

# Hemorrhage Control of a Trauma Patient Case Report: Managing Severe Liver Trauma

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## Introduction

Hemorrhage control remains one of the most critical aspects, not only in trauma, but in all surgical specialties. Operative hemorrhage control remains the mainstay of treatment for surgical bleeding, however, non-surgical bleeding continues to pose challenges.

## Patient Presentation — Initial Evaluation

A 31-year-old male sustained a gunshot wound to the epigastrium. During EMS transport he received a liter of saline and had one large bore IV in his ante-cubital fossa.

On arrival to the regional trauma center, he was found to have a single gunshot wound to his epigastrium just below his xiphoid process. Patient was alert with a blood pressure (BP) of 117/68, heart rate (HR) of 86, and respiration rate (RR) of 20. Physical examination revealed he was slightly agitated, diaphoretic, and had significant abdominal pain. His primary survey and secondary survey were otherwise negative for further injuries.

The patient's initial imaging included a chest x-ray (CXR) (Figure 1), abdominal x-ray (KUB) (Figure 2), and extended Focused Assessment with Sonography in Trauma (e-FAST). The CXR did not demonstrate any acute pathology. The e-FAST did not identify a pericardial effusion but did demonstrate free fluid within the abdomen. On KUB (Figure 2), the gunshot wound is identified with the arrow point (Figure 2a) along the epigastrium, and a retained foreign object (Figure 2b) can be seen along the right upper quadrant.

At the conclusion of his initial triage, his BP was 120/88 and HR 89. Given his overall stability, he was sent for computed tomography (CT) scan of the abdomen and pelvis (Figure 3). The CT demonstrated free air, a Grade IV liver injury with active bleeding, and concerns for duodenal and colonic injuries. Subsequently, the patient was immediately sent to the OR for definitive care.

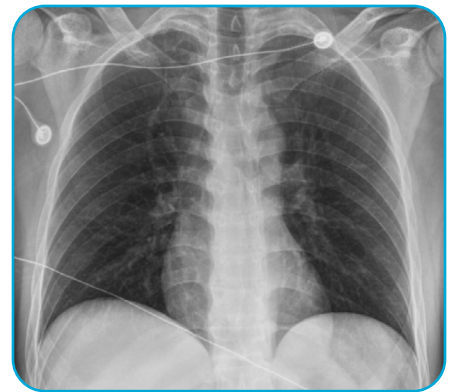


Figure 1. Chest X-Ray (CXR)

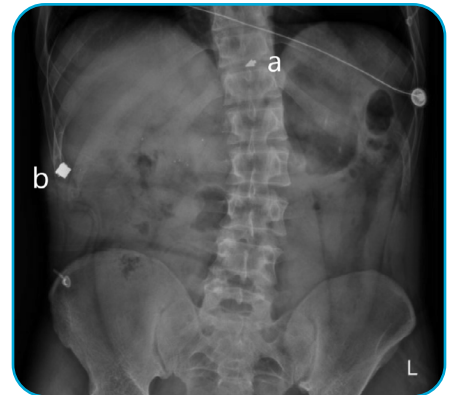


Figure 2. Abdominal X-Ray (KUB)

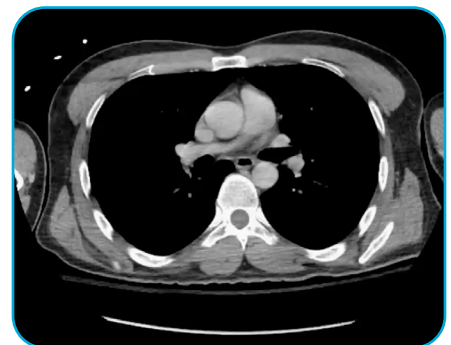


Figure 3. Computed tomography (CT) scan of the abdomen and pelvis  
<https://teleflex.link/Fig.3>

## First Operation

### Exploratory Laparotomy

Because of the high-grade liver injury and anticipated massive hemorrhage, a Massive Transfusion Protocol (MTP) was initiated to ensure a readily accessible supply of blood was on hand. A left subclavian central line was placed to provide a large bore resuscitative line before the initiation of surgery.

An exploratory laparotomy was performed and identified a large liver laceration (Figure 4) involving segments II, III, IV, V, and VI (Figure 4a). Laparotomy pads were utilized to restore parenchymal anatomy and apply direct compression to the organ. There was no large Zone 1, left Zone 2, or Zone 3 hematoma. There was a moderate sized right Zone 2 hematoma. An anterior gastrostomy was identified and whipstitched closed. After medialization of the right colon, it was apparent the right colon at the hepatic flexure was injured and its mesentery actively bleeding. The right colon was resected for hemorrhage and spillage control.

### Liver Repair

On inspection of the liver packs again, it was clear there was continued bleeding through the compressive packs, so further exploration was begun. A Pringle maneuver was performed to arrest major arterial and portal venous bleeding (Figure 4c). The left lobe of the liver was almost completely avulsed off. The amputation was completed with a laparoscopic stapler utilizing vascular loads. The bullet had transected through the dome of the gallbladder (Figure 4b) as well, making further approximation challenging. The gallbladder was whipstitched closed.

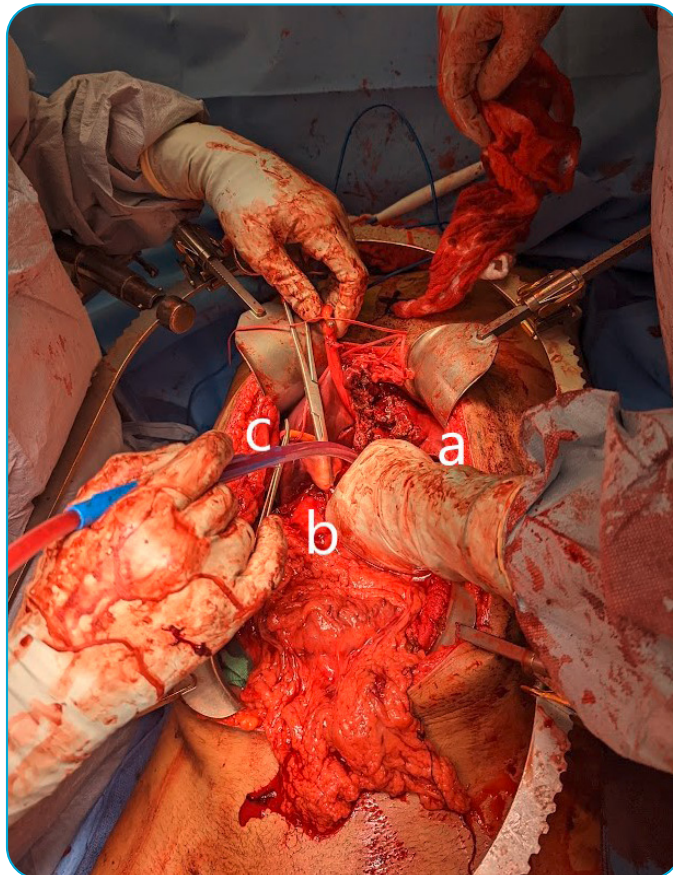


Figure 4. An exploratory laparotomy was performed and identified a large liver laceration involving segments II, III, IV, V, and VI (a). The bullet had transected through the dome of the gallbladder (b). A Pringle maneuver performed (c).

The dead space of the liver, created by the cavitation of the bullet, was packed with absorbable hemostatic agents to fill in the cavity and allow for more compression. Serial 0-Chromic stitches were placed in a “U-stitch” fashion to reapproximate the liver. The resected liver margin, liver repair, and right sided retroperitoneum was lined with QuikClot Control+® Hemostatic Device 12x12, and additional laparotomy pads placed for added volume and compression. His pH is 7.01, 34.5oc and base deficit (-14). Given his injury pattern, acidosis, and need for further resuscitation, the patient underwent a damage control laparotomy, and was managed with an open abdomen. He received a total of 4 whole blood (WB), 13 packed red blood cells (pRBC), 13 fresh frozen plasma (FFP), and one platelets (PLT).

## Resuscitation and Second Operation

The patient underwent a thromboelastography (TEG) based resuscitation overnight and returned to the OR the next morning for his definitive surgery. This operation was initiated first by removing the combination of laparotomy pads (Figure 5a) and QuikClot Control+® Device 12x12\* (Figure 5b) surrounding the bowel, liver, and other viscera of the abdomen.

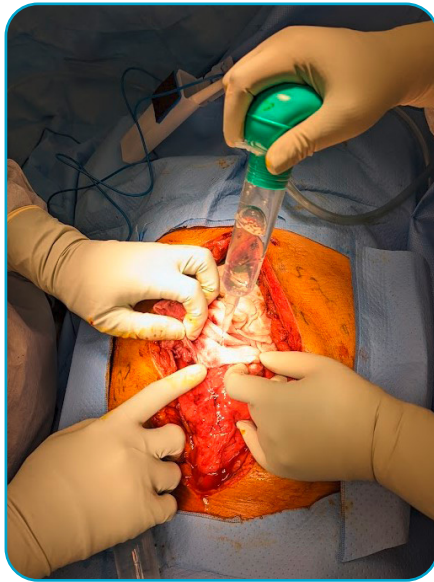


Figure 5a. Removing the laparotomy pads



Figure 5b. Removing the QuikClot Control+® Device

Laparotomy pads and QuikClot Control+® Device were then removed from the liver (Figure 6a, 6b). Similar techniques are employed to tease apart the laparotomy pad and QuikClot Control+® Device from the viscera:

- A. Copious amounts of bulb irrigation
- B. Gentle traction and counter-traction
- C. Manual gentle finger dissection



Figure 6a. Laparotomy pads and QuikClot Control+® Device were then removed from the liver

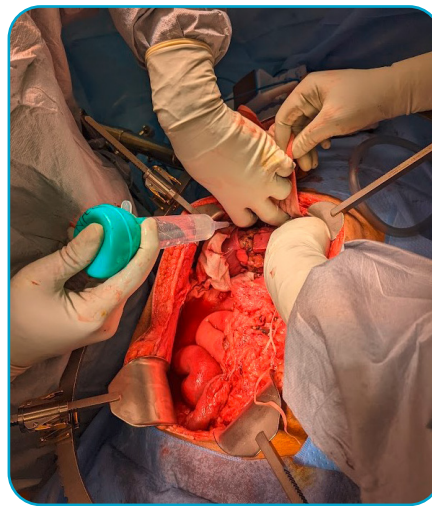


Figure 6b. Laparotomy pads and QuikClot Control+® Device were then removed from the liver

## Resuscitation and Second Operation (cont.)

This can be further appreciated in Figure 7 of a laparotomy pad (Figure 7a) and QuikClot Control+® Device (Figure 7b) being removed. Both products were placed on the liver and bowel and were somewhat adherent to the structures they opposed. Similarly, so, both required the same technique to remove (Figure 6, 7).



Figure 7a. Laparotomy pad removal  
<https://teleflex.link/Fig.7a>

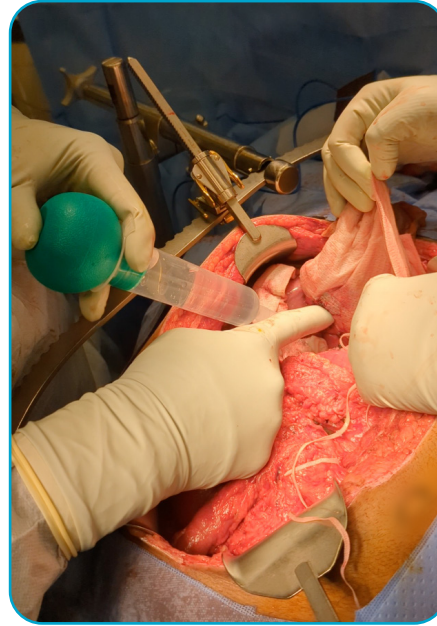


Figure 7b. QuikClot Control+® Device removal  
<https://teleflex.link/Fig.7b>



Figure 8a. Saturated laparotomy pad from same wound bed as 8b.



Figure 8b. Saturated QuikClot Control+® Device from same wound bed as 8a.

A laparotomy pad (Figure 8a) and QuikClot Control+® Device (Figure 8b) which were in the same wound bed were then compared.

The gallbladder was removed, the gastrostomy closed in two layers, and completion right hemi-colectomy performed. Drains were left juxtaposed to the liver repairs. The patient's abdomen was closed.

## Post-op Course

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He was extubated the following day, downgraded to the floor two days later. An interval CT scan performed hospital day 6 demonstrated routine healing (Figure 9). He did not suffer from any post-operative complications including venous thrombus embolic events, intra-abdominal infections, hematoma, or bacteremia. He was discharged hospital day 10.

## Discussion

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In the setting of trauma, mitigating blood loss and its effects are critical to ensure patient survival while minimizing blood loss, blood transfusions, post-operative infections, and other complications related to massive transfusion of blood products.



Figure 9. An interval CT scan performed hospital day 6 demonstrated routine healing  
<https://teleflex.link/Fig.9>

## Pre-operative Decision Making

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This case demonstrates several key aspects of hemorrhage control and blood loss mitigation. There was prompt recognition of the injury. The large Grade IV liver laceration, and the free air was very concerning due to the potential for hemodynamic collapse. Historically, gunshot wounds to the right upper quadrant mandated prompt surgical exploration. Recent literature now supports selective non-operative management in isolated liver injuries.<sup>1</sup> In a typical scenario, a stable patient with a large liver injury would be more likely to proceed to Interventional Radiology (IR) after discussion with the trauma surgeon and the Interventional Radiologist. However, given the free air on the CT scan, the patient required an exploratory laparotomy.

This poses a challenging situation. The patient required an emergent operation for control of bowel spillage and bleeding control, but operating on a fresh liver injury may disrupt any formed clot and cause a stable liver injury to hemorrhage uncontrollably.

## Intra-operative Decision Making

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To prepare for the case, the patient was placed on an x-rayable OR table and large bore vascular access was obtained. If the patient begins to exsanguinate uncontrollably, the subclavian central line allows for large volume resuscitation. MTP was activated early, allowing ready access to large amounts of blood products in the event the patient started to become unstable. Additionally, this institution's first cooler of MTP contains whole blood (WB), which aids in a balanced resuscitation from the beginning of the case.

Laparotomy pads serve as an excellent adjunct in the initial phase of the operation. They are cost effective to pack off the abdomen and apply early tamponade. They work well to absorb the intra-peritoneal blood and evacuate it from the cavity. Once zones of the abdomen were assessed for major vascular injury, and other sources of hemorrhage were controlled, it was clear that the liver packed with laparotomy pads was insufficient to control the hemorrhage. Laparotomy pads do not assist in accelerating the blood's normal clotting mechanism to create a stable and robust clot.

## Management of Severe Liver Injury

At this time, several maneuvers were employed to stem the hemorrhage. A Pringle maneuver was applied with a Rumel tourniquet. Clips were applied to the exposed vessels, and a non-anatomical left wedge resection was performed since the tissues were non-viable with a vascular load stapler. While this decreased the amount of bleeding from the liver, the parenchyma was still bleeding from the venous system. The large liver laceration needed to be re-approximated to better create tamponade and gain hemostasis. Because of the large cavitation from the bullet, the defect required additional packing to gain tamponade. This was accomplished with permeant hemostatic products within the wound and U-stitches to reapproximate the two sides.

## Use of QuikClot Control+® Hemostatic Device 12x12

The patient's physiology demonstrated characteristics of the lethal triad (acidosis, coagulopathy, and hypothermia), and in order to stabilize the patient and continue his resuscitation, the team elected to perform a damage control operation. The retroperitoneum, mesentery, pancreas, and liver continued to ooze, however, there was not a surgically correctable cause. These areas were sources of non-surgical bleeding that would not be amenable to a stitch, however, required some mechanism for hemostasis. These remaining raw surface areas were covered with QuikClot Control+® Device, backed with additional laparotomy pads for compression. Because of kaolin impregnated onto QuikClot®, it facilitates the clotting cascade, allowing the team to gain control of the non-surgical bleeding. Historically, traditional laparotomy pads have been utilized for the same purpose. However, there is no hemostatic agent on these products, and QuikClot Control+® Device facilitates stronger clot formation,<sup>2,3</sup> faster bleeding control,<sup>4</sup> and may improve visualization of the surgical field.<sup>5</sup> Moreover, the Red Cross has reported a national shortage in blood donors since the pandemic, and additional blood transfusions come at an increased cost to not only the patient on the table, but the one to follow should they need MTP.<sup>6</sup>

## Conclusion

In the setting of life-threatening hemorrhage, the goal of the trauma team is to stabilize and save the patient's life. Attacking the problem with a focus on decreasing blood loss, rapid and balanced resuscitation, management of both surgical and non-surgical bleeding, and resource utilization will help in that fight. This case included interventions such as vascular access, initiation of MTP, and hemorrhage control utilizing QuikClot Control+® Device, which are all adjuncts in pursuit of blood loss mitigation. Ultimately, it is up to the treatment team to determine when it's best to utilize them.

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The QuikClot Control+® Hemostatic Device is indicated for temporary control of internal organ space bleeding for patients displaying class III or IV bleeding. It may also be used for control of severely bleeding wounds such as surgical wounds and traumatic injuries.

Rx Only.

CAUTION: Federal (USA) law restricts this device to sale by or on the order of a physician.

\*The QuikClot Control+® Hemostatic Device may be left in place for up to 48 hours.

Refer to package insert for complete warnings, indications, contraindications, precautions, potential complications, and Instructions For Use.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

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