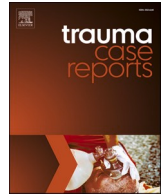




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Case Report

Resuscitative endovascular balloon occlusion of the aorta (REBOA) may also have a place outside major trauma centers - A case report from a Finnish rural hospital

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ABSTRACT

The recent adoption of endovascular and hybrid methods in the management of massive bleeding following trauma to the torso and junctional areas has been a major advance in trauma care. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is one tool to tackle immediate exsanguination in such cases. To take advantage of such methods, rapid femoral artery access is crucial.

In rural hospitals a trauma surgeon, vascular surgeon and interventional radiologist may not be in the hospital during on-call hours. Furthermore, gaining femoral arterial access is an infrequent procedure for a trauma surgeon working outside major trauma centers. Therefore, it might be difficult to acquire and maintain the requisite skills. However, a consultant anesthesiologist is a member of the trauma team and always on call in our hospital. An experienced anesthesiologist is a valuable asset in ultrasound guided arterial punctures and in inserting intravascular introducer sheaths, as was the case in our patient. To our knowledge, anesthesiologists do not commonly participate in the actual placement of arterial introducer sheaths for REBOA catheters in trauma teams. We wish to bring to notice this hidden asset when a team that does not routinely include a vascular surgeon or an interventional radiologist is treating a seriously injured trauma patient.

We report on a patient who had sustained a shrapnel injury to the groin with massive blood loss. To stop further bleeding and to stabilize hemodynamics, we used REBOA to gain proximal control of the bleeding. As a result, the patient avoided surgical retroperitoneal exposure and a dry surgical field was created. We conclude that REBOA may also have a place in rural hospitals, and that, if necessary, trauma team members may adopt novel roles in the treatment of hemorrhage.

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Introduction

Endovascular methods are increasingly being used in the management of massive bleeding following trauma to the torso and junctional areas [1,2]. REBOA is used to tackle the problem of immediate exsanguination in such cases. It is not merely a tool or a technique but rather a management capability involving several disciplines. Therefore, implementation of REBOA in an institution can be demanding [3]. To overcome this problem, practical guidelines on how to implement REBOA have been published [3–5]. We started implementation with lectures by visiting experts and our first simulation workshops in November 2018. A local protocol was published on the deployment of ER-REBOA™ (Prytime Medical, Boerne, Texas, USA) in September 2019. We finally started using REBOA in October 2019.

Case presentation

The emergency department received a prenotification call 5 min before the patient arrived at the hospital on a weekend morning. A twenty-nine-year old Caucasian female had sustained a shrapnel injury in an accelerator laboratory. A gas purification trap (1000 ml) exploded after a sudden increase in pressure. The victim, an experienced nuclear physicist, was alone at the time of the explosion. A piece of shrapnel from the purification trap struck her left groin causing a major hemorrhage. She reached out to her co-workers, who were about 100 m away, for help. Her profuse arterial bleeding was controlled first by a co-worker and thereafter by a paramedic. A load-and-go method was used to transfer the patient to the hospital, which was 5 min away from the scene of the incident.

Following the prenotification call, a major trauma alert was activated, and the on-call trauma team was assembled [6]. Ideally, a trauma team is led by a senior trauma surgeon. A surgical resident, a senior anesthesiologist and two or three nurses constitute the other members of the team. At the time of this accident, the surgeons and operating room nurses were changing shifts and thus extra hands were available. O-negative blood and fresh frozen plasma were ordered – this hospital does not have a massive transfusion protocol, instead specific blood components are ordered as required.

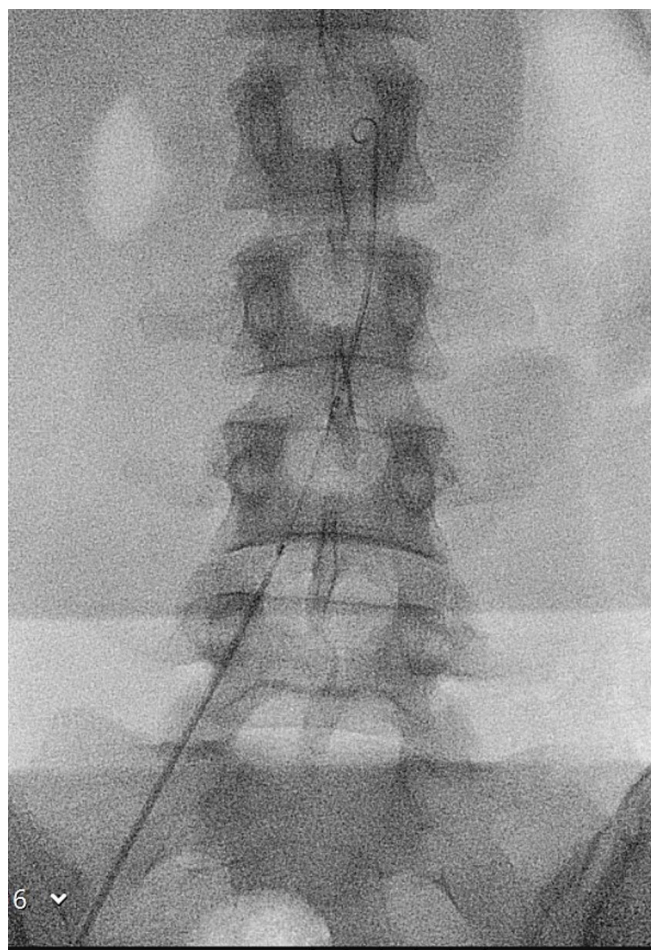


Fig. 1. REBOA catheter en route to zone 3.

On arrival, a paramedic was applying continuous manual pressure to the wound to control the bleeding. The patient was anxious on arrival but soon turned lethargic. An advanced trauma life support (ATLS) -type protocol was conducted to assess the patient's injuries and start resuscitation. A 12-cm-long cut wound bleeding arterial blood was detected in the left groin. eFAST ultrasound was negative, but an immediate CT scan was not possible owing to the patient's unstable hemodynamics. A decision to transfer the patient immediately to the operating room (OR) was made, as the patient was in hemodynamic shock and bleeding could only be controlled by manual compression. A vascular surgeon was called on to come to the hospital and the team was advised to place a 7 Fr introducer sheath in the contralateral common femoral artery for arterial access. This was accomplished under ultrasound guidance in the OR alongside other preoperative preparations by a senior anesthesiologist assisted by a general surgeon and a surgical resident. A few minutes later the vascular surgeon arrived. Arterial systolic pressure measured through the introducer sheath was 46 mm Hg and pulse rate 133/min. A decision to use REBOA was made and an ER-REBOA™ (Prytime Medical) catheter was placed and inflated in zone III. A conventional, non-hybrid OR C arm was used to confirm the position of the catheter (Fig. 1). The patient's hemodynamics responded promptly to the appropriate occlusion of the distal aorta, and 5 min later, with 3 ml inflation of the balloon, systolic blood pressure had risen to 143 mm Hg and pulse rate fallen to 117/min. In addition, bleeding from the injured groin had stopped. The resulting dry surgical field allowed easy access to the injuries. A transection of the first branch of the deep femoral artery was encountered and surgically treated. The psoas muscle was partially cut. Some minor vessel injuries were also detected, but other major vascular structures, including the femoral veins, and femoral nerve were intact.

The REBOA balloon was slowly deflated following discussion with the anesthesiologist. However, the patient did not initially tolerate even the slightest deflation of the balloon, but after 10 more minutes, stepwise deflation was performed with no hemodynamic compromise. The total inflation time of the REBOA was 55 min and finally the balloon catheter was removed.



Fig. 2. Outcome at 6 weeks postoperatively. The shrapnel caused all but the 4 most proximal cm of the scar.

Postoperative CT revealed a small bone avulsion of the left lesser trochanter. Some gas was visible in the left hip joint and in soft tissues in the area as well as on the left iliopsoas muscle. No free gas was observed in the abdominal cavity. An iatrogenic pneumothorax following central venous cannulation during the operation was subsequently treated with pleural drainage. 2500 IU of intravenous heparin was given to prevent thrombosis within the sheath. The sheath was withdrawn and pressure exerted on the puncture site 3 h later in the ICU. No bleeding from the puncture site was encountered and distal vascular status remained intact throughout the treatment process. The patient was discharged home 5 days later. At the 6-week follow-up visit, despite a small, asymptomatic arteriovenous fistula in the puncture site in the right groin, the patient was recovering well (Fig. 2). At 4 months, she had assumed normal daily activities including work and sports.

Discussion

In rural hospitals, a trauma surgeon, vascular surgeon and interventional radiologist may not be in the hospital during on-call hours. In our hospital, a junior surgical resident is on call in the ER for surgical patients and a senior surgical resident is responsible for the surgical wards and OR. Both an orthopedic trauma surgeon and a general surgeon (usually a GI surgeon) are also on call at home with a maximum arrival time of 30 min. Furthermore, a consultant anesthesiologist and an anesthesiology resident are always on call in the hospital.

An experienced anesthesiologist is a skillful resource in performing an ultrasound guided arterial puncture and in inserting an intra-arterial introducer sheath, as was the case in our patient. Placement of a pre-emptive sheath before the arrival of the vascular surgeon saved time. However, the attention required by tunneling must be considered and the person in charge of cannulation and REBOA deployment should not be responsible for other things at that time [4]. To our knowledge, anesthesiologists are not commonly included in a team actively applying endovascular bleeding control. We would like to bring to notice this hidden asset when a trauma team treating a seriously injured patient does not routinely include a vascular surgeon or interventional radiologist.

The REBOA is also associated with adverse effects, such as distal embolisation and lower limb ischemia [7]. However, whether some of the complications are caused by the injury itself or because of the use of REBOA is still debateable [8]. In our patient a minor complication (an AV-fistula with no symptoms) was detected on ultrasound during the follow-up visit, but no major complications requiring an intervention were encountered.

In this case, the patient avoided a retroperitoneal surgical incision to gain proximal control of the bleeding. Because of the REBOA, it was possible to work in a dry surgical field and keep the ongoing blood loss to minimum. We conclude that REBOA may also have a place in rural hospitals and that, when needed, trauma team members may adopt novel roles in the treatment of hemorrhage.

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CRedit authorship contribution statement

Joonas Kuorikoski: Conceptualization, Writing – original draft, Writing – review & editing. **Teemu P. Hevonkorpi:** Writing – original draft, Writing – review & editing. **Fanny Salo:** Writing – review & editing. **Alar Toom:** Writing – review & editing. **Juha Paloneva:** Writing – review & editing. **Tiia Kukkonen:** Writing – original draft, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

- [1] J. Duchesne, S. Taghavi, M. Khan, et al., Circulatory trauma: a paradigm for understanding the role of endovascular therapy in hemorrhage control, *Shock* 56 (1) (2021), <https://doi.org/10.1097/SHK.0000000000001513>.
- [2] M.A. Thraillkill, K.H. Gladin, C.R. Thorpe, et al., Resuscitative endovascular balloon occlusion of the aorta (REBOA): update and insights into current practices and future directions for research and implementation, *Scand. J. Trauma Resusc. Emerg. Med.* 29 (1) (2021), <https://doi.org/10.1186/s13049-020-00807-9>.
- [3] J.B. Hadley, J.R. Coleman, E.E. Moore, et al., Strategies for successful implementation of resuscitative endovascular balloon occlusion of the aorta in an urban Level I trauma center, *J. Trauma Acute Care Surg.* 91 (2021), <https://doi.org/10.1097/TA.0000000000003198>.
- [4] Z. Qasim, K. Bradley, H. Panichelli, J. Robinson, S.C. Zern, Successful interprofessional approach to development of a resuscitative endovascular balloon occlusion of the aorta program at a community trauma center, *J. Emerg. Med.* 54 (4) (2018), <https://doi.org/10.1016/j.jemermed.2018.01.005>.
- [5] S.A. Zakaluzny, B.C. Beldowicz, E.S. Salcedo, J.J. Dubose, L.J. Moore, M. Brenner, Guidelines for a system-wide multidisciplinary approach to institutional resuscitative endovascular balloon occlusion of the aorta implementation, *J. Trauma Acute Care* 86 (2) (2019), <https://doi.org/10.1097/TA.0000000000002138>.

- [6] S.J. Mercer, E.V. Kingston, C.P.L. Jones, The trauma call, *BMJ* (2018) 361, <https://doi.org/10.1136/bmj.k2272>.
- [7] J.R.R. Taylor, J.A.A. Harvin, C. Martin, J.B.B. Holcomb, L.J.J. Moore, Vascular complications from resuscitative endovascular balloon occlusion of the aorta (REBOA): life over limb? *J. Trauma Acute Care Surg.* (2017) <https://doi.org/10.1097/TA.0000000000001514>. Published online.
- [8] G.C. Linderman, W. Lin, R.D. Becher, et al., Increased mortality with resuscitative endovascular balloon occlusion of the aorta only mitigated by strong unmeasured confounding: an expanded analysis using the National Trauma Data Bank, *J. Trauma Acute Care Surg.* 91 (2021), <https://doi.org/10.1097/TA.0000000000003265>.