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Management of perforating liver injury with Bakri balloon. Presentation of a case

Manejo de la lesión hepática perforante con balón de Bakri. Presentación de un caso

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ABSTRACT

Introduction: Trauma injuries are the leading cause of death in Mexico in patients from one to 44 years old. In abdominal trauma, the liver is the organ most frequently affected because of its location and size. Of the patients admitted in trauma centers, 5% have liver injuries. Complex liver injuries account for 10-30% of them, with a high mortality reported from 40-80%. The delay in the recognition of intraabdominal injuries can cause early death due to hemorrhage, or belatedly because of visceral injuries. The main cause of death in liver injuries is massive hemorrhage, which is associated with a mortality rate of 50-54% in the early hours of admission, reaching 80% in patients undergoing surgery. The Bakri balloon is a medical device made with silicon was described in 1992 by Younes Bakri, an Ob-Gyn. It was designed for intrauterine tamponade, and its mechanism of action is based on the increase of intraluminal pressure on the uterine wall, and consequently, on the uterine vasculature. **Case-report:** We report the case of a 39-year-old male patient who came to the emergency room after suffering a stab wound in the right hemithorax. He had hypovolemic shock, so after intensive reanimation was sent to surgery, where a transfixed grade V liver injury was found in the right lobe, was managed successfully with a Bakri balloon was set into the tunnel of the liver injury. The patient was discharged on the eighth day without postsurgical complications. **Conclusion:** The use of a Bakri balloon, not previously described for handling this type of injury, is an excellent alternative with good outcome.

RESUMEN

Introducción: *Las lesiones ocasionadas por traumatismos son la causa principal de muerte en México en pacientes de uno a 44 años. En el trauma abdominal, el hígado es el órgano afectado con mayor frecuencia por su localización y dimensiones; 5% de los pacientes ingresados a un centro hospitalario de trauma presenta lesión hepática; las lesiones complejas de hígado representan 10-30% de todas las lesiones, con una elevada mortalidad reportada de 40-80%. La demora en el reconocimiento de las lesiones intraabdominales puede ocasionar la muerte temprana por hemorragia o tardíamente por lesión visceral. La causa principal de muerte en las lesiones hepáticas es la hemorragia masiva; se asocia con una tasa de mortalidad de 50-54% en las primeras 24 horas del ingreso, alcanzando 80% de mortalidad en los pacientes sometidos a una intervención quirúrgica. El balón de Bakri es un dispositivo médico de silicón que fue descrito en 1992 por el gineco-obstetra Younes Bakri. Dicho dispositivo fue diseñado con el propósito de taponamiento intrauterino y su mecanismo de acción se basa en el incremento de la presión intraluminal sobre las paredes uterinas y por consiguiente, sobre la vasculatura uterina.* ***Presentación del caso:*** *Presentamos el caso de un paciente de 39 años de edad que ingresó a urgencias de nuestra unidad hospitalaria de segundo nivel ubicada en Ciudad Nezahualcóyotl por presentar una herida por instrumento punzocortante en el hemitórax derecho, con datos de choque hipovolémico, por lo que se inició la reanimación e ingresó al quirófano, con el hallazgo de una lesión hepática grado V transfictiva en el lóbulo derecho, la cual fue tratada de forma exitosa con la colocación de un balón de Bakri en el túnel de la lesión hepática. El paciente egresó al octavo día sin complicaciones postquirúrgicas.* ***Conclusión:*** *El uso del balón de Bakri, no descrito con anterioridad para el manejo de este tipo de lesiones, es una excelente alternativa con buenos resultados.*

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INTRODUCTION

Trauma injuries are the leading cause of death in Mexico in patients aged one to 44 years and the third leading cause of death worldwide, causing more than five million casualties per year. In abdominal trauma, the liver is the most frequently affected organ due to its location and dimensions.[1] Five percent of polytrauma patients admitted to a hospital have liver trauma;[2] of these, complex liver injuries represent between 10 and 30% and have a high mortality, ranging between 40 and 80%.[3] At the beginning of the last century, mortality from liver injury exceeded 80%. Other authors have reported a mortality greater than 50% for liver resection for trauma, and an operative mortality of 46 and 80% for liver injuries grade IV and V.[4] Despite continued progress in trauma and critical care, mortality from complex liver injuries is still very high.[5] The natural course of many liver injuries is spontaneous hemostasis; this fact, associated with the great regenerative capacity of the liver, frequently facilitates cessation of bleeding without need for surgical intervention.[2] Seventyseven percent of patients with liver trauma are hemodynamically stable on arrival, and 50 to 86% of all traumatic liver injuries do not arrive to laparotomy with active bleeding.[2] Notwithstanding, undiagnosed injuries to other organs continue to be preventable causes of death, and delayed recognition may lead to early death from hemorrhage, or late death due to visceral injury.[6]

According to its mechanism of injury abdominal trauma is classified as blunt or penetrating. This is important, since understanding the mechanism of injury facilitates early identification and, guides the diagnostic and treatment methods. The most frequently injured organs in patients suffering blunt trauma include the spleen (40-55%), the liver (35-45%) and the small intestine (5-10%). Penetrating trauma can be caused by a firearm projectile or from or a knife. Stab injuries penetrate abdominal structures adjacent to the site of injury, most commonly the liver (40%), the small bowel (30%), diaphragm (20%), and colon (15%). Gunshot wounds can cause additional intraabdominal injuries besides the trajectory of the projectile, by a cavitation effect and, fragmentation. The organs most frequently injured by firearm projectiles are the small bowel (50%), colon (40%), liver (30%) and abdominal vascular structures (25%).[6]

Hepatic injuries are classified by degrees of severity according to organic damage; The American Association for Surgery of Trauma has issued one such classification.[7] Early diagnosis of the magnitude of liver trauma, combined with adequate treatment adapted to the severity of the injury and the patient's hemodynamic condition, may result in significant reduction of morbidity and mortality. Hemodynamic stability is key to the treatment of severe liver injury. Diagnosis of liver trauma begins simultaneously with resuscitation, just after admission, which involves a targeted physical examination, laboratory, focused abdominal sonography for trauma (FAST) followed by multi-slice computed tomography (MSCT).[8] A CT scan of the abdomen with intravenous contrast is the optimal diagnostic method -in hemodynamically stable patients- to define the diagnosis and treatment of liver trauma.[9] The concept of selective non-surgical treatment for penetrating solid organ injuries has been largely unexplored, and surgical treatment is considered the standard method by most surgeons.[10] Despite advances in surgical treatment and resuscitation of trauma patients, severe liver trauma still entails significant morbidity and mortality. Severe liver injury remains the leading cause of death in patients with abdominal trauma, and its treatment continues to challenge surgeons. The main cause of death in liver lesions is massive bleeding, and it is associated with a mortality rate of 50-54% without surgery in the first 24 hours of admission. It reaches 80% mortality in patients undergoing surgical intervention.[8] In the course of the 21st century, progress has been made in achieving hemostasis of liver lesions. Fortunately, most of them (70-90%) require less complex therapy. In contrast, mortality from complex liver lesions remains very high, despite advances in anesthetic resuscitation and the availability of intensive care units (54%).[11] Treatment of liver lesions continues to evolve after more than 80

years, from Pringle's first descriptions of hepatoduodenal ligament compression, to the use of sutures, and gauze packing of liver lacerations.[11] Treatment of traumatic liver injury is based on the patient's hemodynamic status, the mechanism of injury and whether or not there are associated injuries.[12] Most grade I, II, or III liver injuries are successfully treated with conservative management only. In contrast, two thirds of grade IV or V injuries require laparotomy *(Table 1)*. These interventions are generally challenging and difficult. Richardson et al. proposed that the main causes of greater survival are: 1) packing and reoperation, 2) arteriography and embolization, 3) advances in surgical techniques for severe liver injuries and 4) a decrease in hepatic vein injuries requiring surgery.[7,13] The management of a patient with severe trauma involves a sequence of systematized actions. Hemodynamically unstable patients with major liver lesions require rapid maneuvers to control bleeding, avoiding bleeding exsanguination and massive transfusions. Uncontrolled bleeding leads to events that announce a catastrophe, including coagulopathy as a consequence of exhaustion and dilution of clotting factors, acidosis, and hypothermia.[7,8]

The most critical decisions a surgeon faces in complex liver injury are: a) not to enter the operating room unless there is a clear indication, b) in hemodynamically unstable patients, only what is essential for stop bleeding at the first surgery; if simple maneuvers work, the liver should be packed and the surgical procedure (damage control surgery) stopped; c) if major liver resection is required, the decision should be made early during surgery; d) delayed resection is reserved for selected patients.[13] In unstable patients with severe injuries, suprahepatic vein repair and perihepatic packing combined with early correction of hypothermia, coagulopathy and acidosis may lead to better results.[7,8] The treatment of liver lesions continues to evolve from the earliest descriptions of Pringle. Certain forms of treatment that have been popular in the past are now used infrequently. These include hepatorraphy, lobectomy, and ligation of the hepatic artery. In contrast, techniques such as selective vascular ligation hepatotomy, limited debridement, and perihepatic packing have gained popularity in the treatment of liver trauma.[11,14]

Wounds caused by a firearm projectile in the liver and suprahepatic veins present a challenge for resolution. Abdominal packing is a useful and widely accepted technique for achieving hepatic hemostasis in complex lesions. Few reports of cases of balloon tamponade in

Table 1: Classification of liver trauma from AAST (American Association for the Surgery of Trauma).

Grade of lesion	Subcapsular hematoma	Parenchymal hematoma	Laceration	Vascular lesion
I	< 10% of surface		< 1 cm depth	-
II	10-50% of surface	< 10 cm diameter	1-3 cm depth, < 10 cm long	-
III	> 50% of surface o expansive, rupture of subcapsular hematoma	> 10 cm diameter or rupture of parenchymal hematoma	> 3 cm depth	-
IV	-	-	Disruption of parenchyma 25-75% or 1-3 Couinaud segments of the same lobe	-
V	-	-	Disruption of parenchyma > 75% or more than 3 Couinaud segments of the same lobe	Venous lesion or major hepatic vein lesion
VI	-	-	-	Liver tear

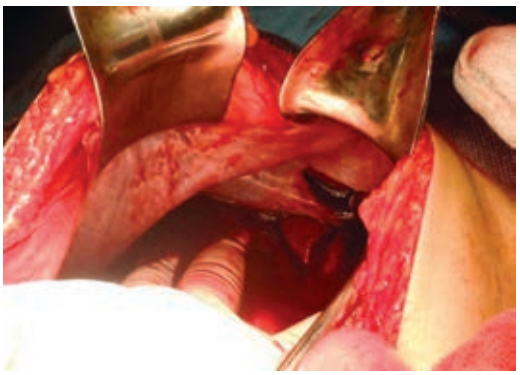

Figure 1: *Diaphragmatic and liver injury.*

the trajectory of a firearm projectile have been reported. Bleeding from penetrating lesions of the liver parenchyma can be controlled by maneuvers such as hepatorraphy, resection, tractotomy with suture and ligature of bleeding vessels, and ligation of the hepatic artery. These techniques can achieve hemostasis in penetrating injuries without severe blood loss.[14] In cases of arterial bleeding, it can be controlled with percutaneous angioembolism, which is indicated based on the response to the Pringle maneuver during the intraoperative period. Failure to control bleeding alerts the surgeon to the possibility of hepatic vein injury. It represents only a small percentage; however, it carries high mortality.[15] The usefulness of balloon catheters for emergency tamponade in exsanguinating hemorrhages has been evident for more than 50 years.[16] The technique of balloon tamponade using a rubber catheter and a Penrose in the management of liver trauma was first described by Morimoto et al. in 1987 for a penetrating gunshot wound piercing the liver; others subsequently used it. This simple technique applies direct pressure at the depth of the liver parenchyma with minimal morbidity in a patient with perforating lesions.[15] Although Sengstaken-Blakemore tubes have been described to inhibit bleeding from esophageal varices, its use has rapidly spread to patients with vascular trauma and solid organ injuries. The use of the use of a hemostatic balloon for iliac vein injury was first reported in 1960, likewise, its use has been expanded for cardiac, aortic, pelvic, and vascular neck injuries (carotid artery, vertebral arteries, and jugular vein), abdominal, liver, subclavian vascular lesions, and facial trauma.[16] The Sengstaken-Blakemore's gastric balloon helps stabilize the esophageal balloon once it is insufflated into the liver parenchyma. More importantly, it can also block bleeding from retrohepatic veins.[14] Bakri initially described the use of the balloon to control obstetric bleeding due to accreted placenta praevia in 1992. The Bakri balloon is a silicone device for intrauterine tamponade, it is 54 cm long (24 French); it has a double lumen. Its mechanism of action is the increase of intraluminal pressure on the uterine walls, thus, on the uterine vasculature. This uniform pressure on the sinusoids impedes blood flow until the hemostatic mechanisms definitively contain the bleeding.[17]

Penetrating liver lesions may not be easy to manage due to their location and trajectory. Repair with closure of the entry hole results in expansion of the hematoma within the liver parenchyma, packaging the lesion with hemostatic agents is ineffective, and performing a tractotomy exposes a large liver surface, especially when bleeding predisposes the onset of consumption coagulopathy. Also, a tractotomy increases the risk of bile leakage and perihepatic collections. The use of an intrahepatic balloon tamponade is a surgical alternative that can be very effective for the control and reduction of bleeding.[15] Whatever the technique chosen, the goal of treatment is the control of bleeding, as well as the prevention of biliary complications.[8] This simple technique can be a useful tool for the treatment of complex liver injuries.[18]

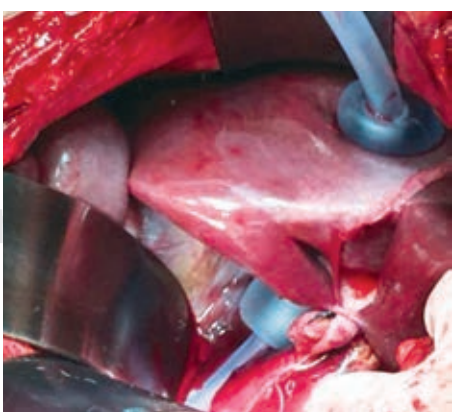

Figure 2: *Bakri balloon in the path of liver injury.*

Figure 3: *Plain abdomen film showing the insufflated Bakri balloon in situ.*

Figure 4: *Liver lesion with no bleeding once the Bakri balloon was removed.*

PRESENTATION OF THE CASE

39-year-old male; who suffered a street attack with a sharp object in the right thorax. Brought to the emergency room of our hospital in Ciudad Nezahualcoyotl, Mexico. On initial assessment, he was found to have hypovolemic shock, bradycardia and neurological deficit. Initial resuscitation and airway management were started, also with crystalloid and blood products infusions based on ATLS. He had a Glasgow score of 3. The 4 cm chest wound was at the sixth right intercostal space, mid-clavicular line, with a cephalocaudal anteroposterior direction. He two other wounds in the posterior thorax, one in the right posterior axillary line, the other in the left renal fossa. The abdomen had no apparent injuries, no peristalsis, some involuntary muscular resistance. Despite administration of crystalloids and blood products, he continued in shock, so it was decided to immediately take him to the operating room.

Through an infraumbilical midline incision a 4 cm lesion in the right hemidiaphragm was identified, repaired with simple points with number 1 polyglactin 910 (Vicryl®). A penetrating liver lesion was located in the right hepatic lobe, from the superior to the inferior face, 4 cm in length and some 8 cm deep *(Figure 1)*, with massive bleeding. A Bakri balloon was inserted in the tunneled wound, insufflating the balloon with 50 cm^3 of air, with which the bleeding was inhibited *(Figures 2 and 3)*. A systematized exploration was continued, with no further injuries found. A ¾ inch Penrose drain was directed to the right subphrenic space and a Bogota-type bag placed as temporary closure of the abdominal cavity. As there was no experience with the use of the Bakri balloon, the Bogota bag would monitor the presence of active bleeding. In any case, the patient would have to undergo

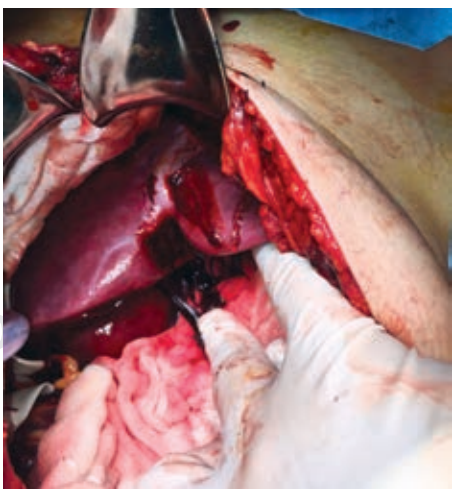

Figure 5: *Haemostatic control of the lesion after removal of the Bakri balloon.*

revision surgery for removal of the Bakri tube and definitive management of the liver injury. A pleurostomy tube was placed in the right hemithorax with an initial blood flow of 300 cm^3. In the immediate postoperative period, the patient was transferred, intubated, to the ICU. He presented no metabolic acidosis, hypothermia, or coagulopathy. Forty-eight hours postoperatively, he entered the operating room for removal of the Bakri balloon, with no reactivation of the bleeding *(Figures 4 and 5)*. The abdominal wall was then closed by planes. The patient left the OR, intubated, directly to the ICU. He was extubated the day after the second operation and discharged to the general surgery ward two days after. The pleurostomy tube was removed on the fourth day, after radiological control. He evolved satisfactorily and was discharged eight days after admission, with no apparent post-op complications.

DISCUSSION

Grade IV and V liver lesions represent the greatest challenge for the surgeon. The treatment options for this type of injury are very diverse and effective depend on many factors, most of them inherent to the patient. In our case, the patient's hemodynamic status required a quick and decisive maneuver to avoid further hemodynamic deterioration and the neurological damage of persistent shock. Thus, it was decided that the fastest way to control the bleeding was by hydrostatic balloon compression. Bakri's balloon was the most indicated device, since, it has a capacity of up to 300 cm^3, which allows a wide margin for a compression that adapts to the size of the injury, besides, there were no other accessories (Sengstaken-Blakemore) available in our hospital.

We can see that, as Demetrio Demetriades et al. comment, hydrostatic balloons are a practical and easy therapeutic option; offer the patient immediate bleeding control, reducing the risk of subsequent complications such as bile leak or rebleeding, they allow the subsequent evaluation of the injury as well as of associated injuries, by subjecting the patient to a second surgical intervention for removal of the balloon. We can affirm that the use of hydrostatic balloons contributes to the immediate control of bleeding, and makes possible a thorough systematic review when performing a laparotomy, avoiding overlooking associated injuries to other organs. It is important to mention the usefulness of the Bakri balloon in perforating liver lesions as another therapeutic option. It should be noted that this use has not been described in any previous publication so far.

CONCLUSION

The Bakri balloon, although designed for other purposes, is a therapeutic option for perforating liver injuries. Its use can be easily reproduced in injuries similar to the one presented in this article.

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