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## Review article

# Treatment strategy for hepatic trauma

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## ABSTRACT

Liver is one of the organs with the highest injury rate, and in recent decades, the guidelines for the treatment of liver trauma have changed considerably. Now, there is a growing consensus that the most important step is diagnosis and depending upon the degree of severity, non-operative therapy is the main treatment method for hepatic trauma if conditions permit. For serious hepatic trauma patients such as those with hemodynamic instability, they should be operated upon as soon as possible. Regardless of the surgical options, doctors should control damage to patients and try to prevent complications. New therapies such as hepatic artery embolization and liver transplantation have been more and more used for the treatment of serious hepatic damage in clinics.

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## Introduction

Liver is a solid organ with the highest injury rate in abdominal injury.<sup>1</sup> Approximately 15%–20% of abdominal injuries refer to hepatic trauma. Hepatic injury takes the third place in abdominal injury and 80%–90% of hepatic injuries are blunt ones.<sup>2</sup> In 2013, a study using ultrasonography to evaluate the intraperitoneal trauma showed that liver was the mostly affected organ and younger people were more vulnerable to hepatic and pancreatic injury.<sup>3</sup>

In 1994, American Association for Surgery of Trauma (AAST) proposed the standard classification of hepatic trauma. According to the classification, level I–II hepatic trauma is called minor hepatic trauma, accounting for 80%–90% of all hepatic trauma. The hepatic trauma of level III and above is called serious hepatic trauma, with the mortality of 10%, and if patients have multiple injuries, the mortality may be elevated to as high as 25%.<sup>4</sup> Serious hepatic trauma is always combined with parahepatic vena cava injury, with the mortality of above 50%.<sup>5</sup> The treatment strategies of serious hepatic trauma have been advanced for decades.<sup>6</sup> The clinical experience shows that early diagnosis, accurate assessment, active resistance to shock, optimal treatment plan and the organ function

preservation are protective factors to reduce the mortality and enhance the treatment.

## Diagnosis of hepatic trauma

It is easy to diagnose hepatic trauma. Patients usually have a history of liver injury, blunt trauma or penetrating trauma. Patients have some typical clinical manifestations such as right upper abdominal pain (sometimes with radiating pain to the right shoulder), nausea and vomiting, thirst, peritonitis, and hypovolemic shock. Imaging examination is widely used for the diagnosis of hepatic trauma. Abdominal ultrasound can quickly assess intra-abdominal hemorrhage, suitable for hemodynamically instable patients, but limited by weak sensitivity and a high rate of misdiagnosis. Therefore, abdominal ultrasound is usually used for the patients who could not tolerate CT scanning. CT is the most commonly used method for the diagnosis of intra-abdominal solid organ injury.<sup>7</sup> For small occult liver damage, enhanced CT scan can reveal the wound and assess the bleeding.<sup>8</sup> Enhanced CT combined with ultrasound is regarded as the most valuable method to evaluate abdominal trauma.<sup>9,10</sup> Thanks for the development of modern imaging techniques, CT scanning can provide adequate information for definite diagnosis of liver injury or intra-abdominal hemorrhage.<sup>11,12</sup>

The most difficult and important aspect is the preliminary evaluation and early rescue. For hemodynamically instable patients, we should promptly determine the order of severity of hepatic trauma, and proceed with timely exploratory laparotomy and treatment.

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### Non-operative therapy for hepatic trauma

In the past, most scholars thought that non-operative therapy was only appropriate for level I–II liver traumas, which were hemodynamically stable without signs of peritoneal irritation or other organ injuries. Nowadays, the concept of hepatic trauma treatment has changed substantially. Karkiner et al<sup>13</sup> summarized the indications of non-surgical treatment in 2005. A study showed that non-operative therapy is effective for isolated liver trauma.<sup>14</sup>

With the development of conservative treatment in medical field, non-operative therapy has been more and more used.<sup>15</sup> Asfar et al<sup>16</sup> revealed that about 80% of blunt hepatic injuries can be treated by non-operative therapy, especially the hemodynamically stable patients. In China, non-operative strategy is widely used in clinic, especially for minor blunt hepatic trauma and liver capsule bleeding. The reasons for this change lie in the following aspects: (1) in about half of blunt liver trauma patients, the bleeding has been stopped before exploratory laparotomy; (2) liver has the great capability of auto-hemostasis after injury; (3) CT has been improved and minimally invasive surgery has been developed; (4) medical treatment in intensive care unit is given.

The study of about 40 000 liver injured patients from 405 trauma centers showed that the probability of operative therapy for successfully treated complicated liver trauma is lower than 40%, regardless of whether or not other organs are injured. This data indicated that non-operative therapy for complicated liver trauma is more successful than operative therapy, and the success rate of non-operative therapy is increasing. In cases of serious liver trauma (levels III and IV), non-operative therapy reduced the mortality to 23.5%.<sup>6</sup>

Based on clinical experience, a substantial amount of evidences suggest that non-operative therapy has a great curative effect. Norrman et al<sup>17</sup> reported that the curative ratio for non-operative therapy was 89%. Besides the adults, non-operative therapy also presents beneficial outcome for children.<sup>18</sup>

For perforating liver injury, operation is the first choice; for multiple organ injury, exploratory laparotomy could find the occult trauma. For blunt trauma patients who are hemodynamically stable, non-operative therapy could be adopted, with monitoring vital signs.

In the absence of complicating factors, abdominal laparotomy is not dependent on the severity of hepatic trauma, as the success rate of non-operative therapy is 90%.<sup>19</sup>

For hepatic trauma patients, the doctors should pay close attention to the hemodynamic status. Hemodynamic stability is the basis of non-operative therapy, i.e., non-operative therapy depends upon the premise that the patients have no other injured organs, especially no intestinal damage.

The monitoring system, angiography and endoscopic retrograde cholangiography are very important for hepatic trauma patients. Doctors should be experienced in order to closely observe the patients and prepare for emergent operation in time. In the early stage, the doctors should accurately judge the severity of injury, monitor the patients' vital signs and ensure hemodynamic changes timely. Moreover, symptomatic treatment, nutritional support, and the maintenance of the patient's water and electrolyte balance are necessary to promote the healing of viscus organs, meanwhile the doctors should also pay attention to the protection of viscus function.

### Operative therapy of hepatic trauma

In China, it is believed that non-operative therapy applied for level III hepatic trauma should be very prudent. Due to a lack of

advanced medical techniques, most primary hospitals do not have adequate monitoring capacity, good ICU guardianship or liver specialists in medical team, and follow-up treatment options, especially after non-operative therapy fails. Therefore, for liver trauma, especially for serious and complicated liver trauma, surgeons should select the optimal treatment method according to the patient's condition and the medical conditions of the hospital and in the end, if possible, they should broaden the indication criteria for operative therapy as required. If the patients are hemodynamic unstable, they should be operated upon promptly.<sup>20</sup>

For perforating liver wounds, operative therapy is the first choice, and for multiple organ damage, exploratory laparotomy can locate and repair occult trauma. For blunt trauma patients, who are hemodynamic stable, non-operative therapy may be suitable, with close monitoring and appropriate preparation for operation.

The aim of operation is to ascertain the traumatic condition, stop any bleeding, prevent bile leakage, remove the devitalized tissues and give adequate drainage. For the patients who need surgical treatment, timing is important. It is reported in literature that about 6.1% of deaths occurred in "mors in tabula" or during the first 24 h after injury and 6.9% of deaths occurred during the hospitalization.<sup>21</sup> If the patients have absolute surgical indications, the surgery should be performed as soon as possible. The principle of surgical treatment is rapid hemostasis, thorough debridement and adequate drainage. Stopping bleeding is the key to treat hepatic trauma because it can influence the mortality of the hepatic trauma patients. In addition, thorough debridement and adequate drainage could reduce the decomposition products of necrotic tissue and prevent the formation of abdominal abscesses.

Surgeons should choose the most appropriate scheme according the result of surgical exploration and the wound condition. Operation methods include single pure suture, deep mattress suture, debridement, anatomical hepatectomy, hepatic arterial ligation, gauze packing, liver coated mesh method, etc. Surgeons should choose the optimal one.<sup>22</sup> Damage control is the principle for operative treatment since it may save time, which is beneficial for those patients transferred to other trauma centers, or requiring further treatment.<sup>4</sup>

Minor liver wounds can be treated by single pure suture. Deep mattress suture is appropriate for contusion and laceration of the liver in which the cleft is deep, including the placement of hemostatic gauze and omentum majus into the liver tissue defect. This is suitable for level III injury, and even some cases of level IV injury. Debridement should be performed based on the anatomical structure of the liver, in order to completely remove any necrotic tissues, ligature the damaged vessels and bile ducts, and retain the normal liver tissue to the greatest extent. This is routinely performed because debridement is focused upon the injured part of the liver, unlike anatomical hepatectomy.<sup>23</sup> The anatomical hepatectomy requires excellent technical skill and a prolonged operation time, and is thus rarely used clinically.

The peripheral hepatic gauze is effective to control bleeding for level III liver trauma, even for levels IV and V liver trauma. This technique is practical for primary hospitals. Nicol et al<sup>24</sup> found that the increased tamponade time was not associated with increased the morbidity of complications such as sepsis and bile leakage. The secondary operation should be performed 48 h after the condition becomes stable and the hypotension, hypothermia, acidosis and blood coagulation disorders should be corrected. The early performance of second surgery could lead to postoperative bleeding.<sup>25</sup> In addition, surgeons should pay attention to excessive filling of the vena cava or renal vein caused by tamponade, which may lead to abdominal compartment syndrome. The filling parts could get effective drainage in order to reduce the risk of infection.

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