Hepatic trauma: analysis of the treatment with intrahepatic balloon in a university hospital of curitiba

Trauma hepático: análise do tratamento com balão intra-hepático em um hospital universitário de Curitiba

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A B S T R A C T

Objective: The authors discuss the surgical strategies in the management of complex penetrating hepatic lesions through liver balloon tamponade. **Methods:** Eighteen patients who received care in a trauma referral center in southern Brazil over the last 5 years were selected retrospectively. Data and variables evaluated were age, sex, hepatic injury grade and location, amount of saline solution filling the balloon and the length of time it was kept in place, associated injuries, the nutritional therapy instituted, hem concentrate transfusion, complications, antibiotics use, ICU need and length of hospital stay. **Results:** All patients were male with an average age of 22.5 years (18-48). Gunshot wounds were more prevalent than stab wounds and their most common locations were the thorax and thoraco-abdominal regions. The m most commonly associated injury was in the diaphragm, and Couinaud segment VIII was the most often injured hepatic region (29.6%). Seven patients (38.9%) survived and the most common complication were biliary fistulae (42.8%). From the eleven deceased patients (61.1%), 6 died on the day of admission, 3 stayed for 18.6 days in hospital and the others died on the 2nd and 3rd postoperative days. **Conclusion:** Transfixing hepatic lesions are usually difficult to manage and carry high morbidity and mortality rates. The use of intrahepatic balloon tamponade can be useful as a therapeutic tool, but not rid of complications, and for that reason it has specific and selected indications.

Key words: Wounds and injuries . Liver. Balloon dilatation/methods. Wounds, penetrating.

INTRODUCTION

The liver, given its size and anatomical location in the abdomen, is one of the most frequently injured organs in abdominal trauma. The overall mortality rate of hepatic injury trauma patients is 10%. Most lesions – 70-90% – are grades I and II. Liver wounds occur in approximately 40% of stab wounds and in 30% of gunshot wounds[1].

Complex lesions comprise around 10-30% of liver traumatic lesions and are still a major challenge even for the most experienced trauma surgeons. The majority of deaths resulting from hepatic trauma derive from intraoperative hemorrhage or postoperative sepsis. The techniques available to control hepatic hemorrhage include direct ligation of the bleeding vessels, cauterization, topical hemostatic agents, hepatorrhaphy, partial liver resection and ligation of the hepatic artery, and they are effective for most patients. However, some patients will present with extensive injuries or an associated coagulopathy requiring a more aggressive maneuver. Liver packing is an adjunct procedure often used to control refractory hemorrhage in selected cases. Nevertheless, problems related to liver packing, such as rebleeding, hepatic necrosis, and subsequent sepsis, have restricted its application in a great number of liver trauma patients[1,2].

Bleeding caused by penetrating trauma can be difficult to control, requiring tractotomy with finger fracture (digitoclasia) and direct hemostasis. In peripheral hepatic injuries, tractotomy is safe and blood loss, acceptable. In central injuries, however, hepatotomy is associated with abundant blood loss and postoperative biliary fistulae[3]. For such injuries, the use of an intrahepatic balloon constitutes a good therapeutic option, as it saves time and reduces surgical trauma, in addition to providing intrahepatic hemostasis through the compression exerted by the insufflated balloon[1].

Based on the severity and difficulty in managing such injuries, the objective of this study is to discuss, after a retrospective analysis of the patients with penetrating liver trauma assisted in our Service, what would be the best indication for the use of intrahepatic balloon in the treatment of severe penetrating liver injuries.

Study conducted at Hospital Universitário Cajuru (Cajuru University Hospital), PR, Brazil.
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METHOD

A retrospective study was conducted of the medical records of patients who were victims of penetrating hepatic trauma treated with an intrahepatic balloon, assisted at the Hospital Universitário Cajuru between June 2001 and June 2006. The variables evaluated were age, sex, grade of hepatic injury, compromised segments, volume of solution infused in the balloon and time it stayed in place, associated injuries, hemotransfusions, complications, antibiotics used, nutritional therapy, need for ICU, and length of hospital stay. The grade of the hepatic injury was established according to the liver injury scale of the American Association for the Surgery of Trauma (AAST, OIS). The extent and location of the hepatic injuries were described according to Couinaud's segmental anatomy. The balloon was crafted intraoperatively, using a 16-gauge nasogastric tube and a Penrose drain n. 3, following Service protocol. After testing, the balloon was passed through the path created by the wound, care being taken to insert it 2-3 cm on average past the entrance and exit orifice, so that, after insufflation, total hemostasis was achieved (Figure 1). The proximal segment of the Penrose drain was brought to the surface through the skin by counterincision, in order to facilitate its removal after emptying. Insufflation was routinely performed with 0.9% saline; in some cases, iodinated contrast was infused to allow postoperative radiological studies (Figure 2). A sentinel drain was left on the liver bed to monitor bleeding and the occurrence of postoperative biliary fistulae.

RESULTS

During the span of time reviewed in the study, 18 patients with penetrating hepatic trauma were treated with an intrahepatic balloon. All patients were male, mean age of 22.5 years (18-48). During the study period, 11 deaths (61.1%) occurred.

Gunshot wounds were the most prevalent type of wound, with a total of 15 injuries. Three stab wounds were recorded.

The most common anatomical locations of wounds were the thoracic and the thoraco-abdominal regions with six wounds each (Table 1).

The most frequently affected hepatic segment was number VIII (29.6%), followed by V (22.2%), I, IV and VI (11.1%), III and VII (7.4%).

Eight patients sustained grade III hepatic injuries, seven had grade IV injuries, and two, grade V. In the surviving group, four patients had grade IV injuries an done sustained a grade V injury (Table 2).

The number of associated injuries was 3.05 per patient, with a greater number in the group of patients who died (3.27 *vs* 2.71). The most frequent associated injury was in the diaphragm (16.3%), followed by kidney and gastric injuries (14.5% and 10.9% respectively). No surviving patient exhibited lesions in large vessels, as opposed to the patients who died, among whom there were two cases of aortic injury (3.6%), two vena cava (3.6%) and two portal vein injuries, one intrahepatic (1.8%) and one extra-hepatic (1.8%). Two patients underwent thoracotomy for clamping of the thoracic aorta, and presented lesions in large abdominal vessels.

The balloon was inflated with an average of 110 mL of 0.9% saline (60 mL-200 mL). The three patients who died had their balloons removed, having remained in place for a mean of 5.6 days (3-8). In the surviving group, the balloon remained in place for 8.7 days (5-13), after which it was emptied at a pace of 10 to 20 mL/day. Only two patients had their intrahepatic balloons deflated at once rather than

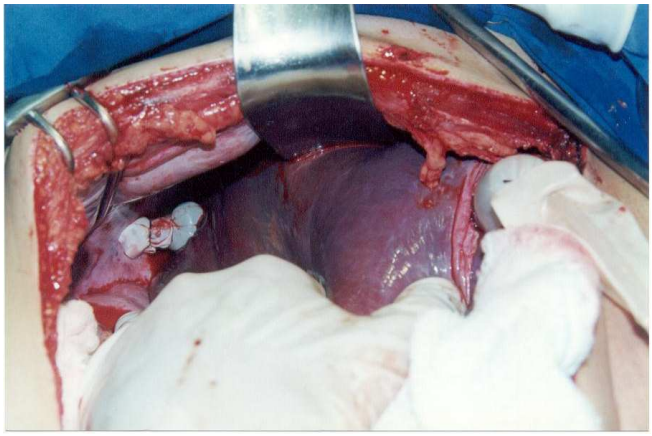

Figure 1 - *Final aspect of the balloon after passing through the injury; later insufflated.*

Figure 2 - *Insufflated balloon with iodinated contrast.*

Table 1 - Anatomic location of wounds.

Location	N
Toracic	6
Thoraco-abdominal	6
Flank	4
Bac	3
Epigastrium	2
Right Hypochondrium	2

Table 2 - Grade of hepatic injuries (AAST-OIS).

Grade of injury	Death group (N)	Surviving group (N)
III	6	2
IV	3	4
V	1	1

gradually. No patient sustained bleeding after the removal of the balloon.

The most common postoperative complication in the surviving group was biliary fistulae, with three cases (42.8%). One patient developed a subphrenic abscess (14.2%). Three patients who died had stayed longer than three days in hospital; two of these patients developed biliary fistulae, and one of them also had an abdominal abscess, pneumonia and upper gastrointestinal hemorrhage.

Reoperation was necessary for four patients: two for intraabdominal abscess drainage, one for the placement of a Bogota bag and pads, and the other because of hepatic injury bleeding. Only one reoperated patient survived, the one who had developed an intraabdominal abscess.

The patients who died had been given more hemotransfusions, an average of 10.36 units of red cells and 3.2 units of plasma against 3.85 units of red cells and 2.7 of plasma in the surviving group. Only one patient, who survived, did not receive hemoderivatives. Two patients who died had received 10 units of cryoprecipitate and 10 units of platelets each (Table 3).

The ICU was used by four (57.14%) surviving patients, who stayed in intensive care for a mean of 9.75 days (4-17). In the group of patients who died, six (54.5%) had stayed in the ICU for 7.5 (1-20) days on average. The other five patients died in the operating room, during surgery or in the immediate postoperative, therefore they did not use the ICU.

Regarding nutrition therapy, only one patient who died had been fed via jejunostomy; three patients among the survivors were fed the same diet; one of them also used total parenteral nutrition for 17 days.

Thirteen (72.2%) patients were on antibiotics. The most prevalent were cefazoline (76.9%), metronidazole (46.15%), gentamycin (30.7%) and ceftriaxone, ampicilin and piperacillin/tazobactam (23%). Cefazoline was used in 10 patients; in eight of them as a prophylactic measure, for one day only. Seven patients used the same antibiotic for more than one day. Metronidazole was used as part of the therapeutic regimen of four patients, and gentamycin and piperacillin/ tazobactam were used by another three patients.

The surviving patients stayed an average of 19.5 days in hospital. Of the 11 deaths, six occurred on the same day the patients were admitted, due to hypovolemic shock; two of those patients died intraoperatively. Two other patients died on the second and third postoperative days as a result of shock and coagulopathy. The other three patients who died stayed 18.6 days on average in hospital. Two of them died of sepsis, and the third developed hypovolemic shock as a result of upper gastrointestinal hemorrhage.

DISCUSSION

Over the last two decades, a fundamental change has been happening in the surgical management of liver trauma. First, it has been recognized that most hepatic injuries stop bleeding spontaneously. In addition, computed tomography (CT) became a more accessible diagnostic method. As a consequence of those changes, there is now a trend toward non-surgical management of patients who sustained blunt hepatic trauma but remain hemodynamically stable. This strategy can also be used with selected patients who were unstable at first, but responded to the administration of fluids or blood[4]. Many studies have shown the success of such strategy in all grades of severity (Grade I-V), and demonstrated that the grade of the injury will not necessarily be a predictor of the success or failure of the treatment. However, the rate of complications with the conservative management for hepatic trauma is reported to be only 3-19%, treatment failure rates are 0-18%, and mortality, 0-9%[5].

Some liver trauma patients will need laparotomy after failure of the conservative treatment or because of the case severity, requiring immediate surgery. Historically,

Table 3 - Mean of hemotransfusions per patient.

Hemoderivative	Death group (mean)	Surviving group (mean)
Red cells	10,36	3,85
Plasma	3,2	2,7
Platelets	1,8	-
Cryoprecipitate	1,8	-

the outcomes of laparotomy in severe hepatic trauma have been poor, with a great number of patients progressing into the deadly triad: hypothermia, acidosis and coagulopathy. Advances in surgical therapy (perihepatic gauze pads with scheduled operations, intrahepatic balloon, venovenous *bypass*, hepatic exclusion) and intensive care have benefited some patients belonging in that group[4].

An aggressive anatomic resection of the liver in trauma is associated with low mortality and morbidity rates when performed by experienced hepatobiliary surgeons, and its role in the treatment of severe hepatic traumas should be reappraised[6,7].

Surgical tactics such as the partial or total vascular exclusion of the liver become useful in the management of patients with severe injuries, as mortality in those cases may reach as much as 80% for grade IV and V injuries[8].

Liver packing with gauze pads has proven efficacy, yet it carries some complications, such as right renal vein occlusion, bleeding and hepatic necrosis with subsequent sepsis, which restrict its utilization[2]. Cué *et al*. studied 35 patients with hepatic injuries who were treated with liver packing to control hemorrhage, and found a survival rate of 51%. However, applying liver packing before coagulopathy or episodes of hypotension arise increases survival to over 75%. These authors recommend that the packing be applied in patients with no tolerance for blood loss or requiring more than 15 units of blood[9,10]. Hepatotomy by finger fracture applying the Lin technique can also be used. Pachter analyzed the role of hepatotomy in 128 consecutive complex hepatic injuries, and found a success rate of 93% in the control of bleeding, with a morbidity rate of 15% (two cases of postoperative bleeding, eight intra- or perihepatic abscesses and six cases of biliary fistula)[11]. Hepatotomy has, however, the inconvenient aspect of damaging vessels during the tractotomy with the hypovolemic patient, especially in central lesions. Bleeding may occur postoperatively after the restoration of hemodynamic balance[2].

Balloon tamponade for complex hepatic injuries was first reported by Morimoto *et al*[12]. This therapeutic modality has shown to be less traumatic than hepatotomy in the central and bilobar hepatic injuries; in addition, it offers advantages over hepatic packing: the balloon can be insufflated selectively to provide hemostasis, without any problems of ischemic sequelae; it causes less organic response, therefore, there is less likelihood of local infection; deflation and removal can be done without the need for reoperation[1]. In the present study, a high mortality rate, 61.1%, was found, not associated with the grade of the hepatic injury, but rather with the presence of large vessel lesions and the number of associated injuries, which was greater in the group of patients who died: 3,27. The presence of associated injuries becomes important as is influences late morbidity and mortality. Carmona *et al.*[13], in 1982, in his study of 443 patients operated on for abdominal trauma with hepatic injuries, over a period of five years, obtained a mortality rate of 3% when the liver was the only injured organ, whereas the mortality rate was 24% when three other organs were involved besides the liver. McInnis *et al*.[14], in 1977, analyzing 163 patients with penetrating hepatic wounds, found 4% of mortality in those with hepatic wounds exclusively, and 50% in patients sustaining associated injuries[15,16].

The severity of those patients' cases can also be seen in the greater need for hemoderivatives and the longer stay in the ICU. Over half of the patients (54%) died on the day of admission, and the main contributing factor to lethality was hypovolemic shock. In a similar study conducted in our Service, Laux *et al*. reviewed data between 1997 and 2000, comprising a total of five patients. Only one death was recorded, the only patient with large vessel injuries and the following trauma scores: PATI=64, RTS=6.82 and ISS=29, against a mean PATI=18, RTS=7.84 and ISS=19.2 for the surviving group. The better conditions and prognosis of the group of survivors is evident[2].

Complications occur in approximately 50% of the patients who survive major hepatic traumas and are treated with damage control surgeries. Mohr *et al*. observed 58% of hepatobiliary complications in their case series[17].

Biliary fistulae are mostly benign, and close spontaneously in three weeks in the absence of distal biliary obstruction. In our study, of the seven cases that progressed with complications (38%), we found five cases of biliary fistula (27.7%). These data diverge from those presented in the literature, due to the fact that our patients died, for most cases, in the first 24 hours, and so there was not enough time for the formation of a fistula, abscess or hepatic necrosis. Only one patient (5.5%) developed intraabdominal hemorrhage postoperatively. That patient was reoperated on and died on the second day of admission. Postoperative hemorrhage may be a consequence of imperfect small vessel hemostasis, the existence of juxtahepatic vascular lesions or coagulation disorders. Literature data establish that hemorrhage occurs in 0.5% to 7% of cases of hepatic trauma. Reoperation, in the case of hemorrhage for coagulopathy, must only be carried out after correction of the acidosis, hypothermia and coagulpathy[16].

The indications for routine perihepatic drainage are still controversial, as opinions are split between those who advocate routine drainage as a means of reducing the build-up of hematic and biliary collections and those who believe that the drains would be entry points for infection[18,19]. In the present study, all patients were drained, only the type of drain varied – Waterman, Penrose and vacuum drainage, and no difference was found between drainage type and complications. We understand that hepatic drainage is beneficial in this situation, in order to serve as an early warning for the occurrence of bleeding or postoperative biliary fistulae.

In patients with transfixing injuries through the central region of the liver that will not cease to bleed, the

use of a balloon represents a feasible hemorrhage control method, and could become a therapeutically alternative for all trauma surgeons. The poor response in patients with more severe injuries puts into question whether another form of treatment, such as surgical resection, would provide a higher survival rate and less morbidity to those patients. Advances in the knowledge of the segmental anatomy of the liver, a consequence of the increasing number of liver transplant surgeries, and the refinement of surgical techniques places resection as a therapeutical option in complex cases. Because of the scant literature on the intrahepatic balloon, and the fact that its use still generates debate, further studies are required to evaluate its actual efficacy.

R E S U M O

Objetivo: *Discutir a estratégia cirúrgica para tratamento de lesões hepáticas penetrantes graves através de tamponamento com balão intra-hepático.* ***Métodos:*** *Estudo retrospectivo com 18 pacientes com trauma hepático penetrante, tratados com balão, atendidos em um hospital de referência em trauma no sul do Brasil. Foram avaliados: idade, sexo, grau da lesão hepática, segmentos acometidos, quantidade de solução salina infundida no balão intra-hepático e seu tempo de permanência, lesões associadas, terapia nutricional, hemotransfusões, complicações, antibioticoterapia, necessidade de UTI e tempo de internamento.* ***Resultados:*** *Todos os pacientes eram do sexo masculino com idade média de 22,5 anos (18-48). As feridas por arma de fogo foram mais prevalentes, sendo a localização mais comum a região torácica e a transição tóraco-abdominal. A lesão associada mais comum foi a do diafragma, e o segmento hepático mais acometido foi o VIII (29,6%). Sete pacientes (38,9%) sobreviveram e a complicação mais comum foi fístula biliar (42,8%). Dos 11 (61,1%) pacientes que foram a óbito, seis morreram no mesmo dia em que foram operados, três ficaram em média 18,6 dias internados e os demais morreram no 2° e 3° do pós-operatório.* ***Conclusão:*** *O tratamento das lesões hepáticas transfixantes costuma ser de difícil manejo cirúrgico e com alto índice de morbimortalidade. O uso do balão intra-hepático foi eficaz no tratamento dessas lesões, porém não é isento de complicações tendo suas indicações bem definidas.*

Descritores: *Ferimentos e lesões. Fígado. Dilatação com Balão/métodos. Ferimentos penetrantes.*

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