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CASE REPORT

First successful emergency room application of resuscitative endovascular balloon occlusion of the aorta (REBOA) in severe postpartum hemorrhage in South Korea: a case report

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Abstract

Background: Postpartum hemorrhage (PPH) is a critical obstetric emergency that may lead to significant maternal morbidity and mortality. Severe PPH, defined as substantial blood loss and the need for multiple blood transfusions, requires immediate and effective intervention to prevent rapid deterioration and death. Resuscitative endovascular balloon occlusion of the aorta (REBOA) has emerged as a novel technique for the control of severe hemorrhage and stabilization of patients in critical conditions, including those with severe PPH. **Case**: We report the case of a 40-year-old primigravid patient at 40 weeks gestation who presented with uncontrollable vaginal hemorrhage following normal delivery at a rural hospital. Initial attempts at hemostasis failed, and the patient was transferred to our hospital with hemorrhagic shock. Upon arrival, her vital signs indicated severe hemodynamic instability, and arterial blood gas analysis confirmed critical acidosis and shock. An emergency medicine physician requested that the trauma team initiate REBOA. A trauma surgeon inserted a balloon catheter into the right femoral artery and positioned the balloon in zone 1, achieving immediate hemodynamic stabilization. The balloon was later repositioned to zone 3 to balance perfusion and hemorrhage control. This intervention allowed for successful surgical management, including bilateral internal iliac artery ligation and hysterectomy. Despite the postoperative development of abdominal compartment syndrome and acute kidney injury, the patient recovered under intensive care, continuous renal replacement therapy, and subsequent hemodialysis. **Conclusions**: REBOA is a valuable adjunct to the management of severe PPH, offering rapid hemodynamic stabilization and a critical window for surgical repair. The successful outcome in this patient demonstrates its potential as an effective emergency intervention, emphasizing the importance of rapid deployment of trained personnel to improve maternal outcomes in patients with severe obstetric hemorrhage.

Keywords

Postpartum hemorrhage; Resuscitative endovascular balloon occlusion of the aorta (REBOA); Hemorrhagic shock; Emergency medical services; Surgical procedures; Operative

1. Introduction

Postpartum hemorrhage (PPH) remains a leading cause of maternal mortality and morbidity worldwide, particularly in low-resource settings where access to advanced medical care is limited [1, 2]. Defined as blood loss exceeding 500 mL following vaginal delivery or 1000 mL after cesarean section, PPH can lead to severe hemodynamic instability and multi-organ failure if not managed promptly and effectively [3, 4]. Despite advances in obstetric care, severe PPH is particularly alarming because it can be fatal if not managed promptly [5]. The main management strategies for PPH include pharmacological interventions, mechanical methods, and surgical techniques; however, these may not be available, and alternative or adjunctive approaches should be explored [6, 7].

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is emerging as a promising technique for the control of life-threatening bleeding in trauma surgery [8]. While traditionally used to treat trauma and gastrointestinal bleeding, the application of REBOA to obstetric hemorrhage is gaining traction, demonstrating its potential for prophylactic and therapeutic use in the management of severe PPH [9,

10]. However, reports on the application of REBOA for life-threatening, severe PPH at the emergency department level are rare.

This case report describes the first successful use of REBOA at the emergency department level in Korea in a patient with severe PPH who presented with uncontrolled vaginal bleeding and hemorrhagic shock after delivery. The strategic application of REBOA facilitated adequate hemodynamic control throughout the surgical procedure, highlighting its potential as an effective intervention in emergency settings.

2. Case report

A 40-year-old primigravid patient at 40 weeks gestation was admitted to our hospital with uncontrollable vaginal hemorrhage after a normal delivery at a local obstetrics and gynecology clinic. Initial attempts at hemostasis at a rural hospital failed, leading to suspected PPH. She was transferred with surgical pads inserted into the vagina for hemorrhage control. Upon arrival, her heart rate was 133 beats/min, respiratory rate was 30 breaths/min, and blood pressure was not measurable. Arterial blood gas analysis showed a pH of 6.93, base excess of −22.4 mmol/L, lactate levels of 11.8 mmol/L, and hematocrit of 15%, indicating hemorrhagic shock. Her initial hemoglobin level was 4.4 g/dL, platelet count was 118,000/μL, and prothrombin time (PT, international normalized ratio) and activated partial thromboplastin time (aPTT) were 17.2 s (1.51) and 28.8 s, respectively. The massive transfusion protocol was immediately initiated. Simultaneously, tranexamic acid was administered. However, her blood pressure remained unmeasurable, and the heart rate further increased to 140 beats/min. An emergency medicine physician contacted the gynecologist while simultaneously requesting the trauma team to initiate REBOA. Another emergency medicine physician attempted central venous catheter placement in the right internal jugular vein. A trauma surgeon was on standby in the emergency department and arrived within 1 min of the consultation call. Severe ongoing vaginal bleeding was observed. The trauma surgeon accessed the right femoral artery and inserted a balloon catheter (RESCUE balloon catheter; Tokai Medical Products, Inc., Japan), positioning the balloon in zone 1. Because REBOA was initiated simultaneously with portable chest radiography, balloon placement in zone 1 was confirmed on imaging. Approximately 20 min after hospital arrival, the systolic blood pressure increased to 180 mmHg post-REBOA, with a visible reduction in vaginal bleeding. Considering the hemorrhagic nature of the shock, the REBOA catheter was repositioned to zone 3 for partial occlusion to maintain perfusion (Fig. 1).

The total occlusion time in zone 1 was 7 min. After switching to partial occlusion in zone 3, the patient's systolic blood pressure stabilized at 130 mmHg. While the trauma surgeon managed the REBOA, a gynecologist prepared for surgery. The patient was moved to the operating room, and partial occlusion was maintained using REBOA. Surgery began 70 min after admission; the bilateral internal iliac arteries were ligated, and a total hysterectomy was performed over a period of 100 min. The trauma surgeon monitored the REBOA during surgery, and when the blood pressure had stabilized, the REBOA was fully deflated. The total REBOA duration was 130 min, with 7 min of complete occlusion in zone 1 and 123 min of partial occlusion in zone 3. Because the blood pressure was stabilized, vasopressors and additional tranexamic acid were not administered during the hysterectomy. Postoperatively, the patient was transferred to the intensive care unit (ICU) with the REBOA catheter in place, and it was removed the following day. On day 3 after admission, the patient developed abdominal compartment syndrome, presumably due to disseminated intravascular coagulation (DIC)-related bleeding, extensive fluid resuscitation, and transfusion-induced bowel edema (Fig. 2).

Concurrent anuria was suggestive of acute kidney injury (AKI). The patient was transferred to the trauma department for further management. Emergency surgery was performed to achieve decompression and hemorrhage. Despite the extensive hematoma and blood loss, no significant bleeding was noted at the previous surgical sites, raising suspicions of DIC (Fig. 3).

Both the small and large intestines showed slight edema but no evidence of ischemia. A large hematoma was surgically evacuated, and bleeding was controlled. Continuous renal replacement therapy (CRRT) was initiated immediately postoperatively and continued for 10 days before hemodialysis (HD) was initiated on day 11. The patient was transferred to a general ward on day 22, and dialysis was discontinued on day 27. She received additional treatment for a surgical site infection and was discharged on day 48. In the first 24 h of admission, the patient received 28 units of red blood cells, 18 units of fresh frozen plasma, and 4 units of platelets; by the time she was discharged, the patient had received 78 units of red blood cells, 60 units of fresh frozen plasma, and 38 units of platelets.

3. Discussion

PPH management requires a multifaceted approach, with early recognition and prompt intervention being critical for the improvement of patient outcomes [11]. Initial management typically involves pharmacological measures, such as intravenous fluids, blood transfusions, and uterotonic agents, to stimulate uterine contractions and reduce bleeding [6]. Surgical interventions may include balloon tamponade, uterine packing and pelvic artery ligation [12]. In cases where these measures fail, hysterectomy might be considered a definitive treatment, although this is a last resort owing to the permanent loss of fertility in women of reproductive age [12, 13].

REBOA involves temporary occlusion of the aorta to reduce blood flow to the lower body, thereby increasing perfusion to vital organs and also stopping peripheral bleeding to stabilize the patient during hemorrhagic shock. This technique, traditionally used to treat trauma and gastrointestinal bleeding, has also shown potential in managing obstetric hemorrhage [14, 15]. REBOA can be used prophylactically and therapeutically in obstetric settings. Prophylactic use during planned cesarean sections in women with complex placental disorders can reduce severe hemorrhage and the need for transfusions and prevent severe PPH [16–18]. Two retrospective studies conducted by a Norwegian group on patients who experienced severe PPH, including after vaginal deliveries and cesarean

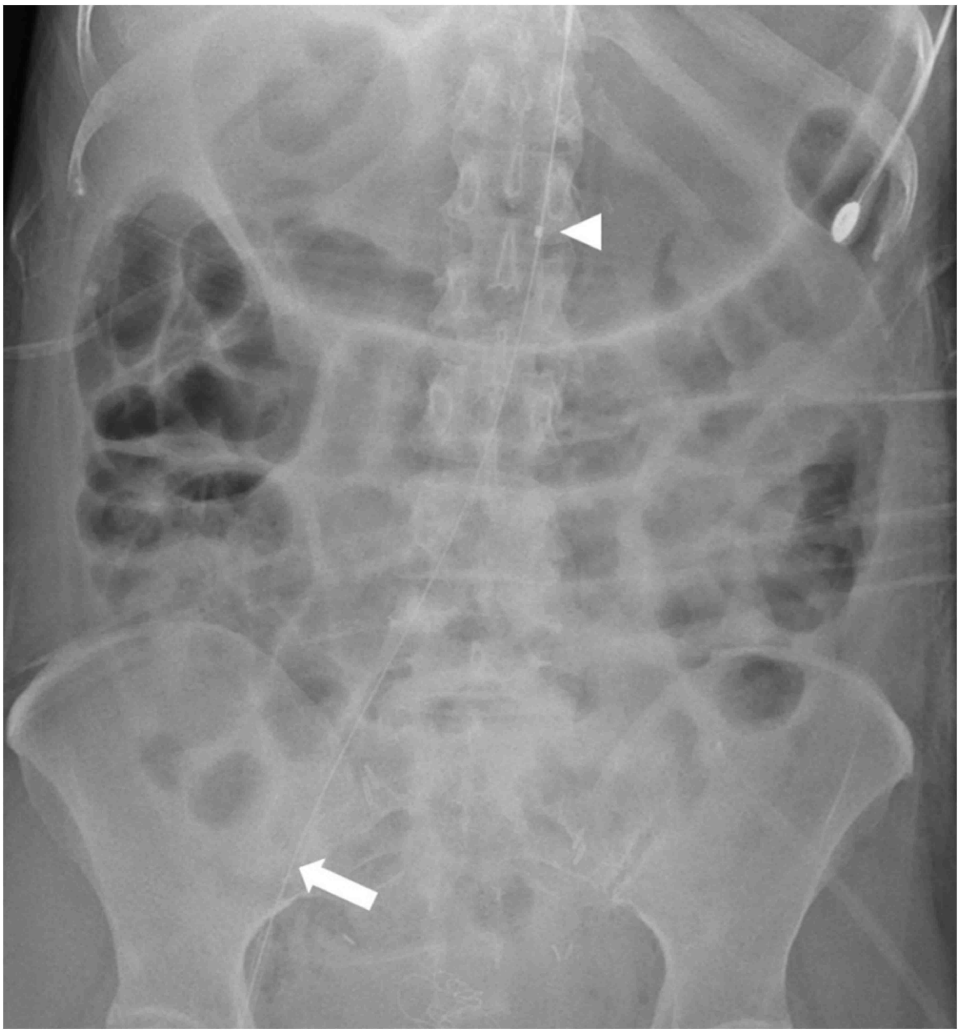

FIGURE 1. The REBOA catheter inserted via the right femoral artery (arrow) is observed, and the balloon (arrowhead) is placed in zone 3.

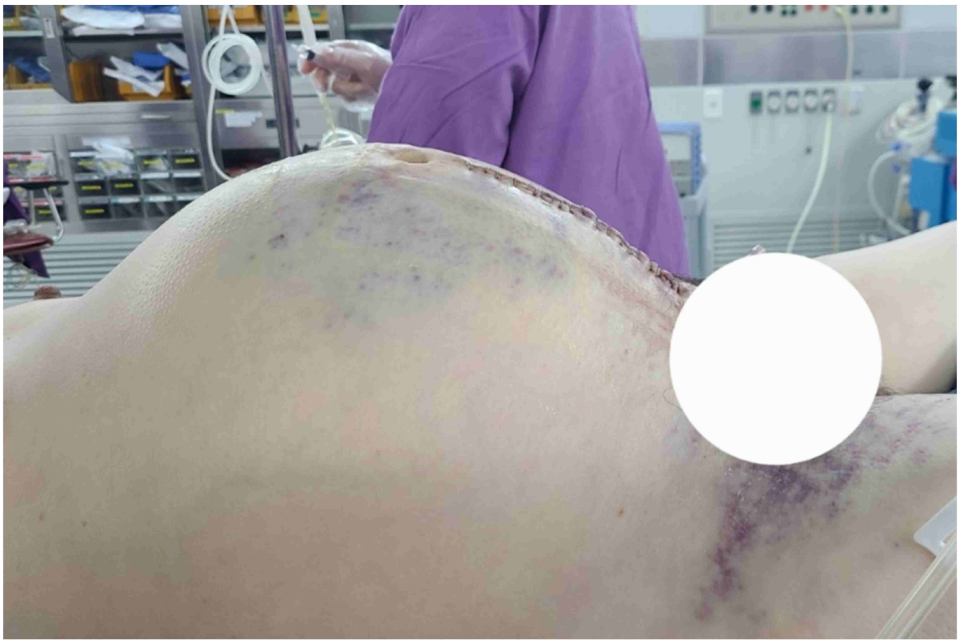

FIGURE 2. Image showing the worsening of the abdominal compartment syndrome 2 days after a total hysterectomy.

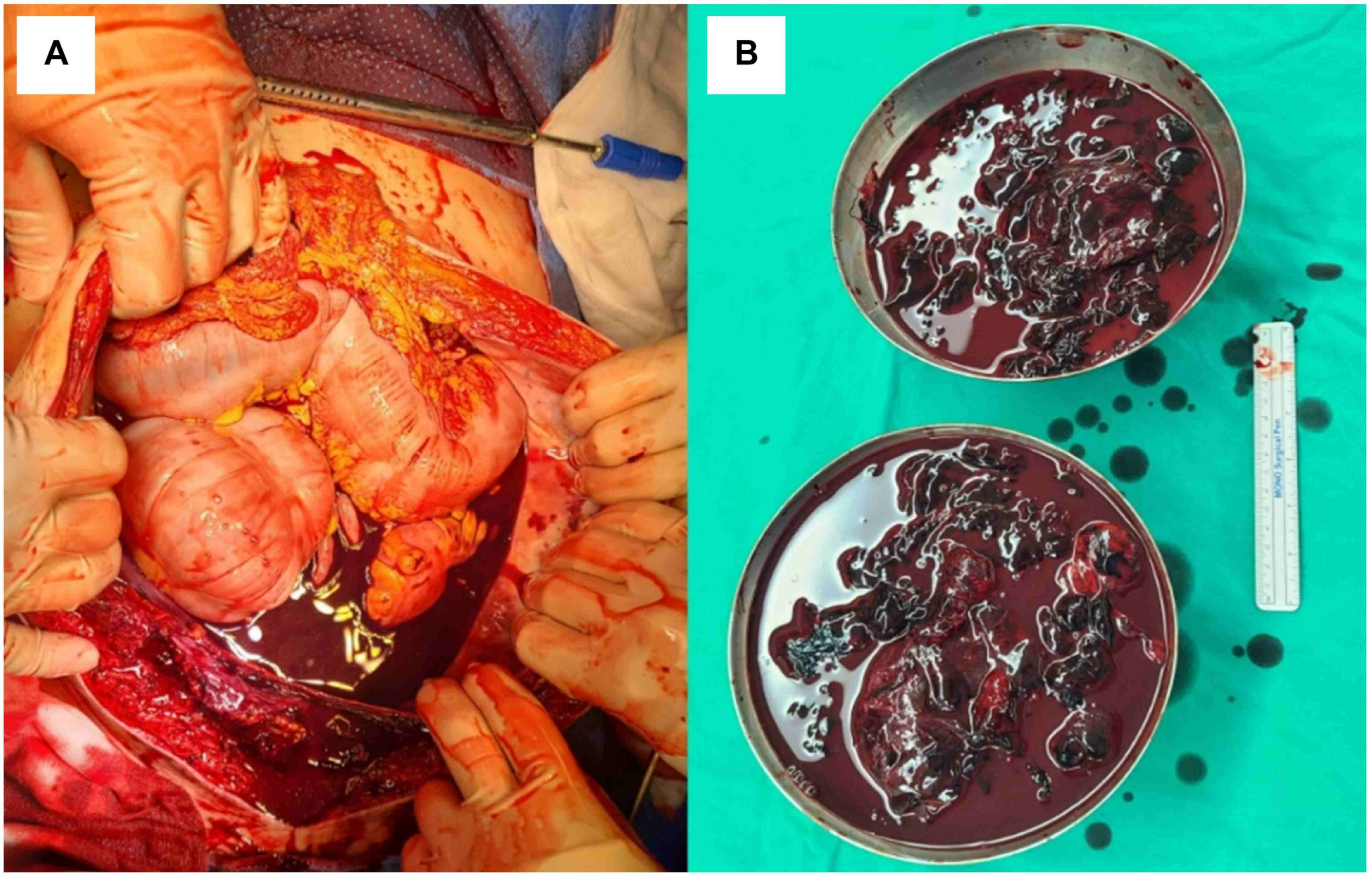

FIGURE 3. Intraoperative clinical photograph. (A) The surgical decompression procedure performed for the abdominal compartment syndrome resulting from hemorrhage induced by disseminated intravascular coagulation (DIC). (B) The hematoma that was evacuated.

sections, demonstrated a 100% survival rate until discharge, emphasizing the safety and feasibility of REBOA. However, in these studies, REBOA was employed after the failure of other methods, such as uterotonics and uterine balloon tamponade, and all procedures were performed in the operating room, indicating that it was not implemented in patients with life-threatening indications of shock in the emergency room. Additionally, in these studies, REBOA was performed by interventional radiologists, and an interventional radiologist was required to carry out the procedure [19, 20]. An analysis of 143 patients who received REBOA for PPH using the Japanese Diagnosis Procedure Combination inpatient database revealed that the procedure was primarily performed by emergency medicine physicians (94%) and was mostly conducted in the emergency room (65%). The in-hospital mortality rate was 7.0%. These results suggest that rapid implementation of REBOA in the emergency department for severe PPH can potentially improve patient outcomes. However, the study did not include detailed clinical information, such as symptoms related to delivery, vital signs, laboratory data and the amount of blood loss, making it difficult to determine the severity of the condition of the patients who underwent REBOA [21].

This case report demonstrates the effective use of REBOA in a life-threatening PPH scenario. A 40-year-old primigravid patient presented with severe hemorrhagic shock after an uncontrollable vaginal hemorrhage following normal delivery. Initial management at a rural hospital failed, necessitating transfer to a higher-level care facility, where REBOA was promptly initiated. The immediate increase in systolic blood pressure and reduction in vaginal bleeding after the implementation of REBOA underscores its usefulness in stabilizing patients to allow for definitive surgical intervention. Reducing hemorrhage time is associated with decreased mortality [22]. Therefore, it is essential to perform REBOA appropriately at the emergency room stage in patients with life-threatening PPH. REBOA is most commonly performed by trauma surgeons, as it may require an incision for femoral artery access, and thus, the expertise of a skilled trauma surgeon is crucial. However, as the application of REBOA expands, similar success rates have been reported by both surgeons and non-surgeons [23]. The availability of personnel may vary depending on the hospital environment. Thus, to rapidly perform REBOA at the emergency room stage in patients with life-threatening PPH, the role of non-surgical physicians will become increasingly important, and appropriate training for these procedures will be crucial.

The trauma surgeon's decision to reposition the REBOA catheter from zone 1 to zone 3 after initial stabilization highlights the importance of tailoring occlusion strategies to maintain perfusion while controlling the hemorrhage. Subsequent surgical interventions, including bilateral internal iliac artery ligation and hysterectomy, were facilitated by the hemodynamic stability provided by REBOA. REBOA is commonly performed in zones 1 or 3. Zone 1 REBOA can lead to

severe visceral ischemia and organ dysfunction, as indicated by increased markers of organ damage, hyperfibrinolysis, prolonged prothrombin times, and higher mortality rates [24, 25]. Conversely, zone 3 REBOA has shown better survival outcomes and fewer complications, such as organ dysfunction and coagulopathies, in recent animal model studies [26]. While both zones have specific risks, zone 3 REBOA generally presents a safer profile with fewer severe complications than zone 1. In our case, the total REBOA duration was 130 min, with complete occlusion in zone 1 for 7 min and partial occlusion in zone 3 for 123 min. The strategic use of REBOA ensured adequate hemodynamic control throughout the surgical process. Despite successful initial management, the patient developed abdominal compartment syndrome on day 3, likely due to DIC and extensive fluid resuscitation. This complication necessitated emergency decompressive surgery, during which a large hematoma was evacuated, and continuous renal replacement therapy was initiated. The patient eventually recovered, highlighting the benefits and challenges associated with REBOA.

The use of REBOA, in this case, underscores its potential as a life-saving adjunct in the management of severe PPH, particularly when conventional measures fail. However, this study had several limitations. First, this was a single-case report, which limits the generalizability of the findings. Larger multicenter studies are necessary to better describe the efficacy and safety of REBOA in obstetric hemorrhages. Second, the implementation of REBOA requires specialized training and expertise that may not be readily available in all healthcare settings, particularly in low-resource environments. Third, the potential complications associated with REBOA, such as ischemia, vascular injury, and reperfusion injury, require careful patient selection and procedural expertise. The long-term outcomes and quality of life of patients undergoing REBOA for PPH require further investigation.

4. Conclusions

REBOA is a valuable adjunct tool for the management of life-threatening PPH. The success of this technique in emergency settings underscores the importance of its rapid deployment by trained personnel, preferably trauma surgeons or emergency medicine physicians, to improve the outcomes of patients with severe obstetric hemorrhage. Further research and standardized protocols are needed to optimize its use and minimize the associated complications, ensuring better patient outcomes in similar critical scenarios.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

SJ and BY—designed the study and collected information about this patient; wrote the original draft. BY and JL—reviewed and revised the manuscript and supervised the study. All authors approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the ethics committee at the Gachon University Gil Hospital, College of Medicine, Incheon, Korea (protocol code GCIRB2024-172). The patient provided informed consent for the study's content to be published and the disclosure of clinical images.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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