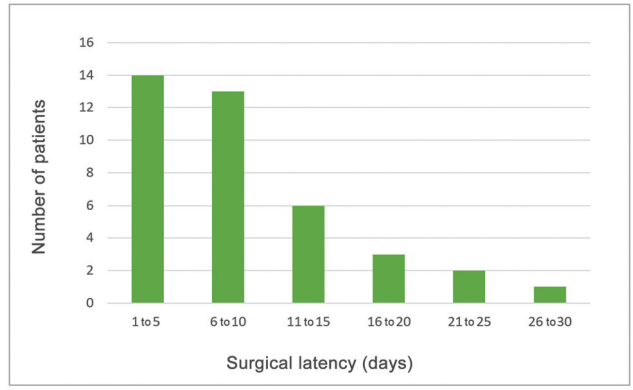

Fig. 2 Number of patients according to days of surgical latency (from admission to the definitive surgery).

Complications Analysis

A comparison was made between the groups with and without complications, and neither surgical latency nor intraoperative time present significant differences between both groups, with *p*-values of 0.238 and 0.86 respectively.

Discussion

In the last 20 years, a 6-fold increase in the number of civilian patients consulting for ballistic fractures has been reported, which is probably due to the greater access to firearms.[2] Fractures caused by gunshots carry a high risk of complications: neurovascular injuries, infection, non-union, among others.[3,4] The current study represents the first Latin American cohort of patients exclusively with gunshot fractures of the distal femur, and it describes their complications.

The patients were mainly young men. Although it was not possible to obtain precise information on the type of weapon that caused the fracture, it is possible to conclude that the injuries were mainly caused by firearms with low-velocity projectiles, which are described as resulting in a lower risk of complications in comparison with weapons with high-velocity projectiles.[9]

The main complication that occurred in our cohort was infection, affecting 12.82% of the cases. Comparatively, Penn-Barwell et al.[10] reported an overall infection rate of 23% in gunshot tibia fractures among soldiers in the United Kingdom. Although the reported rate was around double that of our cohort, it is important to highlight that the injuries occurred in the context of war, with fractures caused by military weapons, which are associated with a higher rate of complications. On the other hand, Ordog et al.[11] reported an infection rate of 1.8% among 3,390 patients with injuries from low-velocity firearms, a rate considerably lower than that reported in the present study. It is plausible to propose that the distal femur has characteristics that make it more susceptible to infections in the context of a gunshot injury.

In our cohort, none of the patients had definitive resolution in their first surgery, in accordance with the

management protocol of our center. In this regard, Polat et al.[12] studied the risk of complications in diaphyseal femur fractures due to gunshots, comparing patients treated in a single surgical procedure and those treated with an external fixator and delayed definitive surgery, and they did not find significant differences between both groups regarding the occurrence of complications. Therefore, regarding the risk of complications, resolution in one or two stages is viable.

Among the factors analyzed, there were no significant differences in terms of the surgical latency and the intraoperative time between patients who did and did not present complications. This may have two explanations: latency and intraoperative time are not actually relevant to the onset of complications, or the power of the present study is insufficient to detect differences. To answer this, an analysis with a larger sample size is desirable.

To our knowledge, there are no publications that suggest the type of osteosynthesis to be used in gunshot fractures of the distal femur. In our cohort, out of the total number of reoperations, 62.5% were treated in the definitive surgery with a DCS plate, and, within this subgroup, 60% of the reinterventions were due to osteosynthesis failure. In this regard, Peschiera et al.[13] suggest that the main predictors of non-union in distal femur fractures are malalignment and medial comminution. Given that gunshot fractures are usually characterized by loss of bone stock and high metaphyseal comminution, it seems prudent not to consider the DCS plate the first alternative in this type of patient. Although none of the patients treated with RIN in our cohort were submitted to reintervention, it is premature to recommend the use of this type of implant as a general rule, given the heterogeneity of ballistic fractures and the fact that the absence of reinterventions could largely only be due to insufficient sample size.

In the present study, there were no deaths after 1 year of follow-up. Although it has been reported that 1-year mortality in distal femur fragility fractures is similar to that od hip fractures,[14] clearly this is not applicable to our population, which consists of a much younger demographic with a low burden of comorbidities. The main strength of the current study is that it provides epidemiological data not previously described in the indexed literature, both nationally and internationally, and it describes a national reality not previously recorded. Among the limitations, it is worth highlighting the difficulty in monitoring patients with gunshot fractures due to poor adherence to treatment and failure to attend follow-up appointments.

We believe that the current study represents a good first approach to the subgroup of ballistic distal femur fractures; however, many questions remain unanswered, and additional studies involving a larger population are required.

Conclusion

Ballistic distal femur fractures occur predominantly among young men. They present a high complication rate, of up to 25%, with infectious complications being the most common.

Conflict of Interests
The authors have no conflict of interests to declare.

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