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Mortality predictors in patients with pelvic fractures from blunt trauma

Preditores de mortalidade em pacientes com fratura de pelve por trauma contuso

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ABSTRACT

Objective: *to analyze the association of mortality with sociodemographic and clinical variables, as well as lesions and complication in patients with pelvic trauma due to blunt trauma.* **Methods**: *we conducted a retrospective, observational study with five-year trauma record data. Death was considered as the main stratification variable for the analyzes. We used the Student t test to compare means, the Chi-Square or Fisher exact test for proportions, and the Wilcoxon-Mann Whitney test for medians. We analyzed the independent factors using a logistic regression model with penalized likelihood, based on the Wald tests, the Akaike Information Criterion (AIC) and the Schwarz Bayesian Information Criterion (BIC).* **Results**: *of the 28 patients with blunt trauma fracture, 23 (82.1%) were men; 16 (57.1%) were, in average, 38.8 years old (±17.3). There were 98 lesions or fractures in the 28 patients. As for severity, seven people had Injury Severity Score higher than 24 (25%). The mean hospital stay was 26.8 days (±22.4). Fifteen patients (53.6%) had ICU admission. Mortality was 21.4%. The analysis showed that age 50 years or more and presence of coagulopathy were factors independently associated with death.* **Conclusion**: *pelvic fractures can have high mortality. In this study, mortality was higher than that described in the literature. Age above 50 years and the presence of coagulopathy are risk factors in this population.*

Keywords: *Wounds and Injuries. Pelvis. Multiple Trauma. General Surgery.*

INTRODUCTION

Pelvic fractures usually result from high energy trauma. In about 90% of the cases, there are other associated lesions, the prognosis relating mainly to the severity of these injuries[1-4]. The mortality in patients with pelvic fracture ranges from 4% to 15% in different studies. Mortality is usually associated with multiple traumas and bleeding. Some risk factors – such as advanced age or shock at admission, defined by a systolic pressure lower than 90mmHg – were positively associated with death. In addition, the Injury Severity Score (ISS), a measure of body surface accumulated traumas, is directly related to increased mortality[5].

After the primary approach of a patient with pelvic trauma based on Advanced Trauma Life Support (ATLS), a complete skeletal muscle assessment should be performed, looking for symmetry, rotation or shortening of lower limbs, in addition to skin thorough exam in search for injuries. The genital region deserves careful investigation, especially when there is local bleeding, including sensory, motor, and reflex neurological examination. Most pelvic fractures do not pose specific treatment challenges, are stable and do not carry a greater chance of retroperitoneal bleeding. However, in patients with complex and unstable fractures, retroperitoneal hemorrhage may be lethal[3,4].

Early fixation of the pelvis is essential to avoid pain, chronic deformities and to facilitate mobilization. Even with anatomical preservation, common late complications are pain and sexual dysfunction. In addition, neurological impairment has been shown to be a sign of poor prognosis regardless of the type of injury. For a better approach to the patient, the type of fracture should be elucidated by stress assessment of the pelvis while the patient is anesthetized [7].

The objective of the present study was to analyze the association between death and

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sociodemographic and clinical variables, injuries and complications in patients with blunt pelvic trauma attended at a reference center for trauma.

METHODS

We conducted a retrospective, observational study, using the trauma registry database of the General Surgery and Trauma Service of the Risoleta Tolentino Neves Hospital – FUNDEP/UFMG (Collector® System Maryland USA) and the electronic records of all patients admitted to the hospital who were victims of Trauma with pelvic fractures, admitted from 2010 to 2014.

The main variable of interest and stratification of the study was the occurrence of death among patients. The other variables analyzed were gender, age, Use of FAST (Focused Assessment with Sonography in Trauma), Laparotomy, ISS (Injury Severity Score) categorized according to severity levels[8], need of external fixator, time (in days) of hospital admission, need for ICU admission and Time (in days) in the ICU (Intensive Care Unit). We also identified the patients' fractures, injuries and complications. We also recorded the mean arterial blood pressure and the mean heart rate at admission, and the presence of bleeding at admission and discharge for all patients.

To verify if the variables of interest were associated with mortality, we used the Student's t test for continuous variables (mean, standard deviation and coefficient of variation) with Gaussian (normal) distribution. For categorical variables, we used the Chi-square test (when one of the categories of analysis had less than five elements) or the Fisher's test (more than four categories. We also computed the following statistics for the continuous variables: median, interquartile range (25th percentile subtracted from the 75th percentile), maximum and minimum values. For comparison of medians, was performed a Wilcoxon-Mann Whitney test. It was also of interest to evaluate the independent factors associated with death. Considering that we observed the phenomenon of quasi-separation in the data, that is, some variables predicted almost completely the outcome, we used the logistic model with penalized likelihood, which allows estimating with more stability the odds ratios and overcomes the limitation of the traditional logistic model that works with convergences based on likelihood ratios[9]. We generated a multivariate regression model to quantify the relationships between one or more factors of interest and mortality. The multivariate analysis was initiated only with the variables that presented $p<0.20$ in the univariate analysis, as follows: after obtaining the first model, the variables were sequentially withdrawn, according to the significance presented by the Wald test. The significance level adopted for this test was 10%. In case of doubt about which variable to remove, the models were maintained for further analysis by two information criteria: Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (BIC). The model chosen was the one with the lowest AIC and the lowest BIC, since lower values of AIC and BIC indicated a better fit of the model[10]. The obtained estimator was the odds ratio (OR) of death (compared to survival). We considered values of $p<0.10$ and obtained 95% confidence intervals.

RESULTS

We identified 28 patients with pelvic fracture after blunt trauma, with the following admission characteristics: 23 (82.1%) were men; 16 (57.1%) were less than 40 years old; mean and median age were 38.8 years (standard deviation 17.3) and 36 years (interquartile range 20), respectively. The mean systolic blood pressure at admission was above 90mmHg and the mean heart rate at admission at 96bpm (66-132). Seventeen patients underwent FAST (Focused Assessment Sonography for Trauma) on admission, six (21.4%) with evidence of intraperitoneal bleeding. There were 98 lesions or fractures in the 28 patients. Pelvic abdominal fracture, pneumothorax, external pelvic fracture and fracture of costal arches occurred in 19 (67.9%), 11 (39.3%), ten (35.7%) and seven (25.0%) patients respectively. Hemothorax, pulmonary contusion and liver injury had five (17.9%) occurrences each.

Table 1. *Mortality among patients with pelvic blunt trauma according to selected variables.*

Variable	Survival (n=22; 78.6%)	Death (n=6; 21.4%)	Total (n=28; 100.0%)	p value
Gender (n,%)				
Male	18 (78.3)	4 (21.7)	23 (100.0)	0.715
Female	4 (80.0)	1 (20.0)	5 (100.0)	
Age (categories) (n; %)				
Up to 39 years	14 (87.5)	2 (12.5)	16 (100.0)	0.034 **
40 to 49 years	5 (100.0)	0 (0.0)	5 (100.0)	
50 years or more	3 (42.9)	4 (57.4)	7 (100.0)	
Age (years)				
Mean (Sd)	34.3 (11.9)	55.5 (24.5)	38.8 (17.3)	0.088 *
Median (IQR)	36 (15)	57 (30)	36 (20.5)	0.064 *
Minimum; Maximum	12; 58	27; 86	12; 86	
Use of FAST (n,%)				
Yes	9 (81.8)	2 (18.2)	17 (100.0)	0.561
No	13 (76.5)	4 (23.5)	11 (100.0)	
Laparotomy (n,%)				
Yes	6 (66.7)	3 (33.3)	9 (100.0)	0.352
No	16 (84.2)	3 (15.8)	19 (100.0)	
ISS (categories) (n; %)				
< 15 (mild)	8 (88.9)	1 (11.1)	9 (100.0)	0.369
15 to 24 (moderate)	9 (81.8)	2 (18.2)	11 (100.0)	
> 24 (severe or very severe)	4 (57.1)	3 (42.9)	7 (1000)	
ISS (continuous)				
Mean (Sd)	18.6 (9.8)	25.3 (11.5)	20.1 (10.4)	0.167
Median (IQR)	18 (10)	23 (18)	18 (16)	0.218
Minimum; Maximum	5; 41	23; 42	5; 42	
Pelvic External Fixator (n,%)				
Yes	5 (100.0)	0 (0.0)	5 (100.0)	0.198
No	17 (73.9)	6 (26.1)	23 (100.0)	
Hospital stay (in days)				
Mean (Sd)	30.8 (22.6)	12.2 (15.5)	26.8 (22.4)	0.070 *
Median (IQR)	26 (36)	6 (17)	21 (35)	0.031 **
Minimum; Maximum	1; 72	1; 41	1; 72	
Hospital stay (ranges) (n,%)				
1 to 7 days	3 (50.0)	3 (50.0)	6 (100.0)	0.099 *
From 8 to 21 days	6 (75.0)	2 (25.0)	8 (100.0)	
More than 22 days	13 (92.9)	1 (7.1)	14 (100.0)	
Admission to ICU (n; %)				
Yes	11 (84.6)	2 (15.4)	13 (100.0)	0.655
No	11 (73.3)	4 (16.7)	15 (100.0)	
Time in ICU (in days)				
Mean (Sd)	5.8 (7.8)	8.3 (10.2)	6.4 (8.2)	0.516
Median (IQR)	1 (11)	4 (18)	3 (12)	0.555
Minimum; Maximum	0; 28	0; 24	0; 28	
Time in the ICU (range) (n,%)				
No day	11 (84.6)	2 (15.4)	13 (100.0)	0.836
From 1 to 7 days	4 (66.7)	2 (33.3)	6 (100.0)	
More than 7 days	7 (77.8)	2 (22.2)	9 (100.0)	

** p<0.10; ** p<0.05*

Table 2. *Absolute figures and percentages of injuries in patients with blunt trauma and pelvic fracture.*

Fractures and injuries (n,%)	Survival (n=22; 78.6%)	Death (n=6; 21.4%)	Total (n=28; 100.0%)	p value
Abdominal pelvic fracture	15 (78.9)	4 (21.1)	19 (100.0)	0.650
Pneumothorax	9 (81.8)	2 (18.2)	11 (100.0)	0.561
External Pelvis Fracture	7 (70.0)	3 (30.0)	10 (100.0)	0.358
Rib Fracture	5 (71.4)	2 (28.6)	7 (100.0)	0.622
Hemopneumothorax	4 (80.0)	1 (20.0)	5 (100.0)	0.715
Pulmonary Contusion	1 (50.0)	1 (50.0)	5 (100.0)	0.389
Liver injury	4 (80.0)	1 (20.0)	5 (100.0)	0.715
Fracture of Vertebrae	2 (50.0)	2 (50.0)	4 (100.0)	0.191
Large vessels Injury	2 (50.0)	2 (50.0)	4 (100.0)	0.191
Bladder Injury	4 (100.0)	0 (0.0)	4 (100.0)	0.549
Spleen Injury	2 (50.0)	2 (50.0)	4 (100.0)	0.191
Renal Injury	3 (100.0)	0 (0.0)	3 (100.0)	0.471
Femur Fracture	3 (75.0)	1 (25.0)	3 (100.0)	0.999
Tibia Fracture	2 (66.7)	1 (33.3)	3 (100.0)	0.530
Colon Injury	1 (50.0)	1 (50.0)	2 (100.0)	0.389
Calcaneus Fracture	2 (100.0)	0 (0.0)	2 (100.0)	0.999
Skull Fracture	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Maxillofacial Fracture	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Sternum Fracture	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Small intestine Injury	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Urethral Injury	1 (100.0)	0 (20.0)	1 (100.0)	0.786
Vaginal Injury	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Clavicle Fracture	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Humerus Fracture	1 (100.0)	1 (0.0)	1 (100.0)	0.999
Total (of fractures and injuries)	74 (75.5)	24 (24.5)	98 (100.0)	

According to the Young-Burgess classification used to determine the type of pelvic ring fracture, the fracture mechanism was by lateral compression (LC) of type I in 13 patients (46.4%), type II in five (17.9%) and type III in one (3.6%); by anteroposterior compression (APC) of type I in two (7.14%) and type II in five (17.86%); and by combination of APC II and vertical shear (VS) in two (7.14%).

Regarding severity, seven patients had an ISS greater than 24, that is, a severe score (25%). Mean and median ISS were 20.1 (standard deviation 10.3) and 18 (interquartile range 16), respectively.

At the end of admission, seven patients (25%) had intraperitoneal bleeding, seven just extraperitoneal bleeding and five intra and extraperitoneal. Nine (32.1%) patients required

Table 3. *Absolute figures and percentages of complications in patients with blunt trauma and pelvic fracture, according to survival and death.*

Complication (n; %)	Survival (n=22; 78.6%)	Death (n=6; 21.4%)	Total (n=28; 100.0%)	p value
Rhabdomyolysis	7 (63.6)	4 (36.4)	11 (100.0)	0.174
Surgical wound infection	8 (80.0)	2 (20.0)	10 (100.0)	0.642
Sepsis	3 (50.0)	3 (50.0)	6 (100.0)	0.091 *
Decubitus ulcer	5 (100.0)	0 (0.0)	5 (100.0)	0.268
Shock	3 (100.0)	2 (40.0)	5 (100.0)	0.285
Renal Insufficiency	1 (25.0)	3 (75.0)	4 (100.0)	0.022 **
Acute Respiratory Infection	2 (66.7)	1 (33.3)	3 (100.0)	0.530
Coagulopathy	0 (0.0)	3 (100.0)	3 (100.0)	0.006 ***
Pneumonia	3 (100.0)	0 (0.0)	3 (100.0)	0.470
Pseudomembranous Colitis	3 (100.0)	0 (0.0)	3 (100.0)	0.470
Compartment Syndrome	0 (0.0)	2 (100.0)	2 (100.0)	0.040 **
Deep Vein Thrombosis	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Central Veins Thrombosis	0 (0.0)	1 (100.0)	1 (100.0)	0.214
Mesenteric Ischemia	0 (0.0)	1 (100.0)	1 (100.0)	0.214
Unnoticed Injury	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Cardiac Arrest	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Hemothorax	0 (0.0)	1 (100.0)	1 (100.0)	0.214
Residual pneumothorax	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Another abscess	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Empyema	1 (100.0)	0 (0.0)	1 (100.0)	0.786
Intestinal bleeding	0 (0.0)	1 (100.0)	1 (100.0)	0.214
Total complications	44 (64.7)	24 (35.3)	68 (100.0)	

** p<0.10; ** p<0.05; *** p<0.001.*

laparotomy and six (21.4%) underwent chest drainage.

Five (17.9%) patients required an external fixator to stabilize the pelvis. None of the patients was treated by hemodynamics.

The length of hospital stay varied from one to 72 days, with an average of 26.8 (standard deviation 22.4) and the median 21 (interquartile range 35). The length of stay in the Intensive Care Unit (ICU) ranged from zero to 28 days, with a mean of 6.4 days (standard deviation 8.2) and median three (interquartile range 19 days). Fifteen patients (53.6%) had ICU admission.

Among the complications during hospitalization, 68 occurred for the 28 patients. The

Table 4. *Factors independently associated with death in patients with blunt trauma and pelvic fracture.*

	Or (95%)			
Variables	Model 1	Model 2	Model 3	Model 4
Age				
Up to 39 years	1.0	1.0	1.0	1.0
40 to 49 years	0.5 (0.1; 13)	2.6 (0.1; 143)	0.9 (0.1; 24)	2.6 (0.1; 148)
50 years or more	7.5 (1.1; 52) **	1.1 (1.1; 676) **	9.1 (0.95; 87) *	28.3 (1.2; 692) **
Compartment Syndrome				
No		1.0	1.0	
Yes		0.96 (0.01; 91)	27 (0.7; 1000) *	
Coagulopathy				
No		1.0		1.0
Yes		83 (1.2; 5917) **		140 (22; 8857) **
Information statistics				
AIC	28.3	25.9	27.1	21.5
BIC	32.2	32.4	30.3	26.7

** p<0.10; ** p<0.05.*

highest frequencies observed were 11 (39.2%) patients with rhabdomyolysis, 10 (35.7%) with surgical wound infection, six (21.5%) with sepsis, five (17.9%) with septic shock, four (14.3%) with acute renal failure, three (10.7%) with respiratory insufficiency, three (10.7%) with pneumonia, three (10.7%) with coagulopathy and three (10.7%) with pseudomenbranous colitis.

There were six deaths (21.4%). Table 1 indicates that there were statistically significant differences between the survivors and those who died in relation to the following characteristics: age group (p=0.034), with a much higher mortality among those aged 50 years or over compared with all the 28 patients (57.4% and 21.4%, respectively); mean hospital stay (p=0.031), this being shorter among those who died compared with the hospitalization time of all patients (six versus 21 days). We further highlight the borderline significance of the findings of mean (p=0.088) and median (p=0.064) age, which were more than ten years lower among the survivors compared with those who died, the mean hospital stay (p=0.070), which was 12.2 days among those who died and 30.8 days among survivors, and, following this result, the mortality progressively lower as the number of hospitalization days advanced (p=0.099).

Regarding the differential mortality due to thoracic injuries, there was no significant finding or at the threshold of statistical significance (Table 2). As for the differential complications (Table 3), mortality was higher in the cases of compartment syndrome (p=0.040), renal insufficiency (p=0.022) and coagulopathy (p=0.006). Death was also more frequent among those who progressed with sepsis, with a borderline significance (p=0.091).

Table 4 shows the results of the logistic models predictive of death.

We observed that the best model, with lower AIC and BIC, was Model 4, after comparing models 2 and 3, for which the AIC indicated that the best model would be 2 (if compared to 1 and 3) and The BIC indicated that the best would be Model 3 (if compared with 1 and 3). In fact, Model 4 indicated that age was a factor independently associated with death: the chance of death in patients aged 50 years or older was

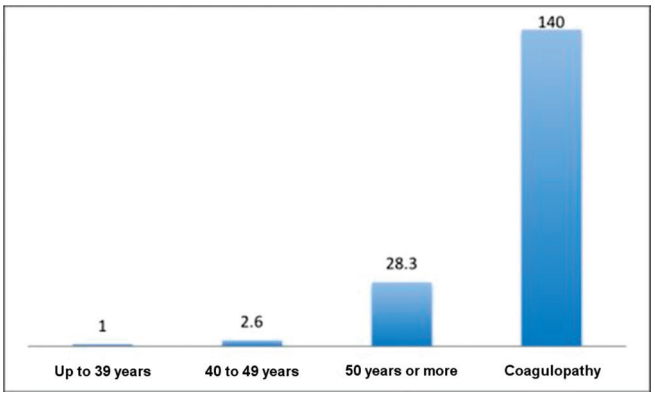

Figure 1 - *Odds ratios associated with mortality (Model 4)*

28.3 times the chance of death among patients under 40 years of age (p<0.05). In Model 4, the presence of coagulopathy was independently associated with death (OR=140, p<0.05, Figure 1)

DISCUSSION

Pelvic fractures are serious injuries and can lead to early and late death[1-4]. This study corroborates these findings, having found mortality greater than 20%. This incidence is a very high *vis-à-vis* the literature on patients with pelvic fractures due to blunt trauma. Mortality ranged from 4% to 15% according to to recent studies[2,5].

The majority of the patients were young adults, aged less than 40 years. Survivors were not only significantly younger, but age was also independently associated with death. This finding was analyzed in this study in a detailed way and the most robust predictive model was the one that took into account the presence of coagulopathy and compartment syndrome. After obtaining this model, we included variables for the number of lesions or fractures and for the number of complications, and there was no improvement in the predictive capacity of death measured by the information statistics proposed here (AIC and BIC).

Advanced age is a factor that contributes to higher mortality among trauma patients[11]. However, little is known about the effects that cause this variation of risk according to age. Patients with the same ISS levels have a higher risk of dying if they are older[12]. Biologic fragility, which is associated with a reduction of the homeostatic reserve and a decrease in resistance to stressors, increases with age[13]. This study adds to what is already known when indicating that coagulopathy, in addition to age, was independently associated with death. A review of coagulopathy, which is a condition that develops in large bleeds, and constitutes the inability to produce adequate hemostasis in response to tissue injury, indicated that this condition is the main cause of death in the first 24 hours of treatment of victims of trauma[14].

Multiple factors contribute to the development of coagulopathy in trauma, the main ones being hemodilution, metabolic acidosis and hypothermia. To prevent and treat this condition, the main measure is to control bleeding quickly and immediately through surgery. The correction of hypothermia and acidosis, as well as the rational use of blood components, should always be sought to obtain the maximum therapy effectiveness and avoid possible complications[14].

We should also note that coagulopathy is associated with the compartment syndrome, being a predictor, thus predating abdominal compartment syndrome (ACS). ACS is a serious complication caused by the exaggerated increase in intra-abdominal pressure (IAP) associated with the failure of at least one abdominal organ. Intraabdominal hypertension (IAH), defined as IAP values above 12mmHg, is what causes ACS[15]. Long before the symptomatic manifestation of ACS, the harmful effects of IAH appear and are not restricted to the abdomen, also affecting the chest and skull[16]. Patients with IAH were 11 times more likely to develop abdominal complications than those who did not present with IAH or ACS[17]. Thus, coagulopathy is part of the lethal triad (hypotension, coagulopathy and acidosis)[18], a vicious cycle that, if uninterrupted, leads to death quickly, requiring rapid and effective bleeding control techniques to interrupt the triad.

Pelvic fracture due to trauma is a severe condition that poses serious risks to life. The mortality found in the study was more than 20%, that is, even higher than what is usually described in the literature. This study resulted in the direct relationship of age and the presence of coagulopathy as independent predictors of mortality.

RESUMO

Objetivo: analisar a associação de mortalidade com variáveis sociodemográficas, clínicas, lesões e complicações em pacientes com trauma de pelve decorrente de trauma contuso. **Métodos**: estudo retrospectivo e observacional com dados de registro de trauma obtidos durante cinco anos. O óbito foi a variável de estratificação das análises. Para verificar se as variáveis de interesse tinham associação com o óbito, foi realizado o teste t de *Student* e teste do Qui-quadrado (ou Fisher) e Wilcoxon-Mann Whitney . Os fatores independentemente associados ao óbito foram analisados por modelo logístico binomial, e com base nos testes de Wald e por Critérios de Informação de Akaike (AIC) e Bayesiano de Schwarz (BIC). **Resultados**: dos 28 pacientes com fratura de pelve por trauma contuso, 23 (82,1%) eram homens; 16 (57,1%) com média de idade de 38,8 anos (desvio padrão 17,3). Houve 98 lesões ou fraturas nos 28 pacientes. Quanto à gravidade, sete pacientes tiveram *Injury Severity Score* superior a 24 (25%). O tempo de internação hospitalar médio foi 26,8 dias (DP=22,4). Quinze pacientes (53,6%) tiveram internação em UTI. A incidência de óbito foi de 21,4%. A análise mostrou que idade igual ou maior do que 50 anos e presença de coagulopatia foram fatores independentemente associados ao óbito. **Conclusão**: as fraturas de pelve podem ter mortalidade elevada. Neste estudo a mortalidade foi superior ao que é descrito na literatura. A idade acima de 50 anos e a coagulopatia se revelaram fatores de risco nessa população.

Descritores: Ferimentos e Lesões. Pelve. Traumatismo Múltiplo. Cirurgia Geral.

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