OPEN FRACTURES: PROSPECTIVE AND EPIDEMIOLOGICAL STUDY

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ABSTRACT

Objective: To delineate the epidemiological profile of patients attended by an emergency unit, diagnosed with open fractures. Materials and Methods: This is an epidemiological, prospective, descriptive, observational study of open fractures attended at the institution, selected by convenience sampling, in the period September 1, 2005 to March 31, 2007. The data were collected from patients using a questionnaire with multiple variables. Results: we obtained 342 patients with 346 open fractures. The majority of the patients were male (86.84%), with an average age of 30.41 years and average hospitalization time of 6.87 days. The main professions were students (21.92%), followed by motorcycle couriers (11.40%). The accidents occurred on public roads (57.30%), affecting mainly the leg bones (37.86%) and classified as level III (45.36%). Associated injuries occurred in 27.19%, with 11.11% complications. There was evidence of alcohol consumption (12.86%) and drug use (1.46%) in the six hours prior to the trauma. Conclusion: The patients were mainly young, male, with incomplete school education. The main cause of the traumas was road accidents, occurring at night (between 7 pm and midnight), with leg bone injuries classified as level III. The associated injuries and early complications were predominantly related to injuries of greater severity.

Keywords: Open Fractures. Epidemiology. Prospective study.

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INTRODUCTION

Open fractures remain a challenge for orthopedists as far as stabilization, alignment and skin coverage besides infection prophylaxis are concerned. They represent severe injuries with high socioeconomic impact.

The Hippocratic treatment of patients severely injured in wars was amputation of the affected limb or cauterization of the wound, evolving in the 15th and 16th centuries with Brunschwig and followers who postulated that the removal of the devitalized tissue was necessary for wounds that did not heal. After World War I, extensive debridement was consolidated as one of the principles of treatment to prevent infection.[1]

Open fractures treated in the orthopedic trauma unit in Edinburgh were seen in 11.5 of every 100,000 inhabitants per year.[2] In the United States, the annual cost is estimated at around U$ 230,600 million.[3] In Brazil, in an epidemiological study, the authors observed that traffic accidents were the main cause of occurrence of these injuries.[4]

Epidemiological studies are of vital importance to the centers of reference of health care services for the population; this information can be used to plan the treatment, define priorities and enhance the understanding of this complex group of traumas.[5,6]

The aim of the project was to define the epidemiological profile of patients attended in the Orthopedics and Traumatology service of Hospital Saint Marcelina, in the period from September 1, 2005 to March 31, 2007, with a diagnosis of open fracture, and to establish the frequency of fractures in terms of the main variables: gender, age, occupation, school education, type of trauma, classification of the lesion, location of the lesion, seasonality (month, day of the week and time of incidents), mode of transport to the hospital, associated lesions, immediate complications, hospitalization time and others.

MATERIAL AND METHODS

The proposed study was epidemiological, prospective, descriptive and observational, involving open fractures attended by con-

All the authors declare that there is no potential conflict of interest referring to this article.

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venience sampling at the institution.

The study group consisted of patients admitted to the service with a diagnosis of open fracture, in the period from September 1, 2005 to March 31, 2007.

A questionnaire was formulated for the gathering of patient data, with variables to be analyzed subsequently. This questionnaire was completed after the signing of the consent term by the patient or legal guardian, maintaining assurance in its methodology of the right to confidentiality and to the freedom of non-inclusion in the study at the beginning as well as at any time.

Inclusion criteria: All the patients hospitalized with a diagnosis of open fracture, with no restrictions as regards gender, age, fracture location or associated lesions.

Exclusion criteria: Patients attended previously in other services; admitted in the emergency room with more than 6 hours of evolution; death before performance of orthopedic procedure; evasion before hospital discharge and those that refused to sign the informed consent term.

We considered lesions associated with the presence of other non-open fractures, vascular lesions besides peripheral nerve, abdominal, thoracic, cranioencephalic, buccomaxillofacial and cutaneous lesions.

Complications occurring in up to seven days after the injury were defined as early-onset complications.

For the classification of fractures we used the method of Gustillo and Anderson[7], modified by Gustillo et al.[8] and widely disseminated in medical literature, which describes the morphology of the fracture and lesions of associated soft parts.

Four 6-hour periods were established for analysis of the accident time (from 1 a.m. to 6 a.m., from 7 a.m. to noon, from 1 p.m. to 6 p.m. and from 7 p.m. to midnight).

The information obtained was processed in a record bank of the Microsoft ACCESS program, version 2003 for data preparation and analysis. Pearson's chi-square test was used for verification of homogeneity among categories of the qualitative variables (distribution by months, day of the week, time, age bracket, school education, type of accident, type of casualty rescue transportation, region affected and severity of the fracture), and to verify the existence of association among variables. A significance level of 5% (alpha = 0.05) was used in all the tests, while tests with $p < 0.05$ were statistically significant.

The research project was duly approved by the committee of ethics of the Hospital, under registration number 37/2005.

RESULTS

The study group consisted of 342 patients with 346 open fractures, attended between September 1, 2005 and March 31, 2007, with an average 0.59 cases per day.

Most of the patients - 297 (86.84%) were male while 45 (13.16%) were female. As regards ethnic distribution, 194 patients (56.72%) described themselves as not white, 142 (41.52%) as white and 6 (1.75%) as yellow.

The average age was 30.41 years (ranging from 1 to 88 years) and standard deviation was 16.8 years. The mode was 21 years, corresponding to 17 cases. The age bracket with the highest rate of cases ranged between 21 and 30 years (Figure 1), with statistical significance ($p < 0.001$). The percentage of children victims of fractures with bone exposure draws attention (11.69%).

There was a predominance of patients with incomplete primary education in 142 (41.52%) cases, followed by incomplete secondary education with 71 (20.76%) and complete secondary education with 58 (16.95%), $p < 0.001$. (Figure 2)

The statistical comparison of the proportions of open fractures

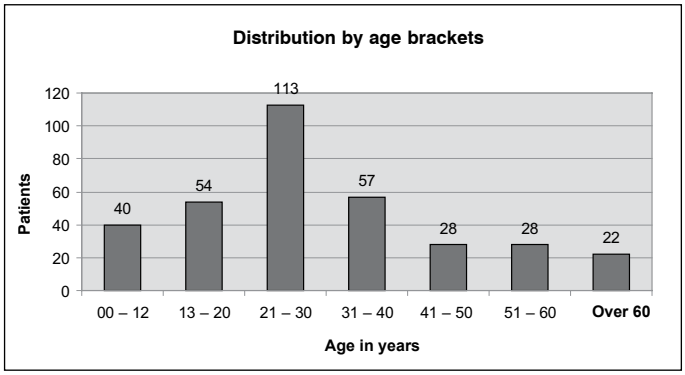

Figure 1: *Distribution of patients by age brackets. (p < 0.001).*

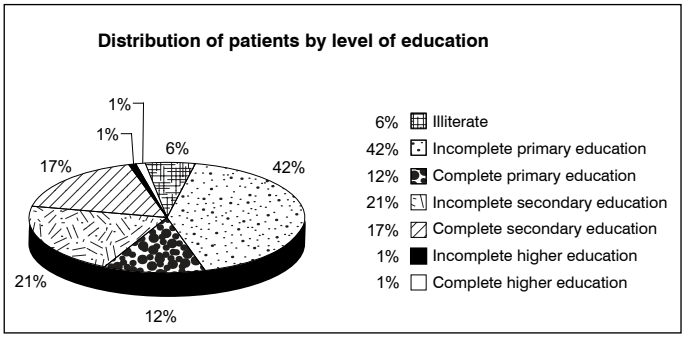

Figure 2*: Distribution of patients by level of education. (p< 0.001).*

per month and per week, performed by means of the study of percentages, did not show a significant difference, with $p = 0.932$ and $p = 0.878$. Even comparing the percentages of the weekend with the others, there was no statistical difference, $p = 0.163$. (Figures 3 and 4) There was a predominance of medical care in the period from 7 p.m. to midnight, with 142 (41.52%) incidents. This difference proved statistically significant, with $p < 0.001$. (Figure 5)

The average hospitalization time was 6.87 days (ranging from 1 to 75 days) and standard deviation of 9.36 days. The mode was 7 days, corresponding to 34 cases.

The most frequent occupation was student, with 75 (21.92%) patients and 39 (11.40%) motorcycle couriers. (Table 1)

Accidents on public roads were the most common with 196 (57.30%) cases (run-over cases, car, motorcycle and bicycle accidents). Compared with the other causes the difference of

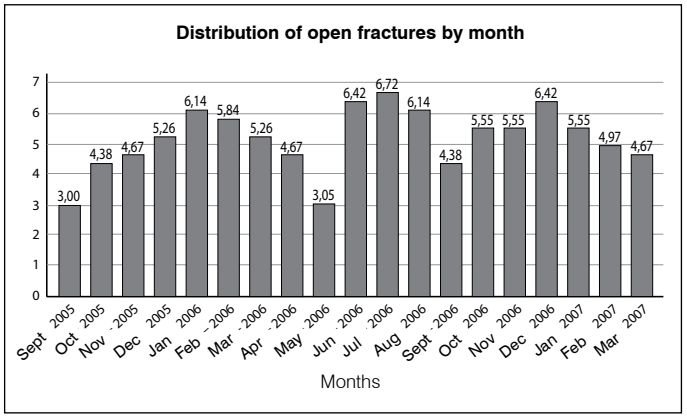

Figure 3: *Distribution of fractures by month. (p=0.932).*

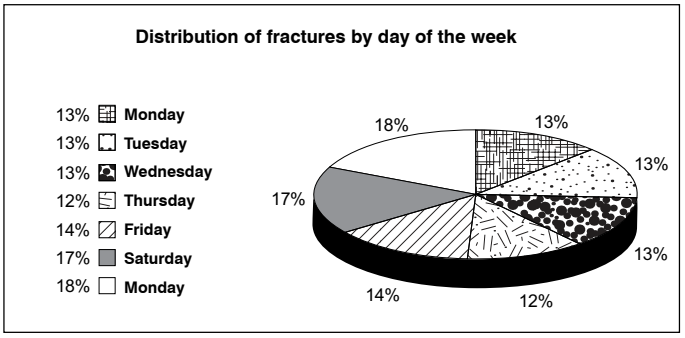

Figure 4: *Distribution of fractures by day of the week. (p=0.878).*

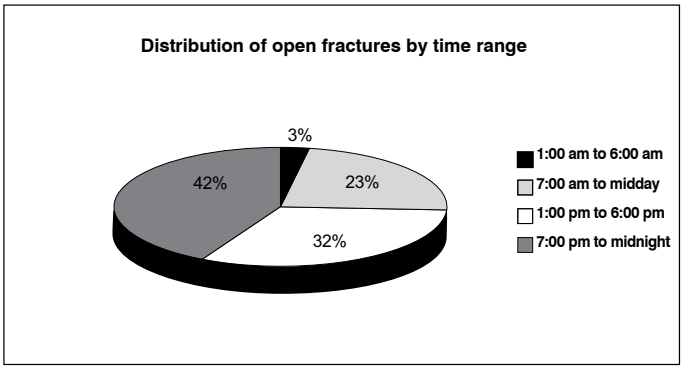

Figure 5: *Distribution of fractures by time range. (p < 0.001).*

Table 1: *Distribution of patients by occupation.*

Occupation.	Frequency	Percentage
Student	75	21.92
Motorcycle Couriers	39	11.40
Civil Construction	36	10.52
Commerce	26	7.60
Retiree	22	6.43
Industry	21	6.14
Self-employed	19	5.55
Security Guard	12	3.50
Unemployed	9	2.63
Housekeeper	6	1.75
Transport	6	1.75
Agriculture	4	1.16
Others	67	19.59
Total.	342	100.00

these proportions was significant, with $p < 0.001$. (Table 2)
The Fire Brigade was responsible for transporting 194 (56.72%) victims to the emergency room, followed by own modes of transport: 110 cases (32.16%), SAMU (Urgent Mobile Health Care Service): 27 (7.89%) and military police air rescue on 11 (3.21%) occasions. The comparisons of the type of transportation and the severity of the fracture are shown in Figure 6.
There was a predominance on the left side in 202 (59.06%) patients, 132 (38.15%) on the right and 8 (2.31%) bilateral. The segments that presented the highest percentages of open fractures were the leg bones with 131 (37.86%) lesions and the hand bones with 57 (16.47%), whereas the difference among open fractures of the leg compared with the others were statistically representative, with $p < 0.001$. (Table 3) When we evaluated only open fractures of the leg, we noticed a higher incidence of the left side with 84 (64.12%) cases. Thirty-eight (11.11%) patients had a

Table 2: *Distributionin relation to trauma etiology.*

Etiology	Frequency	Percentage
Motorcycle Courier	107	31.28
Run-over cases (Public road)	40 (11.69)	16.66
Run-over cases (Sidewalk)	10 (2.92) 57	
Run-over cases (Pedestrian Crossing)	7 (2.94)	
Fall from height	47	13.74
Crushing	42	12.28
Car Accident	23	6.72
Firearm	20	5.84
Fall from own height	14	4.09
Bicycle Accident	9	2.63
Bladed weapon	4	1.16
Physical aggression	3	0.87
Practice of sports	3	0.87
Others	13	3.08

$p < 0.001$

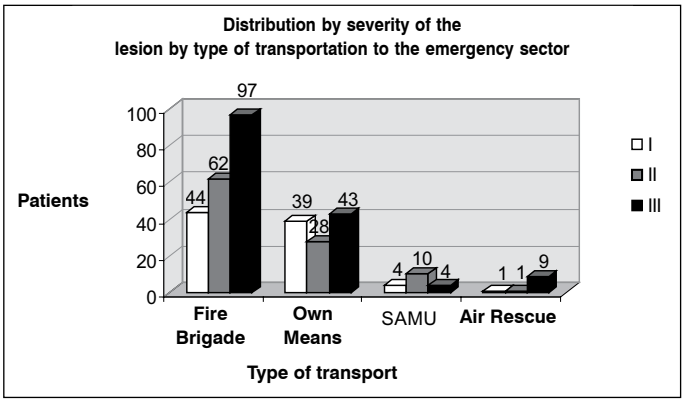

Figure 6: *Distribution by severity of the lesion by type of transportation to the emergency sector. (p<0.001)*

record of open fracture and in the group of patients identified as motorcycle couriers, this percentage rose to 18 (17.4%).
Lesions classified as type III, according to Gustillo, were more

Table 3: *Distribution of frequencies of fractures by anatomic region.*

Anatomic Region	Frequency	Percentage
Leg	131	37.86
Hand	57	16.47
Ankle	39	11.27
Forearm	24	6.93
Thigh	23	6.64
Wrist	18	5.20
Foot	17	4.91
Knee	15	4.33
Elbow	13	3.75
Humerus	7	2.02
Pelvis	2	0.57
Total	346	100.00

abundantly present in 157 (45.36%) fractures, followed by type II 101 (29.19%) and type I 88 (25.54%) with this difference also having statistical significance $p < 0.001$. (Figure 7)

A total 93 (27.19%) patients were found with associated lesions, of which the most frequent were: other closed fractures

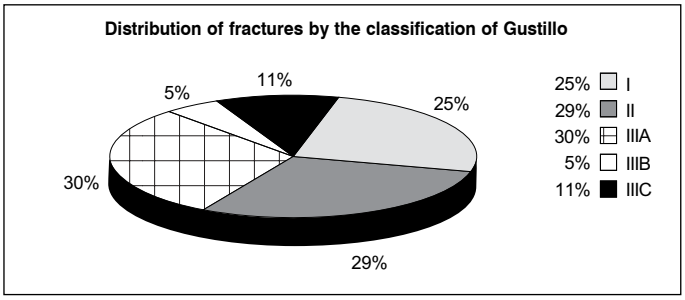

Figure 7: *Distribution of fractures by the classification of Gustillo (p< 0.001).*

36 (38.7%), followed by vascular lesions 15 (16.12%). (Table 4) Early-onset complications occurred in 38 (11.11%) patients. The most common were amputations with 23 (6.67%) cases .(Table 5) The frequency of alcohol consumption and illegal drug use and both in the 6 hours that preceded the trauma were respectively 44 (12.86%), 5 (1.46%) and 11 (3.21%) patients.

Table 4: *Distribution of frequencies of associated lesions by patient.*

Associated Lesion	Frequency	Percentage
Closed fractures	36	38.70
Vascular	15	16.12
Cranioencephalic	12	12.90
Cutaneous	10	10.75
Abdominal	8	8.60
Buccomaxillofacial	7	7.52
Peripheral nerve	4	4.30
Thoracic	1	1.07
Total	93	100.00

Table 5: *Frequencies of early-onset complications.*

Complication	Frequency	Percentage
Amputation	23	60.52
Infections	8	21.05
Deaths	5	13.15
Others	2	5.26
Total	38	100.00

DISCUSSION

The incidence of open fractures, their consequent complications and the shortage of other prospective epidemic articles in Brazilian literature motivated the performance of this study.

The goals proposed initially were attained, there was no loss of data or non-completion of the questionnaires. The bias described by several retrospective studies was resolved with this approach, making the data more trustworthy.

A total 344 patients were attended in the period from September 1, 2005 to March 1, 2007 with 348 open fractures. Two of these patients were excluded, one due to evasion and the other due to intra-operative death in the urgent care center, totaling 342 patients and 346 fractures. No patient refused to sign the term of informed consent or withdrew during the execution of the work.

Most of the patients were male, in the proportion of 6.6 men to every woman and the majority was in the economically active age bracket (from 21 to 30 years), in conformity with the literature.[4,8-11] One fact that concerned us was the large number of children that we encountered in the survey, particularly during the school holiday months.

There was a small predominance of non-white patients, contradicting the results observed from the bibliography,[4] a fact that is directly related to the population of this region that differs from other epidemiological and population studies.

A wide variety of occupations was found, with significant participation of those that called themselves motorcycle couriers with no similarity between our findings and literature,[4] a fact related to the geopolitical and economic differences of the region of each study. Most of the sample group called themselves students, a result that is due to the large number of patients in the student age bracket. The majority of the patients had a level of education below that expected for their age, reflecting a sample of the regional population.[12] The most common level of education was incomplete primary education, while only one Brazilian reference to this variable was found, with its predomination as well.[4] Illiteracy was found in 6.43% of the cases, similar to the mean value of inhabitants of the State of São Paulo (4.7%).[12]

The data obtained in this study evidenced the high demand for this orthopedic emergency service in a reference hospital for trauma. Contradicting the results of Cunha et al.[13,14], there was no statistical difference in the distribution of accidents when we evaluated months or days of the week, which surprised us. We observed a certain level of seasonality in the school holiday months (December, January, June and July) and in the nighttime period, although there was no significance.

The public rescue service proved to be more important in providing assistance to the more severely injured victims. The representative portion of patients with other associated lesions reflects the clear relationship of open fractures with traumas of high kinetic energy and also the importance of a multidisciplinary team trained to provide adequate emergency care.

Accidents on public roads continue the chief causes of these kinds of lesions.[2,10,11,15-20] Previous studies already indicated this type of accident as the main cause of open fractures, particularly at the expense of motorcycle accidents.[4,11] The occurrences of run-over cases on pedestrian crossings denotes disrespect for traffic laws. We believe that the creation of educational campaigns,

specific lanes for motorbikes and other measures can change this statistic.

Approximately one third of injuries resulted from motorcycle accidents, and in almost all of these, open fractures were located in the lower limbs.[19,20] We believe that the use of motorcycles both as a work tool and as a means of locomotion and the greater exposure of the lower limbs in this mode of transport contributed toward these results.

Hand injuries ranked second in frequency, Howard and Court-Bronw[6], Cunha et al.[13] and Larsen et al.[21], however, presented hand injuries as the most important in their series. This difference is based on the large number of civil construction worker patients encountered in those studies and on the fact that our services is a reference to the most critical situations.

Type III open fractures formed the majority, in conformity with literature,[2,4,8,11,17] except for Gustillo[15] who presented only 25.5% of lesions classified as type III. The difference between the incidences of these studies and the data found by Gustillo draws attention. This discrepancy occurs due to the effect of variables such as location of services, degree of urbanization, risk factors and research performance time, requiring new comparative studies of these variables to better correlate them. In this study, the most severe fractures (type III) occurred mostly in the leg bones, probably on account of the most common trauma mechanism, fall from motorcycle. The associated lesions, including other closed fractures, and early complications were more frequently encountered at degree III open fracture, when compared with those of type I and II. The associations verified are also a result of the high energy involved in these traumas.[17,19]

Amputations occurred in 6.67% of the total, a lower percentage than that described in literature.[8,16,19,22,23] Amputations were indicated for the most critical lesions. We believe that the lower frequency observed is related to the availability of a first aid vascular surgery team and the conduct of the service in always attempting to preserve the limb, considering the difficulties faced by patients in acquiring prostheses and in signing up for rehabilitation programs.

The average hospitalization time of these patients was 7 days, similar to literature. This period corresponds to the time necessary for intravenous antibiotic therapy, damage control, treatment of associated lesions, surgical re-approaches and dressings. In an analysis of our sample, we can observe an association of infection in patients with more extensive injuries and with greater implication of soft parts.

A considerable part of the sample declared alcohol consumption or illegal drug use before the accident. We observed that in the period where accidents are more frequent, 7 p.m. to midnight, they coincide with a greater number of patients under the effect of alcohol or other narcotics, showing an association of these substances with accidents involving open fractures. However, no toxicological tests were conducted for investigation.

It is obviously important for the orthopedic surgeon to be familiar with the epidemiological behavior of this pathology. We believe that the short data gathering time was a limitation for probable other conclusions in this study. New surveys with a longer gathering time or multicentric surveys could add new concepts on a vast array of variables of these traumas.

CONCLUSION

In the results obtained there was a predomination of male youths with incomplete primary education, traffic accidents, in the nighttime period from 6:01 p.m. to 11:59 p.m., involving the leg bones and classified as degree III (high-energy trauma), in conformity with literature. The associated lesions and early complications are more closely related to the lesions of greater severity. Due to its type of medical care the public rescue service has objectified a more adequate treatment when in relation to the accident time and the final treatment. These patients remained in hospital for a week on average.

REFERENCES

1. Olson SA, Finkemeier CG, Moehring HD. Fraturas expostas. In: Rockwood e Green. Fraturas em adultos. São Paulo: Manole; 2006. p.285-317.
2. Court-Brown CM, Rimmer S, Prakash U, McQueen MM. The epidemiology of long bone fractures. Injury. 1998;29:529-34.
3. Blincoe L et al. The economic impact of motor vehicle crashes, 2000. National Highway Traffic Safety Administration. Washington 2002 [on line]. Disponível em: http://www.nhtsa.dot.gov, In: Traffic Safety; Articles. [acesso em 22 jan 2010].
4. Müller SS, Sadenberg T, Pereira GJC, Sadatsune T, Kimura EE, Novelli Filho JLV. Estudo epidemiológico, clínico e microbiológico prospectivo de pacientes portadores de fraturas expostas atendidos em hospital universitário. Acta Ortop Bras. 2003;5:158-69.
5. Fletcher RH, Fletcher SW. Epidemiologia clínica: Elementos essenciais. In: Estudos sobre riscos. São Paulo: Artmed; 2005. p.104-8.
6. Howard M, Court-Bronw CM. Epidemiology and management of open fractures of the lower limb. Br J Hosp Med. 1997;57:582-7.
7. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 1976;58:153-8.
8. Gustilo RB, Mendonza RM, Williams DN. Problems and the management of type III (severe) open fractures: A new classification of type III open fractures. J Trauma. 1984;24:742-6.
9. Sortier SB, Estrada FS. Diagrama de flujo para el tratamiento de las fracturas expuestas em urgencias. Revisión epidemiológica y determinación de costos. Rev Mex Ortop Traumatol. 1999;13:431-6.
10. Imran Y, Vishvanathan T. Does the right leg require extra protection? Five-year review of type 3 open fractures of the tibia. Singapore Med J. 2004;45:280-2.
11. Moore TJ, Mauney C, Barron J. The use of quantitative bacterial counts in open fractures. Clin Orthop Relat Res. 1989;(218):227-30.
12. Instituto Brasileiro de Geografia e Estatística (IBGE). Taxa de analfabetismo de pessoas com 15 anos ou mais do Estado de São Paulo de 2008. Síntese de Indicadores Sociais de 2009 – Uma análise das condições de vida da população brasileira [on line] Disponível: http://www.ibge.gov.br/estadosat/temas.php?sigla=sp [Acesso em 24 jan 2010].
13. Cunha FM, Braga GF, Junior SND, Figueiredo CTO. Epidemiologia de 1.212 fraturas expostas. Rev Bras Ortop. 1998;33:451-56
14. Cunha FM, Braga GF, Abrahão LC, Vilela JCS, Silva CEL. Fraturas expostas em crianças e adolescentes. Rev Bras Ortop. 1998;33:431-5.
15. Gustilo RD. Management of open fractures in orthopeadic infection. In: Diagnoses and treatment. Philadelphia: Saunders; 1989. p.87-117.
16. Allison K, Wong M, Bolland B, Peart F, Porter K. The management of compound leg injuries in the West Midlands (UK). Br J Plast Surg. 2005;58:640-5.
17. Martinez FR, Cuéllar EC, Sánchez MS. Epidemiologia y resultados clínicos de lãs fracturas expuestas de la tíbia. Rev Mex Ortop Traumatol. 1999;13:447-54.
18. Sanzana E, Barrera RT, Malzahm JC. Fracturas expuestas de pierna estabilizadas com clavo macizo no fresado. Rev Chil Cir. 2000;52:41-8.
19. Lateef F. Riding Motorcycles: Is it a lower limb hazard? Singapore Med J. 2002;43:566-9.
20. Court-Brown CM, Brewster N. Management of open fractures. In: Epidemiology of open fractures. London: Martin Dunitz; 1996. p 25-35.
21. Larsen CF, Milder S, Johansen AMT, Stam C. The epidemiology of hand injuries in the Netherlands and Denmark. Eur J Epidemiol. 2004;19:323-7.
22. Gustilo RB, Gruninger RP, Davis T. Classification of type III (Severe) open fractures relative to treatment and results. Orthopedics. 1987;10:1781-8.
23. Caudle RJ, Stern PJ. Severe open fractures of the tibia. J Bone Joint Surg Am. 1987;69:801-7.