

# Isolated liver gunshot injuries: nonoperative management is feasible?

## *Lesão hepática isolada por arma de fogo: é possível realizar tratamento não operatório?*

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### A B S T R A C T

**Objective:** to evaluate the safety and effectiveness of non-operative management (NOM) of liver injury, being the only abdominal injury, from gunshot wounds to the abdomen. **Methods:** patients who had liver damage diagnosed as single abdominal injury caused by PAF in the right thoracoabdominal region, hemodynamically stable were studied. All underwent examination with computed tomography. Were analyzed: age, gender, levels of trauma, hemodynamic condition and the abdominal examination on admission, the results of the CT scan, the extra-abdominal lesions found, the serum levels of hemoglobin, clinical course, complications, length of hospital stay, outpatient treatment and death. **Results:** during the study period 169 patients, treated non-operatively, presented liver gunshot wounds. Of these, only 28 patients (16.6%) had liver injury as the only abdominal injury and consequently met the inclusion criteria for this study. The average age was 27.7 years and 25 patients (89.2%) were male. The overall average of verified trauma scores were: RTS 7.45, ISS 10.9, and TRISS 98.7%. The most frequent injuries were grade II and grade III (85.7%). Complications occurred in only one patient who presented a progressive decline in hemoglobin. He underwent a CT scan which showed blush in the liver parenchyma. An arteriography was performed, which showed a successfully embolized arteriovenous fistula. There were no deaths in the patient sample. The average hospital stay was 5.3 days. **Conclusion:** isolated hepatic injury in gunshot abdominal trauma is uncommon. However, the NOM protocol for this type of injury is safe and has low morbidity. This approach should only be followed in institutions with adequate infrastructure, where an experienced and cohesive team is able to follow a specific protocol, with rigorous periodic evaluation of its results.

**Key words:** Wounds and Injuries. Trauma Severity Indices. Liver/surgery. Wounds, Penetrating. Abdominal Injuries.

### INTRODUCTION

The improvement and increasing use of imaging methods, particularly computed tomography (CT), has significantly changed injury management of abdominal solid organ, particularly the liver. The non-operative management (NOM) of blunt liver injury is a reality and, principally in reference trauma centers, it is considered the treatment of choice, provided that the protocol inclusion criteria are met. Currently, NOM is commenced in around 86.3% of such cases<sup>1</sup>, with success rates varying from 82 to 100%<sup>2,3</sup>. Even for blunt liver injuries which are considered complex, the success of NOM reaches satisfactory levels<sup>4</sup>.

Due to these good results associated with blunt liver injury, NOM has also been extended to penetrating liver injuries caused by both stab and gunshot wounds (GSW). In penetrating trauma, due to the frequency of associated intra-abdominal injuries, NOM candidates should be selected with great rigor and discretion. Currently, various

services have used this approach for liver injuries from both stab and gunshot wounds, with success rates ranging from 67-100%<sup>5-15</sup>.

However there is still no consensus for NOM for penetrating liver injuries, mainly by GSW. It is performed in few trauma centers, despite the encouraging results from sites where it is practiced. However, to date, there are no analyses of NOM results for penetrating isolated liver injuries in published studies, that is, which presented no compromised chest, diaphragm or other abdominal viscera. Therefore, the aim of this study is to analyze strictly the results of experiences of NOM regarding liver GSW as single abdominal injuries without associated abdominal and/or chest injuries.

### METHODS

A longitudinal, prospective study conducted on patients with GSW on the right thoracoabdomen, with

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isolated liver injuries, received at Hospital João XXIII, from January 2005 to December 2014. Patients who met the inclusion criteria, determined by the service protocol of general surgery and trauma at Hospital João XXIII<sup>15</sup>, were included in this study. It was approved by the Ethics Committee of the institution and filed under number 049/2009.

The inclusion criteria were: patients with liver damage as the only abdominal injury, caused by GSW on the right thoracoabdomen, and who, on admission, presented hemodynamic stability, defined as systolic blood pressure greater than 90mmHg, heart rate lower than 110bpm, and no signs of peritonitis. The presence of these criteria prompted CT scans. The performance of a CT scan of the abdomen is mandatory to fulfil the protocol criteria. The liver injuries were classified by grade using the classification proposed by The American Association for the Surgery of Trauma (AAST)<sup>16</sup>. Patients with associated injuries to the thoracic cavity (hemothorax, pneumothorax, etc.), and to the abdominal cavity, besides the liver, were excluded from the study. Patients with signs of peritonitis, hemodynamic instability on clinical examination, or signs of injury to the gastrointestinal tract, suggested by imaging tests, were referred for surgical treatment and therefore excluded from the study. Only patients with isolated liver injuries were analyzed.

The data analyzed were: age, sex, trauma scores, hemodynamic status and abdominal examination on admission, CT results, existing extra-abdominal injuries, serum levels of hemoglobin, clinical outcome, the presence of complications and their treatment, length of hospital stay, outpatient follow-up and death.

Patients which, during the treatment period, showed persistent signs of bleeding (fall in hemoglobin or hematocrit), suggestive signs of liver damage complications (jaundice, fever, liver enzyme abnormalities, gastrointestinal bleeding) or abdominal pain, were referred for new scans and subsequent treatment, according to any abnormalities found.

Patients with at least grade IV liver damage remained hospitalized until the seventh day after trauma when another CT scan was performed to examine the

progress of the injury. Hospital discharge was granted when the patient was eating adequately, with normal bowel habits and no abdominal pain or fever. Patients were told to return for out patient monitoring after fifteen, thirty and sixty days after trauma. In the last review of each patient a CT scan of the abdomen was requested to check that the liver injury was completely healed. Long term monitoring is being performed at six, 12, 18 and 24 months from the date of injury. These are the conditions laid down by the current protocol.

## RESULTS

During the study period, 176 patients met the inclusion criteria for NOM of GSW on the right thoracoabdomen, with 169(96%) having liver injury. However, only 28 (16.6%) of the 169 patients had isolated liver injuries (Table 1). Only these 28 patients were studied. Regarding the distribution of gender, 25 patients (89.2%) were male and only three patients (10.8%) female. The average age was 27.7 ranging from 16 to 59 years of age. All patients studied were stable on admission with no signs of peritoneal irritation. The overall average of trauma indices was Revised Trauma Score (RTS) 7.45; Injury Severity Score (ISS) 10.9; Trauma and Injury Severity Score (TRISS) 98.7%. The average hemoglobin levels on admission was 12.4g/dL and on discharge, 11.7g/dL. Transfusion was given to three patients (10.8%) with an average of two units of packed red blood cells per patient. A CT scan of the abdomen was performed on all patients. The most frequent injuries were grade II and III (Table 2).

Injuries associated with other regions, excepting the chest and abdomen, were present in 21.4% of patients (Table3). During the period, five patients (17.8%) repeated imaging exams (ultrasound or CT). The main reasons for repeating these was a change in symptoms (abdominal pain, fever) and a progressive drop in hemoglobin.

Complications were present in only one patient (3.6%), with a grade II injury. This patient had a progressive fall in hemoglobin and underwent another CT scan on the fifth day after trauma, which showed blush of contrast within

**Table 1** - Main types of diagnosed injuries in patients with liver injury in patients with GSW of the right thoracoabdomen.

Diagnosed Injuries	Patients (%)
Liver+Diaphragm+Lung	106 (62.7%)
Liver	28 (16.6%)
Liver+Diaphragm+Lung+Kidney	19 (11.2%)
Liver+Kidney	16 (9.5%)
Total	169 (100%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-2014).

**Table 2 -** Classification of Hepatic Injury by Grade (AAST) and its incidence.

Grade of Liver Injury	Number of patients (%)
Grade I	2 (7.1%)
Grade II	14 (50%)
Grade III	10 (35.7%)
Grade IV	2 (7.1%)
Grade V	0 (0%)
Total	28 (100%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-1014).

**Table 3 -** Associated injuries found.

Associated Injury	Patients (%)
Extremity fractures	3 (10.7%)
Vertebrae fractures	2 (7.1%)
Femoral Vessels	1 (3.6%)
Total	6 (21.4%)

Source: Serviço de Cirurgia Geral e do Trauma do Hospital João XXIII (2005-1014).

the lesion. He was referred for angiography which showed an arteriovenous fistula with a low flow, and embolization was performed. The failure of NOM did not happen in any of the 28 patients studied. In this study no patients died. The average length of hospital stay was 5.3 days; for patients without complications it was 5.1 days and for those with, eight days.

Regarding follow-ups after hospital discharge, only 18 patients (64.42%) attended the two-month appointment for clinical examination, laboratory review and control CT. In all of them, hemoglobin levels were within normal limits and the injuries were completely healed, except for one of them (with a grade IV injury) in which the injury was found to still be in the process of healing. This patient repeated the CT scan at the six-month appointment, and it showed the injury to be completely healed. At the two-year control point, only 15 patients (53.6%) returned, even after an active search. All received final discharge.

## DISCUSSION

NOM for penetrating abdominal trauma, although not universally employed, is evolving. Particularly on GSW, several publications have accumulated significant evidence on its safety and success over the past three decades<sup>6-15</sup>. This is understandable because, to carry it out safely, the environment must be properly prepared, having the necessary infrastructure and being qualified with a readied, united and cohesive medical team. Clinical examinations and detailed studies

of imaging (CT) of the projectiles' paths, to find or exclude the presence of abdominal injuries, are indispensable to perform NOM. Computed tomography of the abdomen, besides being one of the protocol items, has a number of advantages and is essential for this kind of approach, there being evidence level II recommendations<sup>16</sup>. With the advancement of technology, multidetector CT has a sensitivity of 91% to 97%, a specificity of 96% to 98% and an accuracy of 96% to 98% in detecting intra-abdominal injuries in patients with GSW abdominal injuries<sup>17-19</sup>.

Among the benefits of NOM are the decreasing frequencies of unnecessary laparotomies and their complications, length of hospital stays and overall treatment costs. Several publications show that 20-30% of patients with abdominal GSW who underwent laparotomies had unnecessary operations, strengthening the importance of approaches such as NOM<sup>6,7,20,21</sup>.

In recent review articles and guideline about NOM of penetrating abdominal trauma, the method was considered effective with success rates ranging from 69% to 100%<sup>16,22,23</sup>. Lamb and Garner, in their review analyzing 6,072 patients, found that only 15.5% required laparotomies for the treatment of complications or failure of NOM<sup>22</sup>. In Singh and Hardcastle's review about 6,468 patients, only 14.8% required laparotomies due to NOM failure. Of those, 28.2% were unnecessary<sup>23</sup>. There commendations of these reviews and guideline, based on the level of evidence, were: a) patients with abdominal GSW who are hemodynamically stable and without signs of peritonitis maybe candidates for NOM: level II, and b) patients with isolated injuries of solid viscera due to abdominal GSW, in the presence of hemodynamic stability and no worsening of the clinical condition nor abdomen examination, may be candidates for NOM: level III<sup>16,22,23</sup>.

Liver injuries have certain important features which allow NOM to be performed with high success rates. Currently, it is the first choice of treatment adopted in institutions that have the essential conditions for its use. Most of the time, bleeding which originated from the liver damage ceases spontaneously, a fact often noted by trauma surgeons during surgical approaches to liver damage in hemodynamically stable patients<sup>24</sup>. Trunkey

*et al.*, in the period of 1947-1963, documented the surgical findings of 205 liver injuries from stab wounds and 428 from GSW. In that sample, 86% of stab wounds and 72% of GSW did not require any treatment, except for drainage at the time of surgery<sup>25</sup>. This highlights the ease with which this injury can be sealed. However, during surgery, or manipulation of the injury, massive bleeding may occur due to loss of the clot. This bleeding is often difficult to control, requiring complex surgical maneuvers, and is associated with high morbidity<sup>26</sup>. In some circumstances of heavy bleeding in critical injuries, it is not possible to achieve satisfactory hemostatic results using conventional surgical techniques, so damage control surgery maneuvers are required instead. All this can occur in a patient that was hemodynamically stable with no active bleeding. Furthermore, it is known that the hepatic parenchyma has a great capacity for healing and regeneration, whether due to traumatic or surgical injury, maintaining the organ architecture. Work in experimental models shows that three to six weeks after the occurrence of an injury, the force required to tear a scar formed is equal to that which would damage a normal parenchyma, whether a liver injury was sutured or not<sup>27</sup>. This healing ability is one of the most important factors in the indication, use and success of NOM for liver injuries, even for those considered complex. Patients followed in this study showed healed injuries in subsequent CT scans. They also maintained adequate coagulation and did not show signs of liver failure, regardless of the extent of the injuries.

As already mentioned, NOM for liver GSW is not routinely performed and the main reason is the high incidence of associated injuries of other viscera and abdominal structures that require surgical treatment. A laparotomy, in most cases, is still the safest approach. However, in a highly selective group of patients, NOM may be a feasible option for this type of injury, being safe and demonstrating high success rates<sup>8,26,28-30</sup>. The most difficult and important aspect, no doubt, is the selection and appropriate monitoring of the patients. The use of CT, in this situation, principally aims to understand the trajectory of the projectile and therefore to avoid any concomitant surgical injury. It is an essential condition to perform NOM.

Recent studies, including this one, specifically address NOM for liver injuries GSW, showing its safety and efficacy in selected patients. These publications show that NOM was possible for between 26.6% and 32.3% of the patients with liver GSW<sup>28-30</sup>. They show an incidence of

complications that varies from 3.8% to 50%, the less frequent being directly related to the liver injuries. The success rates varied from 68.5% to 100%<sup>26,28-30</sup>. Although severe injuries are associated with increased complication rates, the grades of injury, per se, are not shown to be an independent factor for NOM failure, justifying its performance even for injuries considered complex, i.e. for grade IV and V injuries<sup>26,30</sup>. The presence of contrast blush on a CT, which means to the presence of vascular injury, a pseudoaneurysm or arteriovenous fistula, is a factor that predisposes NOM failure. This finding justifies performing angiography and embolization, increasing the possibilities of NOM success.

The increase in abdominal pain or the onset of jaundice, fever or gastrointestinal bleeding, suggest complications related to the actual liver injury, and must be studied by performing another CT scan. Most of these complications (bilioma, biliary fistula, infected hematoma, bilhemia, among others) can be treated with minimally invasive methods such as endoscopic retrograde cholangiopancreatography (for papillotomy and the insertion of stents), puncture and drainage of collections guided by ultrasound or videolaparoscopy. However, the most frequent complications are related to associated injuries, particularly thoracic (retained hemothorax, empyema, infected pulmonary contusion) and, sometimes, to renal injuries<sup>8,26,28-30</sup>. This higher frequency of subsequent complications to associated injuries explains, at least partially, the low rate of complications found (3.8%) in this study.

We not found, in English-language literature, a specific publication that assesses NOM for liver GSW as the only abdominal injury and with no associated chest injury that required some kind of treatment. The results of this study showed that the incidence of isolated liver injuries, which fulfill the NOM criteria, is low (16.6%) and that morbidity and failure rates were lower when compared to studies in which liver injuries were associated with other abdominal or thoracic injuries. NOM for this specific type of injury is safe, for a well-selected group of patients, presents a low morbidity and can be performed, in principle, for all grades of liver injury. However, even for isolated liver injuries, this approach should only be carried out in environment with adequate infrastructure, where an experienced and cohesive team is capable of following the specific protocol, under strict periodic evaluation of their results. Otherwise, it would be an adventure into the unknown which, of course, is not recommended.

## R E S U M O

**Objetivo:** analisar a segurança e efetividade do tratamento não operatório (TNO) da lesão hepática, como única lesão abdominal, em vítima de perfuração por projétil de arma de fogo (PAF) no abdome. **Métodos:** Foram estudados os pacientes com lesão hepática diagnosticada como única lesão abdominal provocada por PAF na região toracoabdominal direita, hemodinamicamente estáveis. Todos foram submetidos ao exame com tomografia computadorizada. Foram analisados: idade, sexo, índices de trauma, condição hemodinâmica e exame do abdome à admissão, resultados da tomografia computadorizada, lesões extra-abdominais existentes, níveis séricos de hemoglobina, evolução clínica, presença de complicações, tempo de permanência hospitalar, acompanhamento ambulatorial e óbito. **Resultados:** no período do estudo, 169 pacientes do protocolo de TNO apresentaram lesão hepática por projétil de arma de fogo. Destes, apenas 28 pacientes (16,6%) possuíam lesão hepática como única lesão abdominal e preencheram os critérios de inclusão no estudo. A média de idade foi 27,7 anos e 25 pacientes (89,2%) eram do sexo masculino. A média global dos índices de trauma verificada foi: RTS 7,45; ISS 10,9; e TRISS 98,7%. As lesões mais frequentes foram a grau II e grau III (85,7%). Um paciente apresentou complicação. Não houve óbito na série. A média de permanência hospitalar foi 5,3 dias. **Conclusão:** A lesão hepática isolada no trauma penetrante por PAF é pouco frequente e o tratamento não operatório desse tipo de lesão é seguro e apresenta baixa morbidade.

**Descritores:** Ferimentos e Lesões. Índices de Gravidade do Trauma. Fígado/cirurgia. Ferimentos Penetrantes. Traumatismos Abdominais.

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