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Computerized Axial Tomography in patients with severe abdominal trauma: is it a justifiable risk?

Tomografia no trauma abdominal grave: risco justificável?

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ABSTRACT

Objective: to evaluate the evolution of severe abdominal trauma patients, for whom the massive transfusion protocol was triggered, and who were submitted to Computed Axial Tomography (CAT) in the emergency room (ER), in order to verify the patient's prognosis and the diagnostic efficiency of CAT in this scenario. **Methods:** retrospective, longitudinal and observational study performed at a referral center for trauma care in Curitiba, Parana, Brazil. We selected 60 severe abdominal trauma patients who had massive transfusion protocol activation and divided them into two groups: patients who underwent CAT at ER and patients who did not. We verified the diagnostic accuracy of CAT-scan examination and compared the number of deaths, hospitalization time, and transfused blood components in both groups. **Results:** considering the 60 patients, 66.67% received red blood cells at ER; 33.3% underwent CAT on admission due to hemodynamic improvement, and 66.7% did not perform the examination at the entrance. The percentage of deaths was 35% in both groups. Considering the two groups, the difference between the mean lengths of hospital stay was not statistically significant, as well as the difference between the mean numbers of transfused red blood cells. In the group that underwent CAT, 45% did not require exploratory laparotomy. **Conclusion:** CAT could be rapidly performed in patients with hemodynamic instability on arrival at ER, sparing some patients from an unnecessary exploratory laparotomy and not significantly influencing mortality.

Keywords: Shock, Hemorrhagic. Abdominal Injuries. Tomography. Multiple Trauma. Sensitivity and Specificity.

INTRODUCTION

Approximately six million people a year die as a result of unintentional injuries and violence all around the world. They come from all age groups and different walks of life. Unintentional injuries and violence are the main causes of death in the first four decades of life and they account for more years of productive life loss than heart diseases and cancer[1-3].

The management of patients suffering from abdominal trauma follows algorithms which depend on the type of trauma and are based on hemodynamic status[4]. When stable, patients are normally evaluated with abdominal Computerized Axial Tomography (CAT) scan, and treatment is directed according to CAT findings and clinical evaluation[4]. On the other hand, hemodynamically unstable patients should undergo Focused Assessment with Sonography in Trauma (FAST) or peritoneal lavage. If they show signs of abdominal bleeding[4], exploratory laparotomy (EL) is recommended. Considering unstable patients, the use of FAST for abdominal trauma has been inserted in protocols, due to its celerity and higher sensitivity in detecting hemoperitoneum compared to peritoneal lavage. However, this finding does not always correlate with the need for emergency surgery[5].

CAT scanning has become essential in the evaluation of abdominal trauma, but its use is limited in initially unstable patients, who may worsen during the examination due to transportation time and CAT[6] performance. On the other hand, as availability and speed to perform ancillary exams have been increasing, the algorithms for management of abdominal trauma have been evolving and undergoing alterations[6], thus making essential not only clinical evaluations but also CAT findings. Patients with transient instability can be evaluated with tomography[7].

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However, in severe patients, it is still not clear whether CAT provides useful information to alter conducts or if its performance worsens prognosis[7].

The objective of this study was to evaluate the prognosis and evolution of patients with severe abdominal trauma and hemodynamic instability on arrival at emergency room (ER) - patients for whom massive transfusion protocol was activated and CAT performed still at ER - and to verify the diagnostic efficiency and safety of CAT in this scenario.

METHODS

Retrospective, longitudinal, and observational study conducted at the Center for Studies of Hospital do Trabalhador (Curitiba, Parana, Brazil) and approved by the Research Ethics Committee of the same hospital (protocol number 65421917.4.0000.5225).

In order to select severe patients, we used the following objective criteria: vital input data, activation of the massive transfusion protocol according to which patients are classified as hemodynamically unstable or with transient instability, and significant bleeding prospect[8]. During one year (2016), sixty consecutive cases of severe abdominal trauma patients attended at Advanced Support Life (ALS) room, for whom the massive transfusion protocol was triggered, were evaluated. Vital data, such as blood pressure (BP) and heart rate (HR), were collected from patients on arrival. They were then divided into two groups: patients who underwent CAT scanning shortly after admission and initial evaluation at ER and patients who did not. Length of hospital stay, amount of packed red blood cells transfused still in ALS room, and outcomes were all analyzed in both groups.

We chose Mann-Whitney U test to analyze the results, using IBM® SPSS Statistitcs 25® software (United States, 2017). In addition, sensitivity, specificity, positive predictive value, negative predictive value, and CAT accuracy were calculated based on the comparison of this examination's findings with those found in EL. For this group, we considered as true positive results those which had surgical findings in EL consistent with those of CAT. The true negative results were those which did not present any surgical finding, nor any CAT findings. On the other hand, the false negative results were those that did not have findings in CAT scan and presented surgical findings during EL.

RESULTS

Sixty patients were included in this study, the majority (56/93.3%) male. The mechanisms of trauma were gunshot wound (GSW) in 33 (55%), car or motorcycle accident in 11 (18.3%), trampling in five (8.3%), stab wound (SW) in four (6.6%), falls from height (FFH) in four (6.6%), and other mechanisms in three (5%) patients. In the sample, all (100%) patients needed blood products; 20 (33.3%) patients underwent CAT on arrival at ER because of their hemodynamic improvement; and 40 (66.6%) patients did not undergo CAT, following directly to EL (Table 1).

In terms of survival and length of hospital stay, there was no statistically significant difference between the group that underwent CAT and the one that did not (Table 1). One-third of patients (20) received red blood cells in surgical center; 66.6% (40) received red blood cells still at ER; and 34.3% had hemodynamic stability, even if transient. Considering the two groups, the comparison between the means of the number of transfused red blood cells units was p=0.411, calculated from Mann-Whitney U test at a significance level of α=0.05. (Table 1).

Table 1. *Epidemiological data on trauma mechanism, transfused red blood cells, deaths, and hospitalization time.*

	CAT*	Non-CAT*
Number of patients	20	40
Age (average±SD**)	36.55 (±18.16)	30.90 (±14.20)
Trauma mechanism (%)		
GSW***	20	72.50
Car or motorcycle accident	45	5
Trampling	10	7.50
SW****	5	7.50
Falls from height	15	2.50
Other	5	5
Red blood cell concentrate (average±SD**)	2.15 (±2.16)	1.6 (±1.97)
Deaths (%)	35	35
Days of hospitalization (average±SD**)	41.77(±52.45)	22.06 (±14.77)

** CAT: computerized axial tomography; ** SD: standard deviation; *** GSW: gunshot wound; **** SW: stab wound.*

Regarding bleeding classification based on vital data (BP and HR) of all patients, 12 did not have their data collected due to lack of information in their medical records. Among the remaining 48 patients, 12.5% had grade I hemorrhage; 6.3%, grade II; 68.7%, grade III; and 12.5%, grade IV. Among those who had grades I and II hemorrhages, 33.3% were victims of GSW, 22.2% were trampled, 22.2% had automobile accidents, 11% were victims of stab wound, and 11% fell from high height.

Among patients who underwent CAT, 55% required EL. Of these, 63.7% presented the same lesions at EL and in CAT survey (true positives) and 9% had no lesion in CAT or EL (true negatives) (Figure 1). Among those who presented differences (27.3%), in one patient, CAT did not identify a mesenteric superficial laceration of terminal ileum and a grade III hematoma; in other patient, CAT did not identify a small lesion in ascending colon; and, in another one, it suggested total absence of lesions but, at EL, a grade II lesion in sigmoid colon and four thin lesions (grades II and III) in small intestine, located 50cm from Treitz's angle (false negatives), were observed (Table 2).

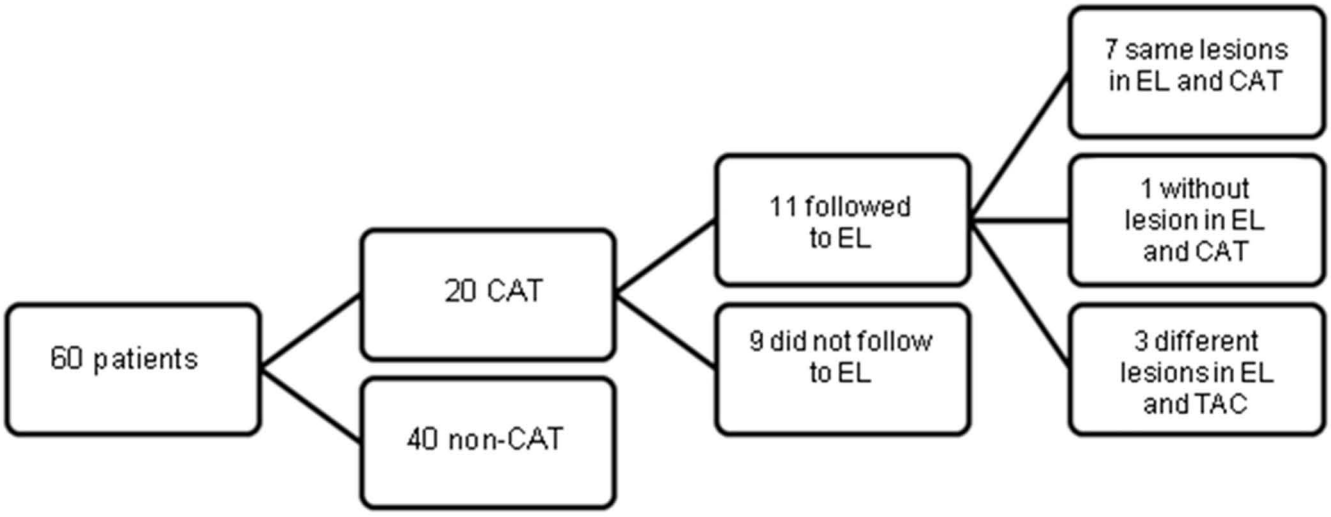

Figure 1. *Flow chart showing results of this study. CAT: computerized axial tomography; EL: exploratory laparotomy.*

Table 2. *CAT accuracy.*

	Accuracy
Sensitivity	70%
Specificity	100%
Positive predictive value	100%
Negative predictive value	25%
Accuracy	70%

DISCUSSION

Hypovolemic shock is the main cause of death in abdominal trauma[3]. According to algorithms dependent on hemodynamic status, stable patients are evaluated with CAT imaging, whereas hemodynamically unstable patients, those without improvement with volume replacement, should be evaluated with FAST and taken to laparotomy if there are signs that confirm abdominal bleeding[4]. Initially unstable patients who present improvement, even if transient, can be evaluated with tomography[7]. The concept of transient instability is debatable. According to the ATLS[3], it refers to patients with shock at admission, but who improve with volume replacement and/or blood products. In this study, massive transfusion protocol activation was used as objective parameter of severity, since this only occurs in patients with severe traumas and hemodynamic instability on arrival at ER.

Vital data at admission are not always documented, but among patients with this parameter in medical record, 18.7% (grades I and II) were not included in hemorrhage grading scale, but presented bleeding perspective, considering high-energy trauma mechanism. In their turn, 81% had grades III and IV hemorrhages, confirming that massive transfusion protocol was activated in severe patients, as well as blood transfusion protocols, following hospital guidelines[8].

Hemodynamically unstable patients should undergo volume replacement with packed RBC according to hemorrhage degree[3]. This is because, in more severe classes, there are significant blood component losses which result in defects in hemostasis[9]. The results of this study demonstrated that, considering all patients (60) with hemodynamic instability at arrival, one-third of them (20) received packed red blood cells in surgical center, since they were referred directly there when they arrived, due to their severity conditions. Two-thirds (40) received red blood cells still at ER, and, among them, 34.3% experienced sufficient hemodynamic improvement to undergo CAT, having their treatment corroborated by literature[7]. This demonstrated that patients might have a positive response to volume replacement in a short period of time, making possible the use of more sensitive diagnostic methods, such as CAT[10]. In their turn, patients who failed to achieve stability (66.6%), even if transient, underwent immediate surgical exploration. Regarding the amount of transfused blood components in each group of patients, the average red blood cell count was the same between the group that underwent CAT and the group that did not.

For evaluation of abdominal trauma, CAT has sensitivity ranging from 92% to 97% and specificity of 98.7%[11], in agreement with the results obtained in the present study regarding the value of specificity (100%). However, sensitivity was of 70%, which, although statistically positive, might be reduced due to the total number of the sample, also justifying the low negative predictive value (NPV=25%), according to Martins Filho *et al*.[12],

NPV values of abdominal CAT scan after trauma are around 95%. The high positive predictive value found (PPV=100%) demonstrated that there was a great chance of injury in positively assessed patients. Analyzed together, these diagnostic tests, indicate that CAT is a reliable examination to determine therapeutic course.

CAT can determine extents, types, and degrees of injuries, resulting in a better therapeutic plan for patients[10]. As we can see in the analysis of patients' EL inventory (patients who underwent CAT), 63.7% presented the same lesion in both exams. However, CAT cannot be performed in a portable manner and requires only visual monitoring while scanning[10]. On the other hand, in our hospital, the tomography room is twinned with ALS room, making it possible to quickly perform CAT in patients with initial instability.

CAT indication for patients with transient hemodynamic instability should consider that the time required to perform the test and the greater difficulty to monitor resuscitation may negatively interfere with the prognosis[10,13]. However, the percentage of deaths in patients who underwent CAT was the same as the one in patients who did not (35%), demonstrating that CAT referral did not increase the number of deaths, data also confirmed by literature[12]. Likewise, the analysis of hospital stay lengths did not present statistically significant difference between the two groups.

Trauma mechanism is important for defining the strategy to be taken on patient's arrival. Abdominal injuries caused by GSW are associated with internal lesions rate of up to 97% and, in the great majority, lead to EL, in agreement with our results that 72.5% of patients directly led to EL were victims of GSW[14,15]. Among patients who underwent CAT the highest index was of trampling victims (45%), a type of blunt trauma that can cause compression and crushing injuries[3]. CAT has the capacity not only to define the presence of the lesion and its extent, but also to exclude other lesions, avoiding unnecessary surgeries[16].

Within statistical limitations, this study's analysis allows to affirm that CAT is an efficient method in the search for abdominal lesions and free fluid in the cavity, presenting adequate sensitivity and specificity. Since applied with adequate infrastructure, CAT can be rapidly performed in patients with initial hemodynamic instability, without significantly influencing mortality and prognosis. It allows a safer therapeutic approach for each patient and avoids unnecessary laparotomies.

R E S U M O

Objetivo: *avaliar a evolução de pacientes vítimas de trauma abdominal grave, nos quais o protocolo de transfusão maciça foi acionado, e que foram submetidos à Tomografia Axial Computadorizada (TAC) no Pronto Socorro (PS), com o intuito de verificar o prognóstico do paciente e a eficiência diagnóstica da TAC nesse cenário.* **Métodos:** *estudo retrospectivo, longitudinal e observacional, feito em centro de referência para trauma. Foram selecionados 60 pacientes vítimas de trauma abdominal grave que ativaram o protocolo de transfusão maciça, divididos em dois grupos: os submetidos à TAC no PS e os que não foram. Verificou-se a acurácia da TAC, comparou-se o número de óbitos nos dois grupos, o tempo de internamento e os hemocomponentes transfundidos.* **Resultados:** *dos 60 pacientes, 66,67% receberam concentrados de hemácias ainda no PS; 33,3% foram submetidos à TAC na admissão, pela melhora hemodinâmica, e 66,7% não realizaram o exame na entrada. O percentual de óbitos foi de 35% em ambos os grupos. A diferença entre as médias do tempo de internamento entre os grupos não foi estatisticamente significativa, assim como a média da quantidade de concentrado de hemácias transfundido. No grupo que fez TAC, 45% não necessitaram de laparotomia exploratória.* **Conclusão:** *a TAC pôde ser realizada de maneira rápida em pacientes com instabilidade hemodinâmica na chegada ao PS, não influenciou significativamente a mortalidade e poupou alguns doentes de uma laparotomia exploratória desnecessária.*

Descritores: *Choque Hemorrágico. Traumatismos Abdominais Tomografia. Traumatismo Múltiplo. Sensibilidade e Especificidade.*

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