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"REBOA" – Is it Really Safe? A Case with Massive Intracranial Hemorrhage Possibly due to Endovascular Balloon Occlusion of the Aorta (REBOA)

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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Patient: Female, 86
Final Diagnosis: Polytrauma
Symptoms: Shock
Medication: —
Clinical Procedure: Resuscitative endovascular balloon occlusion of the aorta
Specialty: Orthopedics and Traumatology

Objective: Unusual or unexpected effect of treatment

Background: Non-compressible torso hemorrhage continues to be the leading cause of preventable death in trauma patients. Recent case series report that resuscitative endovascular balloon occlusion of the aorta (REBOA) in the trauma population is a technically feasible method to manage the patients with exsanguinating hemorrhage. On the other hand, it seems that REBOA is being widely promoted prematurely. Complications due to REBOA haven't been reported much in the literature, and they could have been underestimated.

Case Report: An 86-year-old female presented to our emergency department following a pedestrian-vehicle accident. On admission, she was hemodynamically unstable with systolic blood pressure (SBP) of 78 mm Hg. She responded to fluid administration, and computed tomography (CT) scan showed cerebral contusion, subarachnoid hemorrhage, pelvic fracture with contrast extravasation, and thoracic spine fracture. Her condition deteriorated after the CT scan, and she became hemodynamically unstable. REBOA was inserted and inflated. Her blood pressure recovered and even became as high as SBP of 180 mm Hg. Transarterial embolization for pelvic fracture was successfully performed. A subsequent head CT scan showed massive intracranial hemorrhage with penetration to the ventricle, which was fatal. She died on the same day due to cerebral herniation.

Conclusions: REBOA is now considered as an alternative to resuscitative thoracotomy or even widely indicated to control hemorrhage. We should be more cautious about using REBOA for polytrauma patients since it could make hemorrhage worse. Further research, assessing its potential complications and safety, will be required to elucidate clear indications for REBOA in trauma populations.

MeSH Keywords: Endovascular Procedures • Equipment Safety • Hemorrhage • Multiple Trauma

Full-text PDF: http://www.amjcaserep.com/abstract/index/idArt/900267

Background

Hemorrhage, especially non-compressible hemorrhage in the chest, abdomen, or pelvis, continues to be the leading cause of preventable death in trauma patients. Recent case series reporting on the use of resuscitative endovascular balloon occlusion of the aorta (REBOA) in the trauma population have demonstrated that REBOA is a technically feasible method to manage patients with exsanguinating hemorrhage [1]. On the other hand, it seems that REBOA is being promoted prematurely. Complications due to REBOA haven't been reported much on the literature, and they could have been underestimated. One group reported that broad application of REBOA may carry a significant risk, and it is fruitless without prompt direct hemorrhage control [2]. We experienced a case with massive expanding intracranial hemorrhage post-intervention using REBOA.

Case Report

An 86-year-old female presented to our emergency department following a pedestrian-vehicle accident. She was hit by car a while she was crossing the street. On admission, she was hemodynamically unstable with systolic blood pressure (SBP) of 78 mm Hg. Her initial Glasgow Coma Scale (GCS) score was E3V4M6, and both pupils were equal and reactive to light. She responded to fluid after 1.0 L of crystalloid administration, and her blood pressure (BP) came up to 140/80 mm Hg and remained at that level until the computed tomography (CT) scan was completed. The initial CT scan showed a small cerebral contusion on the left frontal lobe and a small amount of subarachnoid hemorrhage in the cerebral falx (Figure 1), pelvic fracture and hematoma in a gluteal region with contrast extravasation, and thoracic spine fracture. Her condition deteriorated after the CT scan, and she became hemodynamically unstable with BP of 70/30 mm Hg. She was intubated due to her hemodynamic instability, and blood transfusion was initiated. REBOA was inserted and inflated to control hemorrhage from the pelvic fracture. Her blood pressure recovered and even became too high at SBP of 180 mm Hg. Transarterial embolization for pelvic fracture was successfully performed. She was not hypothermic or acidotic during her resuscitation. She was slightly coagulopathic with PT-INR of 1.6 and fibrinogen of 104 mg/dL, even though she received 8 units of red blood cells and 8 units of fresh frozen plasma. Since she was intubated and we could not assess her GCS score post-intervention, brain CT scan was repeated to follow the traumatic brain injury. It showed massive intracranial hemorrhage that occupied the bilateral frontal area with penetration to the ventricle and thick subarachnoid hemorrhage in cerebral sulcus, which was fatal (Figure 2A, 2B). She died on the same day due to cerebral herniation.

Discussion

The management of hemorrhagic shock from non-compressible torso hemorrhage requires prompt bleeding control and restoration of sufficient blood volume. Proximal aortic occlusion has been performed by direct aortic clamping via thoracotomy for the bleeding patients presenting with impending cardiovascular collapse, and it can provide temporary hemodynamic stability and permit definitive repair. REBOA has been proven effective in hemorrhage control, and improved survival has been shown in patients with ruptured abdominal aortic aneurysm (AAA) [3,4]. It was first described through a brachial approach by Heimbecker in 1964 [5]. Due to the risk of cerebral or peripheral emboli from the aortic arch or the descending aorta, the femoral route is the first of choice for deploying the endovascular balloon occlusion (EBO) for ruptured AAA. It has been demonstrated that the advantages of EBO over conventional techniques include the ability to perform the procedure under local anesthesia, speed and effectiveness in achieving

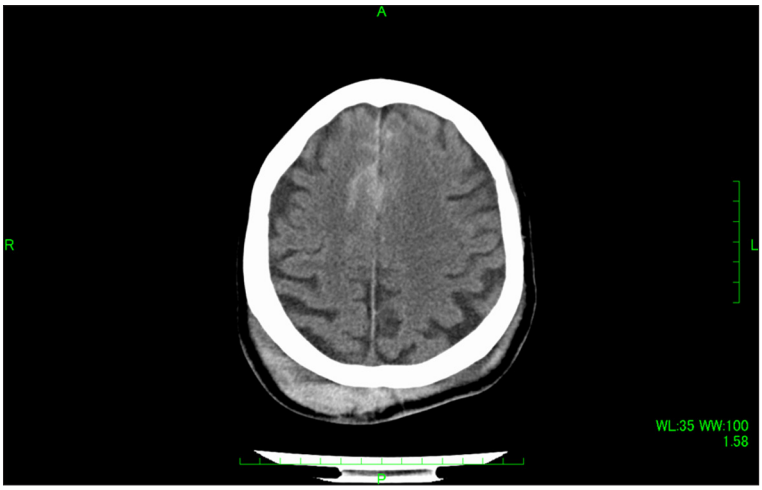

Figure 1. Initial head CT scan showed subarachnoid hemorrhage and small contusion.

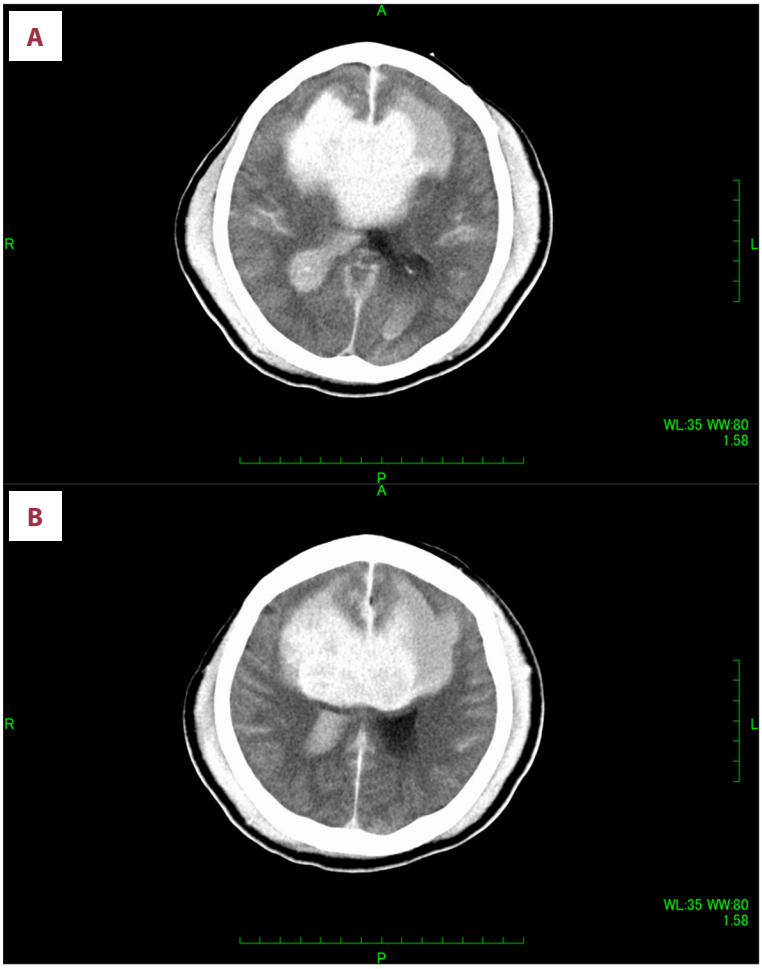

Figure 2. (**A, B**) Subsequent head CT scan showed massive intracranial hemorrhage with penetration to the ventricle.

hemodynamic stability, and use with conventional open or endovascular repair. Ruptures of the occlusion balloon have occasionally been reported as complications of EBO, which can be avoided by monitoring the inflation pressure [6]. There are also reports of the use of REBOA in the setting of postpartum hemorrhage [7], pelvic surgery [8], and hepatobiliary surgery [9]. The use of REBOA in the setting of hemorrhagic shock in trauma population was first reported in 1954 during the Korean War [10], but it has been ignored for a long time due to lack of supportive data, lack of familiarity with the technique, the potential for visceral ischemia with irreversible damage, and the high complication rate (35%) [11]. Recently, Martinelli et al. described their experience with the use of REBOA in 13 patients with hemorrhagic shock from pelvic fracture and reported significant improvement in systolic blood pressure and a survival rate of 46% [12]. In the case series on the use of REBOA, Brenner et al. reported a survival rate of 66% in six patients with both blunt and penetrating trauma [1]. These clinical reports have demonstrated that REBOA is a technically feasible method for proximal aortic occlusion for the management of non-compressible hemorrhage from the abdomen and pelvis, and have resulted in reemergence of the use of REBOA in the trauma population. In addition, the increased availability of and familiarity with endovascular techniques have also played a role in widespread REBOA use.

From a technical point of view, it is unclear that who should perform the REBOA, what the standards should be for training, and what equipment should be prepared. There are various reports that REBOA has been performed by an emergency physician, a trauma and acute care surgeon, and an interventional radiologist [13]. Also, it has been performed both in the emergency department and the operating room depending on institutional capabilities. Specific training courses for fundamental endovascular techniques have been implemented in some countries, but they are not yet widespread. Though REBOA can be placed blindly, it is safer to use fluoroscopy or digital X-ray when introducing REBOA, and not all facilities can provide these settings. A balloon that can be passed through a 7 French sheath is now available in Japan and has already been used in clinical practice. This heterogeneity of conditions surrounding REBOA could potentially affect the results from use of this new device.

A Joint Theater Trauma System Clinical Practice Guideline indicates that REBOA be considered as an alternative to resuscitative thoracotomy in the setting of extrathoracic blunt or penetrating injury and severe shock [14]. There is no clear evidence for REBOA use in the patients with injuries above the diaphragm. It is reported that the deployment of REBOA in the setting of thoracic hemorrhage is not appropriate and potentially dangerous because it could exacerbate hemorrhage from thoracic great vessels [2]. Physiologically, the occlusion of the aorta results in an increase in coronary blood flow, cardiac output, mean arterial pressure, carotid blood flow, and partial oxygen pressure of the brain. In this case, REBOA was introduced to control bleeding from pelvic fracture until the transarterial embolization was completed. Systolic blood pressure was 60 to 80 mm Hg prior to the balloon first being inflated, and it came up to more than 180 mm Hg with the REBOA as well as the blood transfusion. The blood pressure fluctuated during the intervention but constantly remained high, and the subsequent CT scan showed massive intracranial hemorrhage with penetration to the ventricle. This suggests that the REBOA can raise the carotid blood flow and pressure, and can worsen the intracranial bleeding. It also suggests that REBOA could worsen the bleeding above the balloon secondary to aortic occlusion if there is an injury. There is no clear evidence or guideline about how high or low the blood pressure should be maintained while inflating the balloon, especially for patients with injuries above the diaphragm. In addition, not only the increased blood pressure or blood flow but also the patient's conditions are key for worsening of the hemorrhage during the trauma resuscitation. In this case, the patient became coagulopathic during the resuscitation, and it could have made her intracranial bleeding worse. We should keep in mind that patients' conditions such as coagulopathy, acidosis, or hypothermia are the crucial factors.

While REBOA has some important roles in those trauma populations with non-compressible torso hemorrhage, there must be some concern about overestimating REBOA use in severe hemorrhagic patients. We should keep in mind that the rules of aortic occlusion are (1) it does not repair bleeding, (2) it only buys you time, (3) it allows you to catch up, and (4) you still have to stop the bleeding. It is always important that a new technique be rigorously evaluated before its widespread adoption.

Conclusions

REBOA is now considered as an alternative to resuscitative thoracotomy or even widely indicated to control hemorrhage. We should be more cautious about using REBOA for polytrauma patients, especially with injuries above diaphragm. It could make the hemorrhage worse, increasing blood flow and mean arterial pressure. Further research assessing its potential complications and safety will be required to elucidate clear indications for REBOA in trauma patients.

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