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Case Report OMICS International

Partial Zone II Resuscitative Endovascular Balloon Occlusion of the Aorta in Management of Multiple Trauma with Combined Abdominal and Pelvic Injury

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Abstract

Introduction: Resuscitative endovascular balloon occlusion of the aorta has been used in various clinical settings to elevate blood pressure in the setting of shock, even if the evidence base is weak with no clear indications.

Case presentation: We report a case of traumatic hemorrhagic shock in which this technique was used in an unusual manner, treating obvious arterial abdominal bleeding associated with suspected pelvic arterial bleeding, in a Trauma Center where hybrid angiographic-surgical suite is not available. A 35-year-old man was involved in a traffic accident within 2 trucks. He was transported to the Major Trauma Center of an Integrated Trauma System where emergent laparotomy confirmed massive hepatic rupture and a bleeding control was obtained by large abdominal packing. Trauma team decided to considerate Resuscitative Endovascular Balloon Occlusion of the Aorta, positioning a deflated balloon in zone III to eventually manage a pelvic arterial hemorrhage, while performing Bogota Bag. Suddenly a new abdominal arterial bleeding was noted through Bogota Bag. Because Pringle maneuver was considered too difficult in this case because of liver hilum injury, the balloon was moved cranially with the aim to reach zone I. Introducer sheath displacement occurred at this time, and the balloon was then only partially inflated in zone II, usually considered too dangerous, and immediately the target systolic blood pressure of 90 mmHg was obtained. Transfer the patient into interventional radiology suite was then feasible and embolization of active bleeding by right hepatic artery and superior mesenteric artery branch, missed during first laparotomy, were performed. Balloon was definitely deflated after 50 minutes. The patient was discharged by the hospital 113 days later, fully recovered with long lasting motor rehabilitation program.

Discussion: Partial zone II Resuscitative Endovascular Balloon Occlusion of the Aorta in this particular case allowed overcoming procedural mistakes without major complications and with good clinical outcome.

Conclusion: Judicious manage of REBOA inflation time and amount, together with multidisciplinary contemporary damage control strategy with clear and effective team leading, is the key to effectively resuscitate multiple trauma shocked patients.

Keywords: REBOA; Hemorrhagic shock; Zone II; Liver injury; Pelvic injury; Multiple trauma; Trauma leader; Trauma system; Trauma center; Trauma team

Introduction

Hemorrhagic shock is a major cause of death in the acute care setting [1,2]. Although the main aim of resuscitation is to stop the hemorrhage and restore circulating blood volume, persistent hemorrhage can be rapidly fatal. In major trauma, uncontrolled bleeding is the first cause of potentially preventable death [3-5]. Resuscitative endovascular balloon occlusion of the aorta (REBOA) has been used in a variety of clinical settings (postpartum hemorrhage, upper gastrointestinal hemorrhage, pelvic hemorrhage during pelvic/sacral tumor surgery, traumatic abdominopelvic hemorrhage, ruptured aneurysm abdominal aorta [6-9] to successfully elevate central blood pressure in the setting of shock, even if the evidence base is weak with no clear indications. The effectiveness in this clinical target seems to be confirmed by recent pooled analysis [10], that demonstrated an increase in mean systolic pressure by following REBOA use, but benefits in terms of overall reduction of mortality in trauma patients is controversial [11,12] (Table 1).

Prospective data collection is underway in the form of American Association for the Surgery of Trauma sponsored observation studies [13] and a European Registry [14] which should permit the consistent recording of REBOA-specific data such as indications and outcome. The conventional aim of REBOA is to maintain cerebral and coronary

circulation to temporarily control arterial hemorrhage from the injured organ via occlusion using balloon inflation of the aortic lumen, keeping the patients alive until you can get them into the operating theatre or interventional radiology suite for the definitive control of their hemorrhage [5].

References	Year	Study Type	n	Zone	Shock	Mortality
[24]	1954	Case series	2	I	Y	2/2 (100%)
[25]	1986	Case series	15	I	Y	13/15 (86.7%)
[26]	1986	Case report	1	III	Y	Nil
[27]	1989	Case series	21	I	Y	14/21 (66.7%)
[28]	2001	Case report	1	I	Y	Nil
[29]	2010	Case series	13	III	Y	7/13 (53.8%)
[30]	2013	Case series	6	I × 4; III × 2	Y	2/6 (33.3%)
[31]	2013	Case series	5	III	Y	Unknown
[32]	2014	Case report	1	III	Y	Nil
[33]	2014	Case report	1	III	N	Nil
[34]	2015	Case series	7	I	Y	1/7 (14.3%)
[35]	2015	Case series	14	I	Y	9/14 (64.3%)
[11]	2015	Cohort study	452	3	Y	343/352 (75.9%)
[36]	2015	Case series	24	I	Y	10/24 (41.7%)
[12]	2015	Cohort study	24	I × 19 ; 3 × 5	Y	15/24 (62.5%)
[37]	2015	Cohort study	397	-	Y	Not applicable
[38]	2015	Cohort study	24	-	Y	Not applicable
[39]	2015	-	-	-	-	Not applicable
[40]	2016	Cohort study	625	-	Y	386/625 (61.8%)
[41]	2016	Cohort study	46	I × 33; II × 1, III × 8	Y	33/46 (71.7%)
[42]	2016	Case report	1	I	Y	Nil

Table 1: Summary of the reports relating to balloon occlusion in traumatic patients.

Endovascular balloon placement is performed by fluoroscopic guidance or post-placement x-ray confirmation after blind insertion [15]. Recently it has been proposed an ultrasound guided wire advancement [16]. This is an important finding because the need for fluoroscopy is a major limitation to the use of REBOA in settings with limited medical infrastructure. Aortic level of balloon inflation usually is classically reported by a 3 zone classification: zone I thoracic aorta from left subclavian and celiac artery, zone II between celiac and renal artery, zone III infrarenal placement [17,18].

For bleeding in abdominal cavity the REBOA balloon is placed in zone I. For pelvic bleeding, generally from branches of iliac arteries, the balloon is placed in the distal aorta (zone III). Zone II is not used currently. It is also described the prophylactic balloon placement in hemodynamically stable patients at risk of significant hemorrhage [10]. Positioning could lead to device-related morbidity (3.7%) and mortality (0.8%) by arterial injury, insertion site complications and balloon-related thromboembolic events [10]. We present a case in which balloon was positioned and inflated in zone II for technical problem during the procedure, Partial inflation to get controlled hypotensive target, together with hemocoagulative resuscitation and direct bleeding control, allowed good outcome without major side effects.

Case Presentation

A healthy Italian 35-year-old truck driver man was involved in a traffic accident with another truck. Helicopter Medical Emergency System (HEMS) was activated and after the primary survey the patient showed a Glasgow Coma Scale of 14 (E4, V4, M6), respiratory rate >30/min, heart rate (HR) 120beat/min and Blood Pressure (BP) of 100/80 mmHg. Extrication lasted about 60 minutes because of the massive disruption of the truck cabin. Rapid Sequence Intubation for severe respiratory failure was performed. A crystalloids solution infusion started and a pelvic binder was applied to prevent potential further injury. The patient was transported to the Emergency Department (ED) of Bufalini Hospital in Cesena, Italy while activating Trauma Team (TT) and Early Coagulation Support Protocol [19].

In ED TT confirmed HEMS doctor primary survey despite 2000 ml of crystalloids solution already infused. Chest X-ray, Pelvic X-ray and Focus Assessed Sonography in Trauma was performed, showing left hypertensive pneumothorax, multiple pelvic fracture closed with pelvic binder, massive liver disruption and hemoperitoneum. Left side decompressive simple thoracostomy was then immediately performed with slight respiratory and hemodynamic improvement and the patient was moved to the Operating Room (OR) for emergency laparotomy while infusing type 0 Rh-negative Packed Red Blood Cells (PRBC), Fibrinogen Concentrate (FC) and Tranexamic Acid (TA) with high flow warming infusion system. The laparotomy showed massive hepatic rupture and bleeding control was obtained by 33 gauzes packing. Radial arterial catheter was positioned to measure invasive BP and fluid infusion was stopped to evaluate the hemodynamic state.

Peripheral Oxygen Saturation (SpO_2) was than measurable 98% for the first time, with inspired Oxygen inspired Fraction (FiO_2) of 1. Hemogasanalysis at that time revealed relative hypoxia 120 PaO_2/FiO_2 ratio, hypercarbia 67 mmHg partial pressure arterial CO_2, severe mixed acidosis pH 7.009, Base Excess -14 mmol/L and Lactate 8.63 mmol/L. TT was evaluating clinical conditions to understand if patient was stable enough to be moved to Computed Tomography (CT) room outside the OR in order to get total body CT scan. No information about the presence of arterial pelvis hemorrhage was available at that moment. Surgeons and team leader decided to insert a deflated REBOA in zone III to eventually manage a pelvic arterial hemorrhage. Surgeons performed a Bogota Bag [20] to manage the patient with open abdomen assessing a secondary survey, while BP increased to 110/70 mmHg and HR was 80/min. Bilateral thoracostomy tubes were positioned for the definitive treatment of the left and suspected right

pneumothorax. Suddenly arterial bleeding was noted through the Bogota Bag and BP dropped to 75/45 mmHg. Surgeons evaluated that Pringle maneuver was too difficult and dangerous in this particular case for the huge retroperitoneal supramesocolic hematoma and hepatic hilum injury. Already placed deflated REBOA was then moved up with the aim to inflate it in zone 1, but unfortunately introducer sheath displacement occurred at this time. Balloon was then partially inflated in upper Zone II (Figure 1) to obtain a Systolic BP of 90-100 mmHg.

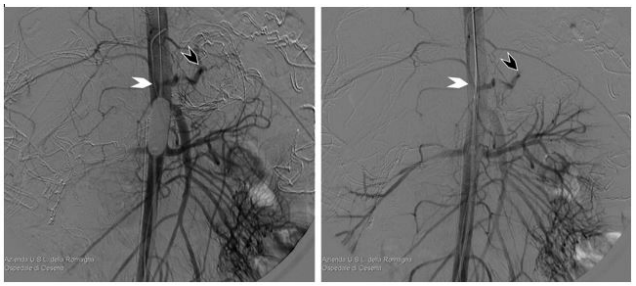

Figure 1: Aortography showing vasospasm of celiac tripod ostium (white arrow) and splenic artery (black arrow) with inflated balloon (left figure) and deflated balloon (right figure).

Patient was then transferred into interventional radiology suite, where interventional radiologist detected active bleeding from right hepatic artery and from a superior mesenteric artery branch. This last mesenteric arterial bleeding was missed during laparotomy for large mesocolon hematoma. Celiac Tripod vasospasm probably induced by balloon inflation in zone II made the procedure more difficult than usual. Bleeding lesions were treated by embolization and REBOA was definitely deflated after 50 minutes, while arterial pelvic hemorrhage was excluded by complete angiographic exam. A total of 3900 ml PRBC, 5400 ml Fresh Frozen Plasma, 600 ml Platelets Concentrate, 4 gr FC and 2gr TA was infused.

Hemo-coagulative resuscitation was guided by point of care thromboelastometry. Systolic BP remained constantly above 100 mmHg and HR about 90/min with maintenance fluid infusion. CT scan was performed before transferring the patient into the Intensive Care Unit (Figure 2). The exam revealed also sternum fracture, spleen contusion without bleeding and previously missed left posterior diaphragmatic herniation of stomach fundus, multiple pelvic unstable injury (bilateral acetabular fracture, bilateral superior pubic and ischiopubic rami, right vertical sacral ala fracture). TT decided to delay surgical diaphragmatic hernia repair because of severe traumatic coagulopathy and improved gas exchange with 280 PaO_2/FiO_2 ratios at Positive End Expiratory Pressure of 5 cm H_2O. Pelvic fractures eternal fixation was performed bedside during Intensive Care Unit resuscitation, allowing pelvic binder removal. Injury Severity Score [21,22] was 66 and Abbreviated Injury Scale was 5 abdominal, 5 thoracic and 4 bone.

In day 2 Mean Arterial Pressure was 60 mmHg without vasopressors infusion, Cardiac Index was 2.9 L/min, mixed venous oxygen saturation was 70%, BE was -0.5 mmol/L. The patient was anuric with hysovolemic continuous renal replacement therapy. Lactate levels were continuously high for hepatic failure. Surgical second look was performed 42 hours later.

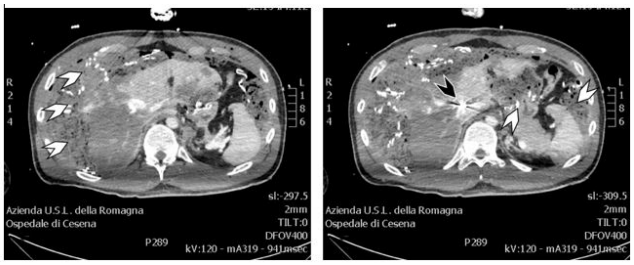

Figure 2: Abdomen CT scan showing massive hepatic injury without active bleeding. Black arrow: embolization coil in right hepatic artery. White arrows: packing gauzes around liver and spleen.

The abdomen was de-packed with no re-bleeding, the diaphragmatic hernia was reduced and primary synthesis of abdomen wall was uneventfully obtained. Serum Creatinine levels reached 6.63 mg/dL with the need of renal replacement therapy for 78 days, mainly performed by continuous veno-venous hemofiltration. Pelvic external fixation was removed at day 40. The patient was discharged by the hospital 113 days later almost fully recovered, with long lasting motor rehabilitation program.

Discussion

The trauma patient described above presented hemorrhagic liver injury and suspected hemorrhagic pelvic arterial injury. In order to evaluate, identify and treat the leading cause of shock, REBOA was first positioned deflated in zone III while performing simultaneously Damage Control laparotomy for hepatic packing, to treat potential coexisting pelvic arterial bleeding. After performing abdominal closure using Bogota bag, patient was again hemodynamically unstable and REBOA was moved to upper Zone II instead of Zone I for introducer sheath displacement during the procedure. Partial inflation in this position caused a transient occlusion of celiac tripod with a secondary vasospasm in the territory of hepatic artery and a contemporary improvement of invasive BP. The interventional radiologist was able to visualize the celiac tripod and to perform embolization of right hepatic artery and superior mesenteric artery branch, where a previously missed bleeding was detected.

The procedure was effective in controlling the bleeding and hemorrhage control was achieved. Partial inflation with controlled hypotensive target allowed benefits overcome risks of a defective procedure. REBOA adoption, even in a potentially dangerous position, gave authors time to move patient from OR to angiographic room (not available at the moment in our hospital a hybrid surgical angiographic suite) [23-41] and time to find the primary source in a severe and multiple hemorrhagic trauma, with good clinical outcome.

Conclusion

Authors think that REBOA partial inflation with controlled hypotensive target pressure, together with best standard care of trauma patients, could decrease REBOA-related morbidity and increase its efficacy in treating abdominopelvic traumatic hemorrhagic shock. Judicious manage of REBOA inflation time and amount, together with multidisciplinary contemporary damage control strategy with clear

and effective team leading, is the key to effectively resuscitate multiple trauma shocked patients.

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