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## International Journal of Surgery Case Reports

journal homepage: [www.casereports.com](http://www.casereports.com)

## Hepatic “BOLSA” a novel method of perihepatic wrapping for hepatic hemorrhage “BOLSA”

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## ARTICLE INFO

## Article history:

Received 13 April 2015

Received in revised form 2 June 2015

Accepted 7 June 2015

Available online 18 June 2015

## Keywords:

Liver laceration  
 Hepatic trauma  
 Vicryl mesh wrap  
 Hepatic trauma  
 Liver laceration management

## ABSTRACT

**INTRODUCTION:** Severe traumatic liver hemorrhage quickly leads to exsanguination. Perihepatic packing is frequently used in damage control surgery. This method can be unsuccessful and accompanied by complications. Vicryl mesh wraps have been described in the treatment of liver hemorrhage. In this report, we describe an enhanced technique of hepatic wrapping in a case of hepatic bleeding after liver biopsy in a coagulopathic patient. The technique is called the hepatic “BOLSA” (Bag on Liver Supporting Anti-Hemorrhage).

**PRESENTATION OF CASE:** A 59 year old male presented in the recovery room after liver biopsy of a mass, followed by angio-embolization of the hepatic mass 9 h earlier. The patient was acidotic, coagulopathic, and demonstrated intra-abdominal hypertension. Computed tomography demonstrated perihepatic fluid. The patient continued hemorrhaging despite attempts to correct coagulopathy by transfusion. Multiple operating room visits were required where a combination of packing and hemostatic agents could not stop hepatic venous parenchymal hemorrhage. Mesh wrap consisting of Vicryl and PDS suture were used to create the “BOLSA” to achieve hemostasis.

**DISCUSSION:** Perihepatic packing compromises pulmonary excursion, elevates intra-abdominal pressure, is a risk factor for sepsis, and requires an additional trip to the operating room for removal. The use of Vicryl mesh wrap obviates these complications. Previously described mesh wraps require anchoring. The self-supporting structure of the BOLSA simplifies construction and application.

**CONCLUSION:** The BOLSA is an effective tool in treatment of severe liver hemorrhage in coagulopathic patients. It is the modern simplification of hepatic wrapping and the solution to the side effects of perihepatic packing.

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## 1. Introduction

Severe traumatic liver hemorrhage results in rapid exsanguination and patient mortality [1,6–8]. Many methods of obtaining hemostasis have been proposed. Liver resection for hepatic injury, proposed by McClelland and Shires, has fallen out of favor [10]. Perihepatic packing is often used in the unstable patient prior to angio-embolization of hepatic arterial bleeding. This method, however, can be unsuccessful and accompanied by complications, including hemorrhage on pack removal [5]. Additional operating room visits for laparotomy pack removal are necessary to prevent perihepatic sepsis from prolonged packing [4,5]. The use of mesh wrapping has been proven successful in the treatment of splenic injuries since 1979 [2]. The use of preformed polygalactin 910 (Vicryl) mesh has been subsequently applied for the treatment of

liver hemorrhage [1–4,18]. Multiple methods of mesh fixation have been described but are time consuming when the objective is to return the patient to the intensive care unit (ICU) for resuscitation [1–4,15]. In this case report, we describe an enhanced technique of hepatic wrapping in the setting of severe hepatic hemorrhage after liver biopsy in a coagulopathic patient. The technique is called the hepatic “BOLSA” (Bag on Liver Supporting Anti-Hemorrhage).

## 2. Presentation of case

A 59-year-old-male with a history of prostatic cancer underwent a computed tomography (CT) guided percutaneous transhepatic core needle liver mass biopsy, followed by angio-embolization of the hepatic mass nine hours prior to presentation in the recovery room. His vital signs were: blood pressure 84/55, heart rate 77, and respiratory rate 26. The patient was acidotic with pH 7.31, base deficit of 6.5, INR of 1.6, PT 17.8 and bladder pressure of 25 mmHg. Repeat CT of abdomen and pelvis was completed to reassess the perihepatic hematoma in light of increasing bladder pressure and

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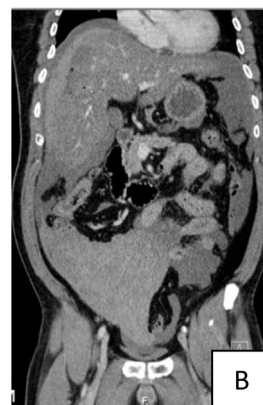
persistent hypotension (Fig. 1A & B). It demonstrated expansion of the perihepatic hematoma without evidence of blush. After discussing the possibility of repeat angiographic embolization with the referring angiographer we concluded on admission first to the surgical ICU for coagulopathy correction. The patient's coagulopathy wouldn't correct despite multiple transfusions of fresh frozen plasma and cryoprecipitate, the patient developed severe intra-abdominal hypertension with compartment syndrome (bladder pressure: 40 mmHg). The patient was taken to the operating room (OR). The bleeding liver mass was located in the dome of segments 7 and 8. The falciform ligament was taken down and the right upper quadrant packed. The patient stabilized and the packs were dry at the end of the case. He resumed bleeding within twenty-four hours. Angiography of the right hepatic artery did not show any blush. The bleeding was thought to be venous in origin, fed by a superior right hepatic artery branch. Selective right hepatic artery embolization was performed. He returned to the OR later that day for continued hemorrhage. A hepatic artery branch was ligated and laparotomy packing performed in the right upper quadrant. The patient stabilized. On post-operative day (POD) 2 from his index exploratory laparotomy, he returned for re-exploration. As soon as the liver packs were removed, parenchymal bleeding resumed. Surgicel, Argon beam coagulation, fibrin sealant, and more packing were insufficient to create hemostasis. As a result, we initiated the BOLSA.

Intraoperative improvements after BOLSA placement were marked. From the anesthesia records: during case 1, initial exploratory laparotomy and packing: BP at surgery start was 80/45, went as low as 75/45 and at end of case was 90/50. Case lasted 19 min. Transfusions were described as "massive transfusion protocol ongoing". Total transfusion for case was 3 units packed red blood cells (PRBC), 3 units fresh frozen plasma (FFP), and EBL was listed as 2 l. Case 2 later that day for ongoing bleeding after angiography lasted 32 min and had initial BP of 100/49 to a low of 80/40, finishing at 125/55.

During the third case, after 48 h, BOLSA placement, showed low BP at start of 90/45, to end BP of 110/50, assisted with vasopressors. Case lasted 2 h total. BOLSA creation was approximately 10 min and placement around liver 10 min. Transfusions given were: PRBC 4, FFP 3, Platelets 1 10-pack. Fourth case, 48 h later for cholecystectomy, Wittmann patch placement lasted 2 h 2 min. Vitals were 100/60 at start, 120/60 at end. Transfusions were PRBC 2, FFP 2, Platelets 1 10-pack. The final case was for abdominal closure, 7 days later, with no transfusions.

### 3. Materials and methods

(POD 2 continued) Two 12 cm × 12 cm sheets of polyglactin 910 mesh were sutured together with a running number 1 PDS suture creating a long rectangle of mesh. Number 1 PDS suture was run in a mattress fashion, creating a purse-string along each of the longer sides of this rectangle. The right coronary and triangular ligaments were taken down. Pro-coagulant absorbable material (Gelfoam, Surgicel) was placed into the cavity where the mass was located. The BOLSA was placed around the right lobe of the liver such that it completely wrapped the right liver covering the mass and the pro-coagulants. The purse strings were then tightened and tied accommodating the gallbladder without strangulation. No sutures were applied to the ligaments. (Fig. 1C–E) On POD 4, cholecystectomy was performed for ischemic cholecystitis secondary to the right hepatic artery embolization. A Wittmann patch was placed secondary to visceral edema preventing fascial closure. The patient underwent serial tightening of the Wittmann patch bedside. The pathology report of the liver biopsy returned on POD 7 as a hemangioma. On POD 9 from BOLSA placement, the patient returned to



**Fig. 1.** (A & B) Liver segment 7/8 mass. Grade 3 liver laceration. (C) Conjoined Vicryl mesh with bilateral purse string, (D) Liver wrap, (E) Purse strings tied. Gallbladder is unrestricted. No transfusing sutures.

the OR where the BOLSA was removed without bleeding and the abdomen closed primarily. The patient progressed to resumption of activities of daily living and was discharged home.

#### 4. Discussion

In the era of damage control surgery, survival is associated inversely with the time spent in the operating room [3]. The tamponade effect of perihepatic packing is a quick method of controlling hemorrhage [5,9,12]. Despite its effectiveness, there are undesirable effects. The pressure used to achieve hemostasis is also applied to the diaphragm, compromising pulmonary function. The laparotomy pads can elevate intra-abdominal pressure threatening abdominal compartment syndrome [3]. In addition, retention of packing greater than 3 days has an 83% incidence of intra-abdominal sepsis [5].

The method of mesh wrapping was first introduced by Buntain and Lynn for the treatment of splenic hemorrhage [17]. The tamponade effect created by the mesh wrap is the same mechanism found in perihepatic packing. It is most effective in Grade 3 and 4 liver lacerations [11,16]. Hepatic wrapping provides the same effect but without the elevation of abdominal pressure, obstruction of right diaphragmatic excursion, and the risk of sepsis. Blood flow of the inferior vena cava or portal vein are not affected as the pressure is limited to the liver's surface. Cholecystectomy is not necessary as the mesh accommodates the gallbladder without causing compressive ischemia. In the present case, the cholecystectomy was performed because angio-embolization of the right hepatic artery caused ischemic cholecystitis.

Vicryl mesh sheets exist in most ORs, obviating the need for purchasing a separate hepatic wrap. The mesh wrap can be applied selectively to the affected lobe or to the entire liver. Removal of the mesh wrap is not mandatory. The mesh is absorbed by hydrolysis in a period of 10–12 weeks and will not interfere with liver growth in neonates [18]. The mesh hydrolysis also provides a bacteriostatic effect that allows its application in contaminated fields, even in immunocompromised patients [13,14,19,20]. Lastly, radiographic imaging is not affected by the mesh [4]. Percutaneous drainage of bilomas, hematomas, or abscesses can be completed without complications [2,4].

The success of hepatic mesh wrap in controlling liver hemorrhage has been proven previously by many authors. The novelty of our wrap lies in its self-supporting structure. Previous methods require an anchoring stitch directly to the falciform ligament or to the diaphragm [2,3]. The unique purse-string suture on the mesh edges allows tension to be distributed equally according to the curvature of the liver. The construction time published by Stevens et. al [3], is approximately 5 min in practiced hands. However, the simplicity of our construction further reduces the time to hepatic tamponade. It must be stated that this method does not treat injury to hepatic veins or retrohepatic vena cava injuries [1–3].

#### 5. Conclusion

The ease and popularity of perihepatic packing has overshadowed other methods of hepatic hemorrhage control. Hepatic wrapping has proven to effectively control liver parenchymal hemorrhage. Other authors have recommended application in American Association for the Surgery of Trauma (AAST) Grade 3–4 lesions [2,20]. However, hepatic wrapping can be considered in AAST Grade 1 & 2 lacerations where hemorrhage becomes uncontrolled and requires laparotomy. This will afford trauma surgeons the opportunity to close the abdomen with hemostasis preventing a second laparotomy, and its associated sequela of fascial separation and infection. The BOLSA is the modern simplification of hepatic

wrapping and is the solution to the side effects of perihepatic packing. The BOLSA should be reinstated into the armamentarium used in trauma patients with liver injury to prevent unnecessary operating room visits. Its rapid application and effective hemostatic results are the reasons to accept this technique as a valuable tool in the treatment of severe liver hemorrhage.

#### Conflict of interest

No disclosures.

#### Sources of funding

Nothing to declare.

#### Ethical approval

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

#### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

#### Authors contribution

Nathaniel Ng, M.D. role: writing and literature review.  
Susan F. McLean, M.D., F.A.C.S. role: study concept and design, data collection and writing.  
Melhem R. Ghaleb, M.D. role: writing.  
Alan H. Tyroch, M.D. F.A.C.S., F.C.C.M. role: writing.

#### Guarantor

I, Susan F. McLean, M.D., F.A.C.S., accept full responsibility for the work and/or the conduct of this study, had access to the data, and controlled the decision to publish.

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