

# Endovascular Resuscitation for Ruptured Abdominal Aortic Aneurysms with Main Stent-Graft and REBOA via Single-Sided Access

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**Background:** Aortic balloon occlusion or resuscitative endovascular balloon occlusion of the aorta (REBOA) for hemorrhage control during endovascular aortic repair (EVAR) is a technique that has been used for decades for ruptured abdominal aortic aneurysms (rAAA). This usually requires bilateral femoral access, however, when only single-sided vascular access can be obtained this complicates the procedure if these techniques are to be used. We present two cases of single-sided vascular access, recently performed at our institution, using simultaneous REBOA and aortic stent-graft placement during EVAR in rAAA.

**Method:** This is a description of two clinical cases where REBOA and EVAR were performed through single-sided vascular access for the treatment of rAAA at Örebro University Hospital between March 2018 and June 2018.

**Conclusion:** This case report demonstrates that despite the limitation of single-sided access, an aortic stent-graft can be placed for treatment of a rAAA during continuous aortic occlusion with REBOA, facilitated by using a multidisciplinary EndoVascular resuscitation and Trauma Management (EVTM) team approach.

**Keywords:** rAAA; EVAR; REBOA; Hemorrhagic Shock; Endovascular Resuscitation

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## INTRODUCTION

The incidence of ruptured abdominal aortic aneurysms (rAAA) has in recent years declined, at least in Scandinavia, however, the mortality rate remains high [1]. Some studies have suggested lower mortality rates with endovascular aortic repair (EVAR) of rAAA but a complete consensus is yet to be established [2–6]. Previously, EVAR of rAAA has been viewed as unsuitable for those

presenting with profound hypotension due to the increased time involved for preparation. However, some centers treat all rAAA using EVAR and hybrid techniques with excellent results [2]. Intraluminal aortic balloon occlusion is a technique that has been used for decades to gain proximal aortic control of hemorrhage in rAAA [7–9]. Resuscitative endovascular balloon occlusion of the aorta (REBOA) or aortic balloon occlusion (ABO) may potentially help to stabilize the profoundly hypotensive patient and allow time for transport, diagnosis and appropriate preparation and execution of an endovascular repair [10–12]. This usually requires the aortic stent-graft to be inserted from the contralateral groin and a second occlusion balloon to be inflated inside the main body of the stent-graft in order to continue aortic occlusion and simultaneous modulation of the graft while the more proximal balloon is deflated and withdrawn. However, when only single-sided vascular access can be obtained this complicates the procedure if these techniques are to be used. We present two cases of single-sided vascular access,

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recently performed at our institution, using simultaneous REBOA and aortic stent-graft placement during EVAR in rAAA. This illustrates how endovascular techniques may be useful in extreme situations and how access difficulties can be solved to facilitate endovascular treatment.

## PATIENTS AND METHODS

This is a description of two clinical cases where REBOA and EVAR were performed through a single-sided vascular access for the treatment of rAAA at Örebro University Hospital. Ethical committee approval was obtained for all REBOA and/or EVAR procedure patients. Both patients were treated with REBOA procedures performed by the on-call vascular surgeon and EVAR was performed in the hybrid operating room.

## RESULTS

### Case 1

A 76-year-old male who 8 years previously had been operated with EVAR for an infrarenal abdominal aortic aneurysm, and later received a cross-femoral venous bypass because of a unilateral limb graft occlusion, presented to the emergency department with a distended abdomen after a sudden debut of abdominal pain radiating to the back. An acute computed tomography (CT) scan revealed a rAAA with ongoing extravasation and massive retroperitoneal hematoma caused by a type Ib leakage and dislocated graft limb into the aneurysmal sack. The patient was initially hemodynamically stable and was transported to the hybrid operating room where he quickly deteriorated with a systolic blood pressure (SBP) of around 40 mm Hg. A 7 Fr sheath was placed in the right femoral artery proximal to the cross-femoral bypass anastomosis using ultrasound guidance. Zone 3 REBOA with total occlusion was performed and the patient's SBP immediately stabilized around 90 mm Hg. A 4 Fr sheath was placed proximally to the 7 Fr sheath using ultrasound guidance and was later upgraded to a 16 Fr DrySeal sheath. The REBOA was partially deflated to let a guidewire pass and the dislocated graft limb was extended with a GORE™ 16 mm bridging-graft and a 20 mm iliac-graft after mapping of the internal iliac artery. The REBOA was then deflated and removed after a total occlusion time of 25 minutes with the patient remaining hemodynamically stable. The whole procedure was done under local anesthesia and the patient received 2 units of packed red blood cells (PRBC). The patient was then taken to the intensive care unit where 3 hours later he developed abdominal compartment syndrome and anuria. A decompressive laparotomy was subsequently performed by the on-call vascular surgeon and the abdomen was left open with a Bogota Bag in place. Within 30–40 minutes the patient started producing



**Figure 1** CT scan showing the use of REBOA in a ruptured abdominal aortic aneurysm for hemodynamic stabilization.

urine, a second-look laparotomy the following day showed no signs of ischemic bowel and the abdomen was closed. Because of elevated infectious and liver values, a CT scan was performed showing signs of acute pancreatitis, treated conservatively with intravenous fluid administration, analgesics and avoidance of oral fluid or food intake. The remainder of the patient's in-hospital care was uneventful and at 30 days post-intervention, he was recovering well, with no signs of endoleak seen on CT and ultrasound examinations, and a functional cross-femoral venous bypass.

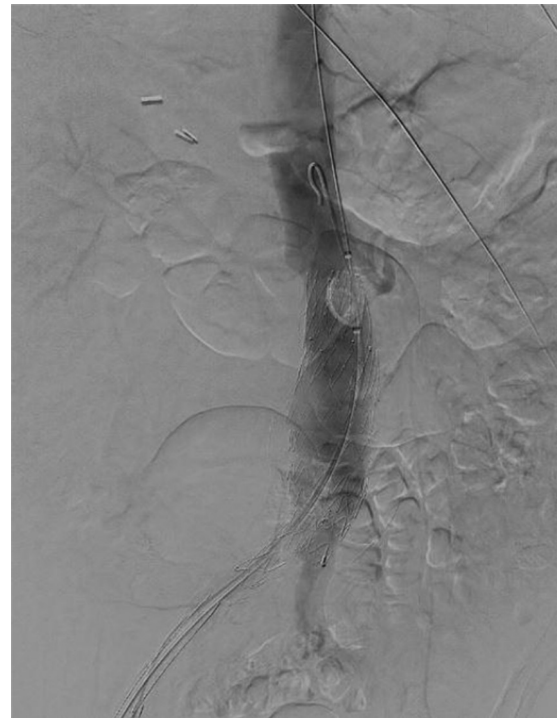
### Case 2

A 63-year-old male was seen to swerve his car to the side of the road by a passerby. He was found in an unconscious state and later transported by ambulance to the emergency department. During transport, the patient was tachycardic (125 bpm) with a SBP of 90/55 and a faint palpable carotid pulse. Upon arrival at the emergency room, 57 minutes after the emergency call was received, he was hemodynamically unstable with a SBP of 40 mm Hg and GCS 3. The patient was intubated, an 8 Fr sheath was placed by a blind puncture in the right femoral artery on the first attempt and Zone I REBOA was performed (Figures 1 and 2), stabilizing the SBP between 60 and 70 mm Hg. A CT scan revealed a previously unknown infrarenal rAAA with ongoing extravasation and massive retroperitoneal hematoma, and the



**Figure 2** 3D image of inflated REBOA in Zone 1.

patient was transported to the hybrid operating room where a massive transfusion of PRBC, fresh frozen plasma (FFP) and platelets (PLT) was initiated. Blood gas analysis showed severe metabolic acidosis with increasing levels of lactate. Ultrasound of the left femoral artery showed signs of significant stenosis and no blood flow, with attempts to puncture not resulting in any backflow. With the REBOA in place, the decision was made to work through a single-sided access and a 36 mm COOK Zenith Alpha™ bifurcated main body graft was introduced proximally to the 8 Fr sheath through a separate puncture in the right femoral artery and deployed in the aorta. The REBOA was deflated to allow angiographic visualization of the renal arteries and graft placement, with the patient's SBP immediately decreasing to 50 mm Hg. Stent-graft migration was noted and a 36 mm aortic cuff was placed above the bifurcated graft below the level of the renal arteries. The REBOA was removed and a new aortic occlusion balloon was placed in the main body of the aortic stent-graft below the renal arteries to allow visceral perfusion (Figure 3). Due to the occlusion of the left femoral artery, ultrasound-guided puncture of the left external iliac artery was performed in order to catheterize and extend the main stent-graft with an iliac limb extension to the left common iliac artery. A new angiography was performed revealing no signs of endoleakage. The aortic occlusion balloon was removed and the vascular accesses sealed, with the patient remaining stable



**Figure 3** Angiography showing Zone 3 partial ABO and parallel guide wire through a single-sided access.

with a SBP of 70 mm Hg. During the procedure, a total of 14 units PRBC, 14 units FFP and 3 units of PLT had been administered. By this time, the patient had developed an extended abdomen with obvious signs of abdominal compartment syndrome, acidosis, and increasing lactate levels. During preparation for a decompressive laparotomy, the patient's SBP slowly started to decrease despite high levels of inotropic therapy and he later died.

## DISCUSSION

Many patients who reach hospital with a rAAA are usually hemodynamically stable enough to allow proper diagnostics and preparation for surgery, however, some are hemodynamically unstable with profound hypotension and impending cardiac arrest [13]. This has previously been a strict indication for open aortic repair, but with the introduction of compliant occlusion balloons for hemodynamic stabilization endovascular definitive treatment has become a tempting option. When simultaneous REBOA and EVAR is performed for rAAA, this usually requires bilateral femoral access, with an aortic occlusion balloon inserted on one side and the aortic stent-graft inserted from the contralateral groin [2]. When faced with access complications in a hemodynamically unstable patient, many would choose the traditional open approach to aortic repair as alternative techniques have previously been sparse [14]. EVAR has in recent systematic reviews been considered a safe method of treating rAAA and should be preferred when technically



feasible [15]. In this report, we present the technique of single-sided simultaneous deployment of both REBOA and an aortic stent-graft with continuous aortic occlusion in two recent cases of rAAA with hemodynamic instability, impending cardiac arrest and unilateral iliac or femoral artery occlusion. This allowed the patients to stabilize, gaining time for proper EVAR execution. Non-compressible massive hemorrhage with hemodynamic instability is one of the most challenging conditions for physicians to deal with. This requires a cooperative relationship between a multidisciplinary team to ensure timely resuscitation, diagnosis, preoperative and perioperative support, definitive operative treatment, and excellent postoperative care. Both cases presented were facilitated thanks to the EndoVascular resuscitation and Trauma Management (EVTM) concept practiced at our institution [16–21]. Resuscitation by early vascular access and REBOA placement by the vascular surgeon, simultaneous circulatory management by the anesthesiologist in addition to rapid diagnostic imaging and working through single-sided accesses allowed EVAR to remain the optimal treatment option in both cases.

## CONCLUSION

This case report demonstrates that despite the limitation of single-sided access, it is technically feasible for an aortic stent-graft to be placed for treatment of a rAAA during continuous aortic occlusion with REBOA, facilitated by using a multidisciplinary EVTm team approach.

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