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Computerised tomography in the diagnosis of intestinal and mesenteric injuries in closed abdominal trauma

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A B S T R A C T

Background: The frequency of bowel and mesenteric injuries is increasing. They are difficult to diagnose and delays in their diagnosis leads to a significantly increased morbidity and mortality. The aim of this study is to evaluate the usefulness of the computed tomography (CT) in the detection of blunt bowel and mesenteric injuries.

Method: Between January 2000 and October 2007, 79 patients with blunt abdominal trauma (60 men and 19 women) were included in our study. They underwent laparotomy after performing the abdominal CT. The CT findings were compared with the findings at laparotomy in order to determine the accuracy of the CT in the detection of bowel and mesenteric injuries.

Results: For the detection of bowel and mesenteric injuries we obtained for the CT: sensitivity = 84.2%, specificity = 75.6%, positive predictive value = 76.2%, negative predictive value = 83.8%, positive probability value = 3.45, and negative probability value = 0.21. Accuracy: 79.7%.

Conclusion: The abdominal CT is suitable for detecting bowel and mesenteric injuries following blunt abdominal trauma.

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Utilidad de la tomografía computarizada para el diagnóstico de lesiones intestinales y mesentéricas en el trauma abdominal cerrado

R E S U M E N

Introducción: Las lesiones de víscera hueca y mesentéricas en pacientes politraumatizados están en aumento. Su diagnóstico representa un reto para el radiólogo y el clínico experimentado, ya que su retraso aumenta la morbimortalidad. El desarrollo de la tomografía computarizada (TC) helicoidal lo ha mejorado, aunque los resultados publicados son contradictorios. El objetivo de este trabajo es valorar la utilidad de la TC en el diagnóstico de estas lesiones en el traumatismo abdominal cerrado (TabC).

Palabras clave:

Tomografía computarizada

Trauma abdominal cerrado

Lesiones de víscera hueca

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Material y métodos: Entre enero de 2000 y octubre de 2007, 79 pacientes con TabC (60 varones y 19 mujeres) se incluyeron en este estudio. Se les realizó laparotomía exploradora tras la realización de TC abdominal, lo que permitió comparar los hallazgos de las pruebas de imagen preoperatorias con los de la laparotomía.

Resultados: Para la detección de lesiones de víscera hueca y mesentéricas se obtuvo para la TC sensibilidad del 84,2%, especificidad del 75,6%, valor predictivo positivo del 76,2%, valor predictivo negativo del 83,8%, coeficiente de probabilidad positivo de 3,45 y coeficiente de probabilidad negativo de 0,21. La precisión fue del 79,7%.

Conclusión: La TC helicoidal abdominal es una prueba útil para la detección de lesiones de víscera hueca y mesentéricas en pacientes con TabC.

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Introduction

The increasingly used conservative treatment of blunt abdominal trauma (BAT) entails the following for its use: a) haemodynamic stability of the patient; b) monitorisation and systematic clinical re-evaluation; and c) availability of imaging techniques (fundamentally ultrasound and computed tomography [CT]) in the emergencies area.¹⁻⁵

Failed conservative treatment and delays in the surgical intervention imply a significant increase of the morbidity-mortality of these patients.^{6,7} One of the reasons of said failure is the late diagnosis of mesenteric and bowel injuries, due to the fact that there are more incidents because of the generalised use of safety belts, along with the fact that their preoperative diagnosis has classically been classified as difficult to establish.^{8,9}

The use of modern imaging techniques, especially the spiral CT, has allowed for more diagnosing precision after the BATs, together with a reduction in the number of unnecessary laparotomies, although their usefulness in the diagnosis of intestinal injuries is controversial.⁸⁻¹² Here we present a study that looks for establishing the usefulness and precision of the spiral CT when diagnosing bowel injuries after BAT.

Patients and method

Between January 2000 and October 2007, 353 patients with BAT (222 men and 131 women), with an average age of 35 years (range, 14-73 years) were admitted to this hospital. Out of the total patients, 79 (60 men and 19 women) were included in this study, as they underwent an exploratory laparotomy. The indications to perform an exploratory laparotomy were the following: a) presence of haemodynamic instability of intraabdominal origin after being admitted in a stable condition; b) indicative findings in the abdominal CT and clinically compatible; and c) appearance of diffuse rebound tenderness in the clinical evolution or sepsis (extraabdominal cases were excluded); all of this after carrying out the abdominal CT, which allowed us to compare, retrospectively, the findings of the preoperative imaging tests with the findings from the laparotomy.

Patients and protocol

All of the patients were evaluated and treated following the principles based in the Advanced Trauma Life Support (ATLS) philosophy when they arrived to the hospital. After their primary evaluation, and if the patient was haemodynamically stable, they underwent a double-spiral CT (GE HiSpeed NX/ir; GE Medical Systems, Milwaukee, WI) with oral and intravenous contrast: they were administered 200 mL of oral contrast before carrying out the test and 150 mL of non-ionic intravenous contrast during the test, at an infusion speed of 2.5 mL/s with a delay in the image taking of 70 s. The parameters of the image were slice thickness of 7 mm, 120 Kv, 200 mA, and a reconstruction interval of 7 mm.

The radiologist on call evaluated the findings obtained and carried out the clinical history. These findings were compared with those collected in the surgical protocol carried out after the laparotomy and they were also included in the clinical history of the patient.

Statistical study

Data analysis was performed using the SPSS program, version 11.0. The sensitivity (S), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), and negative likelihood ratio (NLR) were calculated with the 95% confidence intervals (CI) of the abdominal CT for bowel and mesenteric injuries.

Results

The traumatism production mechanisms were divided in traffic accidents [car (32), motorcycle (15), being run-over (7), and bicycle (5)], falls (15), and other causes (5); the traffic accidents stand out as the principle cause of traumas (74.6%), specially automobile accidents (40.5%). From the total number of patients that were admitted to this hospital for BAT, some type of bowel or mesenteric injury was observed in 32 of them (9%) (from insignificant mesenteric haematomas to acute peritonitis due to intestinal or bladder perforation, etc).

The results of the detection of bowel and mesenteric injuries in the abdominal CT compared with the findings of

Table 1 – Findings from abdominal CT compared to laparotomy for bowel and mesenteric injuries

		Laparotomy (bowel and mesenteric injuries)	
		Yes	No
Abdominal CT (bowel and mesenteric injuries)	Yes	32	10
	No	6	31
CT indicates computed tomography.			

Table 2 – Values from the abdominal CT to detect bowel and mesenteric injuries

Abdominal CT (bowel and mesenteric injuries)
S = 84.2% (from 68% to 93.4%)
Sp = 75.6% (from 59.4% to 87%)
PPV = 76.2% (from 60.2% to 87.4%)
NPV = 83.8% (from 67.3% to 93.2%)
PLR = 3.45 (from 1.98 to 6)
NLR = 0.21 (from 0.10 to 0.44)
CT indicates computed tomography; NLR, negative likelihood ratio; NPV, negative predictive value; PLR, positive likelihood ratio; PPV, positive predictive value; S, sensitivity; Sp, specificity.

the laparotomy are represented in Table 1. Table 2 shows the values of the statistical parameters calculated for this test, based on the data from the previous table. As can be seen, the abdominal CT shows an acceptable S and Sp to detect these types of injuries. The estimated PPV and the NPV are also acceptable, as well as the PLR and the NLR. Based on these results and keeping in mind the 95% CI of each of the parameters studies, it can be confirmed that the abdominal CT is a useful test, not only to confirm the presence of bowel and mesenteric injuries in BAT (high PLR) but also to discard the absence of these (low NLR). The precision of this technique is 79.7% (95% CI, 68.9-87.6).

Characteristics of the findings from the computed tomography

In 10 of the 42 patients with CTs compatible with bowel injuries, the injury was not confirmed by laparotomy, which corresponded to "subtle changes" in the small intestine loops and the mesentery. Specifically, laparotomy was indicated in these patients for not being able to clinically discard the harmlessness of the findings from the CT in a definitive manner. Of the 32 patients with CTs compatible with a bowel injury, a pneumoperitoneum was found in 6 of them; abundant free liquid without signs of solid organ injuries was found in 20 of them; continuity solutions were found in the intestine in 2 of them, and there were signs of mesenteric tears in 4 of them. The 6 false negatives corresponded to minimal mesenteric tears (2), one haematoma and an

intestinal contusion (1), and to small serous membrane losses of the intestinal wall (3). There were no complications or deaths related to the radiological procedure.

The findings of the CT for the BAT that did not require surgery include: a) solid organ injuries (liver and spleen); b) minimal quantity of free liquid without apparent injuries in the entire abdominal cavity; c) retroperitoneal and abdominal wall haematomas; and d) no signs of injuries.

Discussion

The detection of bowel and mesenteric injuries using imaging techniques in patients with BAT who are haemodynamically stable has always been a challenge for radiologists, and the results published in existing medical literature are contradictory.¹³⁻¹⁵ The recent advances in imaging techniques and the creation of new technologies, mainly with the introduction of the spiral CT, have optimised its diagnosis.^{5,6,9} As poly-traumatised patients can rapidly become unstable, the fact that the radiological techniques have improved (specially the speed of the complementary explorations and the quality of images) has made it possible that a growing number of patients can benefit from their use.¹³

The results obtained in this study show that the abdominal spiral CT is a useful test to detect bowel and mesenteric injuries in patients with BAT. In addition, the results of this study are compatible with those published in the existing medical literature.^{13,15}

Traffic accidents represent, in this series and according to the bibliography,^{13,16} the most frequent production mechanism of BAT: they represent 75% of the cases in this study. The incidence of this type of injuries in this current study is slightly higher (9%) than those recently published (around 6%)¹³; this could be due to 2 facts: a) the greater frequency of traffic accidents in this series compared to other series, and b) that the authors of this article have considered even the most minimal injuries observed in the laparotomy field. Various authors have questioned the use of oral contrast to carry out the CT in poly-traumatised patients^{8,10} and they affirm that not only does it not benefit the diagnosis of these bowel injuries, but that it also implies a delay in the diagnosis of these patients and increases their risk of broncho-aspirations. The protocol of the treatment of the poly-traumatised patient in this hospital includes the use of oral and intravenous contrast to carry out this test, and therefore the authors of this article have no experience in not using them. There were no complications or deaths related with the radiological procedure in any of the patients of this series.

The findings of the CT for the diagnosis of bowel injuries are usually divided into a) injury diagnoses (pneumoperitoneum, continuity solution in the intestinal wall, escape of contrast and ectopic air), and b) those indicative of injuries (specific thinning of the intestinal wall and free liquid with no signs of solid organ injuries).^{13,17} Although the pneumoperitoneum is considered as a diagnosis of this type of injuries, it is not usually present in more than half of the cases.¹³ In this study, it has been found in 19% of the patients and it was

the diagnosis in 100% of the patients, although the existence of a pneumoperitoneum (false positives) secondary to the interstitial air dissection from the thorax¹⁸ has been published. Regarding the free liquid with no signs of solid organ damage, this must be considered with great precaution due to the fact that finding it may lead to a great quantity of false positives concerning the diagnosis of bowel injuries, therefore, this finding should be correlated with the patient's signs and symptoms and, if the patient is haemodynamically stable and presents no other injuries indicative of laparotomy, a new CT should be correlated between 6 and 8 h from the first one.^{14,19} When finding mesenteric tears or "subtle changes" in the mesentery, the same previously mentioned guidelines should be followed for the finding of free liquid. Indeed, in this series, it is possible that when not following an expectant attitude and one that included periodic re-evaluation (clinical and radiological) in patients of this type explains the elevated percentage of false positives of these in the CT regarding the clinical transcendence.

Another important consideration is if the technological evolution is not accompanied by adequate training of specialist doctors, in which case said evolution would not be worth anything, and for this reason, its evaluation is very important to detect the weak points and constantly improve health professionals.^{20,21} In the present case, the good results obtained by the radiologists stand out.

To conclude, due to the elevated exactness of the urgent CT to diagnose bowel and mesenteric injuries as well as the absence of side effects, its use is recommended in haemodynamically stable patients with BAT and those with suspicions of intraabdominal injuries. Carrying out said test as soon as possible may reduce the morbidity and mortality related to this type of injuries.

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