RISK FACTORS ASSOCIATED WITH INFECTION IN TIBIAL OPEN FRACTURES.

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Abstract

Background. The objective of the treatment of open fracture is to prevent infection, stabilize the bones, and restore function. However, infection is the most important step in achieving the latter aims. Objective. The objective of the current paper is to find risk factors associated with infection in a sample of tibial open fractures. Patients and Methods. A retrospective analysis was carried out. The study included all patients who underwent to tibial open fracture treatment in the Hospital Geral Roberto Santos-HGRS, Salvador, Bahia, Brasil, from March to October, 2009. Patients under the age of eight, with multiple fractures or suffering from systemic or bone disease were excluded. Clinical and demographic data were collected and Patient outcomes were divided into two groups: Group 1 comprises those without infection whereas group 2 comprises those with lesions which became infected. The two groups were evaluated in search for associated factors that could lead to infection. Results. We studied 50 patients. Our overall infection rate was 14 (28%; CI95%=15.5-40.5). Infection was significantly associated with place of trauma (OR 3.78; CI95%=1.4-5.5; p=0.02), and time delay superior to 24 hours (OR 3.4; CI95%=1.4-20.8; p=0.03). Fractures graded as Gustilo I, II and IIIA had a lower chance for infection compared to Gustilo IIIB and IIIC (OR 4.32; CI95%=1.3-19.1; p=0.01). Fractures graded Tscherne III and IV had a higher chance for infection, and it was the most significant isolated factor (OR 8.07; CI95%=2.4-47.1; p<0.00). Conclusions. We confirmed the relationships between infection with Gustilo classification and as well as between infection and trauma from the countryside of Bahia State. We also presented a new relationship between soft tissue and infection, and another relating time delay of more than 12 hours with infection.

Key words: open fracture; infection; treatment; trauma.

Resumen

Introducción: El objetivo del tratamiento de las fracturas abiertas es prevenir las infecciones, estabilizar el hueso e restaurar la función. En relación a los objetivos mencionados, la prevención de infecciones tiene mayor destaque y es el punto mas importante a ser alcanzado. Objetivo: El objetivo de este trabajo es identificar los factores de riesgo asociados con la infección en un grupo de pacientes con fracturas abierta de la tibia. Paciente y métodos. Fue realizado un análisis retrospectivo con pacientes que tuvieron fractura abierta tibial que estaban en tratamiento en el Hospital Roberto Santos-Geral-HGRS, Salvador, Bahía, Brasil, de marzo a octubre de 2009. Fueron excluidos de este estudio todos los niños menores de 8 años con fracturas múltiples o que tenían alguna enfermedad sistémica o en los huesos. De acuerdo con los datos clínicos y demográficos, los pacientes fueron divididos en dos grupos: el grupo 1 estaba constituido por los que no tenían infección en las fracturas y el grupo 2 por los que tenían infección. En los dos grupos se investigo factores que podrían estar asociados a la infección. Resultados. De 50 pacientes estudiados la tasa de infección global fue de 14 (28%, IC95% = 15,5-40,5). El hecho de desenvolver infección fue asociado con el lugar del trauma (OR 3,78; IC 95% = 1,4-5,5, p = 0,02), y la demora en recibir tratamiento adecuado en tiempo superior a 24 horas (OR 3,4; IC95% 1.4-20.8 = p = 0,03). Las fracturas clasificadas como Gustilo I, II, IIIA tuvieron una menor chance de infección cuando comparadas como Gustilo IIIB y IIIC (OR 4.32; CI95%=1.3-19.1; p=0.01). Fracturas clasificadas como Tscherne III y IV tuvieron una mayor frecuencia de infección, lo que resulto ser el factor más importante e significativo (OR 8.07; CI95%=2.4-47.1; p<0.00). Conclusión. En nuestros resultados observamos; una relación entre infección y la clasificación de Gustilo. También observamos asociación de infección cuando el trauma de los tejidos blandos es más grave (Tscherne III y IV), cuando hubo demora en el tratamiento adecuado (tiempo mayor de que 12 horas) y en pacientes que vivían en las zonas rurales del estado de Bahía.

Palabras clave: fractura abierta; infección; tratamiento; trauma.

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Introduction

The objective of the treatment of open fracture is to prevent infection, stabilize the bones, and restore function. However, preventing infection is the most important step in achieving the latter aims.[1,2,3]

In the case of tibial open fractures, infection should be prevented by prompt debridement within the first six hours (the so-called "six-hour rule") and early stabilization, if possible[1,2,3]. Whether or not correct procedures are followed, several clinical features can contribute to infection and poor prognosis, including time delay for debridement, severity of both lesions to bone and soft tissues, other health conditions affecting the patients, energy involved in the trauma and so on.[1,2,4]

The "six-hour rule" is based on experimental data[5] and there is no consensus among clinical studies that this rule effectively diminishes the infection rate[1,2,5,6,7,8,9,10]. Another problem is the large variety of methods used for early stabilization in order to minimize the risk of infection as well as to provide optimal recovery of functioning[4,7,9]. Open fractures classifications such as the Gustillo scheme[11,13] also try to improve the understanding of how a fracture's severity can lead to poor prognosis or infection, but their ability to predict prognosis remains uncertain.

For a surgeon and his patients, it is extremely important to find out factors or clinical features that are able to successfully predict an outcome. The control of those risk factors, whenever possible, can lead to improvement of the initial treatment in order to obtain the best results[1,2,11,12,13.] The objective of this work is to find risk factors associated with infection in a sample of tibial open fractures.

Patients and Methods

A retrospective clinical analysis of patients who underwent to tibial open fracture treatment in the Hospital Geral Roberto Santos-HGRS, Salvador, Bahia, Brasil was carried out. The study was conducted from March to October, 2009, and data was extracted from patient's medical records. All patients with an open tibial fracture were included. Patients under the age of eight or having incomplete information registered on their charts were excluded as well as those suffering from systemic disease, metabolic bone disease, or multiple fratures. Sample size was estimated to be 48 patients based on an infection prevalence of 15%, adopting a difference of 0.1 and an alpha error of 0.05.

In all cases, the initial treatment included careful debridement using at least 10 liters of saline solution as soon as possible, followed by antibiotic treatment for a minimum of eight days. This is in accordance to the standard Institutional protocol.

Clinical and demographic data were collected such as height, weight, gender, age, marital status, origin, type and characteristics of the trauma, time from trauma to debridement ("time delay"), and type of stabilization. Fracture type was assessed by AO classification[11], and both Gustillo grading system[11] for open fractures and a modified Tscherne grading system[14] for soft tissue trauma were used to evaluate the severity of the lesions.

Patient outcomes were divided into two groups: Group 1 comprises those without infection whereas group 2 comprises those with lesions which became infected, both evaluated in a period of one week after the trauma. Infection was identified based on clinical and laboratory findings, according to the criteria of early acute infection within a period of two week proposed by Wielleneger[15]. That means we count as infection any aspect of superficial or deep infection associated or not with fever, high white blood cell count or ESR6,[15]. The two groups were compared in search for factors that could be associated with infection.

Statistical analysis

The data were described in percentages with CI95% for nominal data, and in means ± sd for continuous data. The association between group 1 and 2 were made by bivariate risk analysis with OR and CI95% calculations, and tested by chi-square test with Fischer and Yates correction. The value <0.05 was adopted as the level of significance.

The study was approved by the Ethic Committee of the Bahian School of Medicine and Public Health and also was approved by the Institution, HGRS. The study was funded by the involved Institutions.

Results

We studied 50 patients, divided into 41(82%; CI95%=71.4-92.6) male and 9(18%; CI95%=7.4-28.6) female, with an mean age of 32,9(±12,5) year old. Our overall infection rate was 14 (28%; CI95%=15.5-40.5). The development of infection was significantly associated with place of trauma (OR 3.78; CI95%=1.4-5.5; p=0.02), and a time delay superior to 24 hours (OR 3.4; CI95%=1.4-20.8; p=0.03) Infection was also related to the degree of soft tissue damage and to bone fragmentation. Fractures graded as Gustilo I, II and IIIA had a lower chance for infection compared to Gustilo IIIB and IIIC (OR 4.32; CI95%=1.3-19.1; p=0.01). Fractures graded Tscherne III and IV had a higher chance for infection, and it was the most significant isolated factor (OR 8.07; CI95%=2.4-47.1; p<0.00). We did not find any association between infection and age, gender, smoking, drinking, marital status or choice of stabilization device. Data are shown in tables 1 and 2.

Discussion

Our overall infection rate was 14 (28% all percents should be have CI95%). Infection was significantly associated with several characteristics of the lesions such as place of trauma and Gustilo classification

Characteristic	Number (%)	Infection (%)	p (Odds Ratio)
Gender			0.21
Male	41 (82%)	13 (31.7%)	
Female	9 (18%)	1 (11.1%)	
Age (years)			0.37
Less than 20	8 (16%)	2 (25%)	
between 20 and 40	27 (54%)	6 (22.2%)	
More than 40	15 (30%)	6 (40%)	
Marital state			0.62
Single	33 (66%)	8 (24.2%)	
Married	15 (30%)	6 (40%)	
Divorced	2 (4%)	0 (0%)	
Origin			0.02 (3.8)
Salvador City	23 (46%)	4 (17.4%)	
Great Salvador	12 (24%)	2 (16.6%)	
Countryside	15 (30%)	8 (53.33%)	
Type of accident			
Motorcycle	18 (36%)	5 (27.7%)	
Being run over	13 (26%)	3 (23.1%)	
Gun Shot Wound	8 (16%)	1 (12.5%)	
Falling	5 (10%)	3 (60%)	
Traffic accident	3 (6 %)	2 (66.6%)	
Direct trauma	3 (6%)	0 (0%)	

Table 1- Social, demographic and characteristics of the trauma in the whole group.

system. We also presented a new relationship between soft tissue and infection, and another relating time delay of more than 12 hours with infection. Based on these findings a time delay superior to 24 hours increases 3.4 times the chance for infection, while fractures graded Tscherne III and IV had also a chance 8.07 times higher for infection.

The infection rate in the present study was higher than most previous studies. Harley et al (2002)2 presented an overall infection rate of 9.3% and Spencer et al (2004)[9] showed an infection rate of 10.4%. We believe that this disagreement was due to the clinical features of our sample. We had a higher prevalence (76%) of grade III fractures, while these authors had 30.2%[2] and 49.5%[9], respectively. With reference to the prevalence of tibial fractures, Spencer et al (2004)9 had 35% and Harley et al (2002)[2] had only 15%. Tibial fractures have also higher infection rates due to the lack of soft tissue coverage and to their poor vascularization[7]. Therefore, the severity of the trauma associated with the fact that our sample is comprised exclusively of tibial fractures may have contributed to explain our infection rate.

Muller et al (2003)[3] studied a sample comprised of 36% tibial fractures and 54.6% Gustilo grade III fractures. That study is more similar to ours and their results showed an infection rate of 20.5%. On the other hand, Gustilo et al (1984)[16] and Muller et al (2003)[3] showed infection rates of 63.1% and 48,8%, respectively, among grade III fractures. Andrew et al (2010)[10] have also shown an overall infection rate of 27% while studying a sample of high-energy fractures, including only those classified as grade III. All those findings are in accordance with our results and partially explain our higher infection rate.

The time between trauma and debridement in our series showed a severe delay in the initial treatment (44% of our patients were treated after 24 hours). The reasons for the prolonged treatment times included late presentation, lack of hospital beds, extended transportation time, patient instability requiring neurosurgical or general surgical intervention, and operating theater unavailability. Those problems are relatively common taking into account that the Roberto Santos General Hospital is a trauma referral center for a vast geographic area and for a population close to 15 million people.

In the study performed by Spencer et al (2004)[9], they found that 60% of the patients were treated within 6 hours and Harley et al (2002)[2] found that only 47%

Characteristics	Number (%)	Infection (%)	p (Odds Ratio)
Time delay			0.03 (3.4)
Less than 12 hours	14 (28%)	2 (14.3%)	
Between 12 and 24 hours	14 (28%)	2 (14.3%)	
More than 24 hours	22 (44%)	10 (45.4%)	0.03
AO Classification			0.62
A	11 (22%)	2 (18.2%)	
B	15 (30%)	4 (26.6%)	
C	24 (48%)	8 (33.3%)	
Gustillo Classification			0.01 (4.3)
Type I	1 (2%)	0 (0%)	
Type II	11 (22%)	2 (18.2%)	
Type IIIA	21 (42%)	3 (14.3%)	
Type IIIB	16 (32%)	8 (50%)	
Type IIIC	1 (2%)	1 (100%)	
Tscherne Classification			0.00 (8.1)
Grade I	9 (18%)	0 (0%)	
Grade II	29 (58%)	6 (20.7%)	
Grade III	11 (22%)	7 (63.6%)	
Grade IV	1 (2%)	1 (100%)	
Fixation			
External	35 (70%)	12 (31.4%)	
Internal	10 (20%)	1 (10%)	
No fixation device	5 (10%)	1 (20%)	

Table 2 – Characteristics of the injury and Treatment.

of their patients were treated within 8 hours. Both authors stated that time delay in the treatment of open fractures is a common problem in many general and referral hospitals[2,9]. Besides, most of our patients came from the countryside, which means rural trauma that occurs in areas far from cities, and it could help to explain both the extensive delay in the treatment and the higher infection rate.

The six-hour rule to debridement was based on historical and laboratory data5. Only few recent clinical studies showed a statistically significant association between infection and time to debridement above 6 hours[7,17]. However, the study performed by Kindsfater and Jonassen[17] had an important limitation taking into account that 17 (77%) of their grade III fractures were in the delayed group (over 6 hours). On the other hand, a large recent review of the orthopedic literature wasn't able to support the six-hour rule theory[1,2,4,9,18].

Based on the study conducted by Patzakis e Wilkins4 we divided the patients into three groups: patients treated in less than 12 hours, between 12 and 24 hours and after 24 hours from trauma time. Our results showed that up to a time delay of 24 hours the infection rate is not significantly increased. However, we find a 3.4 times higher chance for infection in the group treated after 24 hours (45.4%). The severity of the trauma in our sample associated with the delay to treatment could have influenced our results. We know that time was not an independent predictor of the risk of infection[10,18] alone. However, Andrew et al (2010)10 found that their patients treated within three hours had an infection rate of 17% and those treated after eleven hours had a significant higher rate of 36.1%; their samples was made up exclusively of severe cases (grade III). Our findings support Andrew´s study as well as the idea that time may be an important predictor of infection in severe fractures (grade III).

We advocate for debridement as early as possible as the best choice in treating open fracture and we do not believe that our findings can justify any delay. Moreover, debridement gives the surgeon an idea of how important the factor time is when planning the procedure. Spencer et al[9] stated that emergency surgeries based exclusively on the "six-hour" rule can lead to procedures done in the worst-case scenario with regard to the orthopedic team, adequate

synthesis material and a patient's health conditions. Our findings also indicate that when the six-hour rule is not the most important point to consider, in some complex cases better results could be achieved if the surgery can be planned more adequately and carefully within 24 hours.

In the present study, Gustillo's classification[11] was able to predict infection (OR 4.33) and the same relationship was not obtained with respect to AO classification[12]. The association between Gustilo's classification and infection has been emphasized by several authors. In the study performed by Kathod et al7, for instance, they found infection rates as follows: 8.7% (in type I), 10.9% (in type II), 23.5% (in type IIIA), 67.7% (in type IIIB), and 62.5% (in type IIIC). These findings are very similar to ours (Table 2), despite the fact that our sample was comprised by more severe cases and a more prolonged time delay.

The use of Gustilo's classification system is widespread and well-accepted. However, its agreement rate is significantly low (60%)[19] and the system may not show the real extent of soft tissue involvement[11,17,19]. The Tscherne system[12], on the other hand, is solely based on soft tissue lesion and represents a new approach to open fractures. In our study, Tscherne's classification showed a better relation to infection than any other risk factor alone (OR 8.07). It suggests that damage to soft tissue alone could be the most important risk factor for a poor prognosis, but we did not find similar papers so that we could discuss this issue in depth. Further studies would be necessary to confirm or not these findings.

The present study has some strong points that made our results more significant. Our data represents a homogeneous sample comprised exclusively by tibial open fractures and focuses on what happens in more severe cases, most of which were treated after a six-hour period. The weak point is that we did not study infection in the long run, after hospital discharge. Eventually, the findings of our study could have been influenced by small sample size, and information bias because it was based on retrospective design (medical records). Therefore, our results must be confirmed by other similar studies.

The study contributes significantly to the current literature about risk factors for infection in tibial open fractures. We confirmed the relationships between infection with Gustilo classification and trauma from the countryside. We also presented new relationships between soft tissue damage and infection, and another relating time delay of more than 12 hours with infection.

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