Case Report

Vol. 6, No. 3; 2022; pp 140–143
DOI: https://doi.org/10.26676/jevtm.268

Prone Zone 3 REBOA Rescue for Postoperative Hemorrhagic After Sacrococcygeal Tumor Resection

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In this report, we describe a 41-year-old man who underwent resection of a large chordoma. During his post-operative recovery, he experienced delayed-onset non-compressive pelvic hemorrhage in the surgical resection bed resulting in nerve root compression. Zone 3 REBOA was prepositioned intra-operatively prior to placing the patient in the prone position for hematoma evacuation and exploration for surgical hemostasis. The balloon was completely inflated to facilitate exposure to the site of hemorrhage in this patient with a high risk for neurologic injury during this operative re-exploration.

Keywords: *Resuscitative Endovascular Balloon Occlusion of the Aorta; REBOA; Hemorrhagic Shock; Postoperative Hemorrhage; Chordoma*

Received: 19 November 2022; Accepted: 24 December 2022

INTRODUCTION

The use of resuscitative endovascular balloon occlusion of the aorta (REBOA) as an adjunct for management of hemorrhagic shock from blunt or penetrating trauma is well described [1,2]. However, fewer reports exist on the use of REBOA in management of postoperative hemorrhage from non-compressible sites. Traditionally, the treatment of postoperative hemorrhage has entailed balanced blood product resuscitation, correction of coagulopathy, and surgical or endovascular control of the bleeding source [3,4]. In many cases, even when rapid operative or endovascular options are readily available, REBOA can serve as a bridge to definitive hemostasis. Here, we describe the deployment of a Zone 3 REBOA in a patient with major postoperative hemorrhage following resection of a large sacral chordoma.

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CASE REPORT

A 41-year-old man with morbid obesity (body mass index 44) presented for evaluation of significant sacral swelling. He reported a remote pilonidal cyst incision and drainage, and a family history notable for ulcerative colitis (mother) and prostatic cancer (father, grandfather). He underwent several years of outpatient management with oral prednisone for a working diagnosis of chronic coccydynia. Differential diagnosis included lumbar disk herniation or sacroiliitis secondary to inflammatory bowel disease. Eventually, a gluteal soft tissue ultrasound revealed a 18 cm left gluteal soft tissue mass with internal vascular flow. Magnetic resonance imaging (MRI) and computed tomography (CT) of the pelvis further characterized a 18 cm × 17 cm × 14 cm

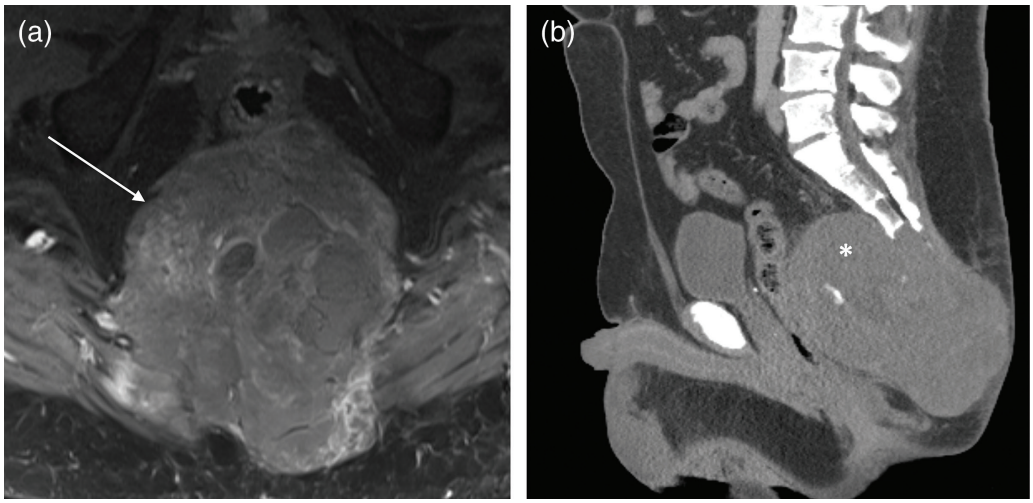

Figure 1 Representative axial MRI image (**a**, arrow) and sagittal CT image (**b**, *) showing the large sacral chordoma.

well-circumscribed pre-sacral mass involving the coccygeal tip, extending posteriorly to involve the sacral nerve roots (Figure 1*a,b*). He was then referred to our tertiary medical center for surgical evaluation and management.

Image-guided core biopsy of the mass confirmed the diagnosis of a chordoma. He underwent open excision of the sacral chordoma with bilateral S2 nerve sacrifice and sacrectomy by a multi-specialty team using the StealthStation surgical navigation system (Medtronic, Minneapolis, MN, USA). The chordoma was adherent to the distal rectum, so this was resected and repaired intraoperatively with subsequent laparoscopic diverting loop ileostomy. The total operative time was 10 hours with estimated blood loss of 1.5 L. The patient received 14 U packed red blood cells, 12 U fresh frozen plasma, and 2 U of platelets. He was transferred to the neurosurgical intensive care unit (Neuro ICU) postoperatively and was extubated on postoperative day (POD) 1.

The patient continued to recover expectedly until POD 8 when he was diagnosed with an acute deep venous thrombosis of the right gastrocnemius vein as well as a left upper lobe segmental pulmonary embolism. An unfractionated heparin infusion was initiated. On POD 9 the Neuro ICU team noted increased sanguineous drain output; CT angiography reveled a 15 cm × 15 cm × 8 cm hematoma in the surgical resection bed but no active extravasation. Later, while being turned in bed, the patient became acutely hypotensive, with increased sanguineous output noted from the pelvic Jackson–Pratt drains along with frank bleeding from the incision and per rectum. He also endorsed new severe right lower extremity radiculopathy, raising concern for neural element compromise.

The patient was tachycardic and hypotensive requiring vasopressors, but he remained interactive. Blood product transfusion was initiated, and the massive transfusion protocol was activated. Given new neurologic symptoms and ongoing rapid blood loss, open surgical exploration was deemed necessary to relieve any compression on the neural elements and to achieve hemostasis. While the operating room was being prepared, early femoral arterial access was obtained for placement of a REBOA catheter as a bridge to definitive surgical hemostasis. Consent was waived in the emergency setting, and a 7 French (Fr) arterial access sheath was placed in the patient's left femoral artery under ultrasound guidance. The femoral sheath was secured in place using silk suture and a clear, sterile surgical dressing.

The patient's hemodynamics improved with resuscitation, so Zone 1 REBOA was deferred. We decided instead to use Zone 3 REBOA to facilitate surgical exposure and hemostasis during prone positioning. After induction of general anesthesia in the operating room, a REBOA catheter (Prytime Medical Devices, Inc., Boerne, TX, USA) was introduced through the left femoral sheath and advanced to the 30 cm corresponding with distal aortic positioning. The balloon was inflated with a small volume of saline and the catheter was seated at the aortic bifurcation with an attendant decrease in pulsations on the arterial line tracing from the access sheath. The balloon was then deflated to minimize inflation time during positioning. The catheter was anchored with multiple sutures including one in the bifurcation between the balloon and pressure monitoring ports. A surgical team member was dedicated to monitoring the catheter during all positioning maneuvers.

Following hematoma evacuation in the prone position the patient's hemodynamics worsened and the source of bleeding was confirmed to be adjacent to multiple nerve roots, presumably from the pudendal artery. To facilitate visualization and operative hemostasis near

Figure 2 Intraoperative vital signs showing the abdominal aortic pressure above (109/61) and below (49/41) the Zone 3 balloon. Complete occlusion was confirmed with the lack of pulsatile flow distal to the balloon.

multiple nerve roots, the balloon was inflated to achieve distal aortic occlusion for a total time of 34 minutes (Figure 2). After hemostasis was achieved with a combination of bipolar cautery and ligation of the pudendal artery, the patient was returned to the supine position and the catheter was removed, with both catheter tip and the balloon intact. Total operative time was approximately 4 hours, estimated blood loss was 1.5 L, preoperative hemoglobin concentration was 10.1 g/dL and postoperative hemoglobin was 10.7 g/dL, postoperative platelet count was 152, and the international normalized ratio was 1.2 following intraoperative administration of 3 U packed red blood cells, 5 U fresh frozen plasma, 1 U cell saver, and 1.5 g calcium gluconate. The 7 Fr access sheath was removed several hours later in the Neuro ICU once hemostasis was assured with no evidence of continued coagulopathy.

Following this procedure, systemic anticoagulation was held, and an inferior vena cava (IVC) filter was placed to mitigate the risk of further venous thromboembolic events. Unfractionated heparin infusion was resumed on POD 8 after the REBOA procedure. On POD 12 once assured that the patient was neurologically stable while on therapeutic anticoagulation, he was transitioned to low molecular weight heparin.

In the subsequent weeks, the patient underwent embolization of a pudendal and inferior gluteal artery pseudoaneurysms, completion abdominoperineal resection with ileostomy take-down and end-descending colostomy, and complex wound closure with an omental flap. He was discharged to an acute rehabilitation facility in stable condition on hospital day 68.

Ethical Approval and Informed Consent

Ethical approval and informed consent were not required as all data were anonymized. The patient endorsed description of his clinical course for educational purposes.

DISCUSSION

The safety of REBOA for use in civilian and military trauma systems as an adjunct for the control of non-compressive truncal hemorrhage has been well established [1,2,5,6]. Here, we describe the novel use of REBOA as a bridge to definitive surgical hemostasis in a non-compressible pelvic hemorrhage following resection of a large sacrococcygeal chordoma. Pre-positioning the REBOA catheter in Zone 3 prior to prone positioning afforded maximal flexibility with our hemostatic options on exploring the surgical site. Once the area of hemorrhage was exposed, it became clear proximal vascular control was needed to permit hemostasis without risking nerve injury. We thus inflated the balloon and were then able to control the site of hemorrhage from the pudendal artery precisely.

The indications and benefits for the use of REBOA as an adjunct for managing acute non-traumatic exsanguination are still emerging. Several case series describe the use of REBOA in postpartum hemorrhage and upper gastrointestinal bleeding [7,8]. A recent multi-institutional review of 37 patients with acute non-traumatic hemorrhage in which REBOA was deployed (43% gastrointestinal bleeding, 22% Zone 3) found its use was associated with an improvement in hemodynamics in 80% of cases in which the balloon was inflated, with a mean inflation time of 35 minutes [9]. None of the Zone 3 deployments resulted in patient death, whereas Zone 1 deployment was associated with a 50% mortality rate. This presumably correlates with the more acute nature of gastrointestinal bleeding events (i.e. variceal hemorrhage or bleeding secondary to peptic ulcer disease), complications (i.e. aspiration), as well as the patients comorbidities (i.e. cirrhosis and portal hypertension). Interestingly, seven (19%) of the REBOA insertions in this series were prophylactic and did not result in balloon inflation [9].

Additional case series cite similar instances in which the use of REBOA may prove advantageous, such as in obstetric emergencies, upper gastrointestinal hemorrhage, ruptured aortic aneurysms, and even in non-traumatic cardiac arrest. In one series of 11 patients in which REBOA was utilized to help control non-traumatic

hemorrhage, there were no complications directly related to vascular access, and the overall in-hospital mortality was 65% [10]. Partial balloon occlusion has also been described as an adjunct to achieving hemodynamic stability while potentially sparing the risk of reperfusion injuries [11].

CONCLUSIONS

In this case report, we describe REBOA as a bridge to surgical hemostasis in a patient with severe, life-threatening postoperative hemorrhage following resection of a large sacral chordoma. Zone 3 REBOA insertion in this case allowed for more precise localization of the source of hemorrhage near multiple nerve roots. This report provides further evidence for expanded applications for REBOA in non-traumatic hemorrhagic shock. Larger studies are warranted to quantify the potential morbidity or even mortality benefits in these patients.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

The authors of this publication have no disclosures nor conflicts of interest relevant to the topic of this publication.

Funding

This case report was not supported by any active grants or funding mechanisms.

Author Contributions

All authors have substantially contributed to the study and manuscript.

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