

SHORT REPORT

Intraoperative management of REBOA: experiences and lessons learned from the London Trauma Network – 10 points for consideration

Chana M,¹ Davenport R,^{2,3} Tai N^{2,3}

1. Southmead Hospital, North Bristol NHS Trust, Bristol, UK
2. Barts Centre for Trauma Sciences, London, UK
3. The Royal London Hospital Major Trauma Centre, Barts Health NHS Trust, London, UK

Corresponding author:

Manik Chana
Southmead Hospital, North Bristol NHS Trust, Bristol, BS10 5NB, UK
Email: manik.chana@nhs.net

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Plain English Summary

This paper describes the collected learning from a group of specialists about a technique to manage life threatening bleeding in patients with severe trauma. This technique involves inflating a balloon to temporarily limit blood flow through the major blood vessels. It highlights the risks associated with the procedure, and the importance of involving vascular specialists.

Key words: trauma, REBOA, haemorrhage, perioperative care

Abstract

Non-compressible torso haemorrhage resulting from vascular injury is the leading cause of death in trauma patients. Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) provides temporary haemorrhage control, permits transfer for definitive care and is becoming established in trauma systems throughout Europe. Drawing on experience of managing these critically injured patients, it is clear that involvement of vascular surgeons is highly important. Surgical management of vascular injury and of potential procedural risks and distal ischaemia associated with REBOA is essential for delivering time critical, safe care. We share 10 key points for intraoperative REBOA management for the vascular surgeon, wider surgical team and the endovascular resuscitation team to jointly consider.

Introduction

Trauma accounts for a significant proportion of annual worldwide mortality, with the World Health Organisation (WHO) estimating that 5 million people died following injury in the year 2000, accounting for 9% of total global annual mortality.¹ In the same year, 12% of the global burden of disease occurred following injury.¹ Traumatic vascular injuries are associated with high mortality, limb amputation rate and place high demand on healthcare resources.² Non-compressible torso haemorrhage resulting from vascular injury is the leading preventable cause of death in trauma patients. Rapid interventions are

required to prevent the sequelae of uncontrolled haemorrhage, support coronary and cerebral perfusion and prevent death from exsanguination.³ Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) is a minimally invasive procedure which provides temporary haemorrhage control and physiological stabilisation. The importance of this endovascular technique is increasingly recognised within modern trauma resuscitation.⁴ Its use has been extended into pre-hospital care,^{5,6} with over 40 pre-hospital REBOA being performed since 2014, and has further progressed with the development of bespoke catheters and strategies.⁷ In the UK, the in-hospital use of REBOA is currently the subject of a multicentre registry study which began in 2017. It is the first of its kind and aims to recruit 120 patients.⁸

Trauma teams are comprised of clinicians from different specialities with differing experiences and skill sets; however, it has been shown that, with specific training, REBOA can be safely performed regardless of base speciality.⁹ It is recognised that REBOA comes with procedural risk related to vascular access trauma, thrombosis of lower limb run-off vessels and limb ischaemia, which is seen in 9% of patients,¹⁰ and the complications of visceral ischaemia-reperfusion (which is demonstrated in animal models).^{11–13} REBOA is a bridge to definitive haemorrhage control and patients who undergo REBOA require timely surgery to dissect, mobilise and control bleeding structures. For these reasons, the early involvement of vascular

surgeons in the care of trauma patients undergoing REBOA is appealing, both to manage potential complications of REBOA and for subsequent definitive haemorrhage control procedures.

Guidelines exist concerning safe REBOA practice.¹⁴ A recent meeting of the London Trauma Network drew upon institutional lessons learned and shared experience in dealing with these rare cases of critically injured patients.¹⁵ The importance of the involvement of vascular surgeons was highlighted specifically. We share 10 key points for intraoperative REBOA management that arose from discussions at this meeting for the vascular surgeon, wider surgical team and the endovascular resuscitation team to jointly consider.

Key points

1. ED to OR handover should happen in the operating theatre, with time of aortic occlusion emphatically underscored (especially if zone 1).
Rationale: Patients with REBOA in place will require definitive surgical management to control haemorrhage. In order to minimise the time of aortic occlusion and distal ischaemia, the Trauma Team Leader and/or Prehospital Team Leader should ensure that the whole theatre team and surgeons receive an additional abbreviated handover in the operating theatre, emphasising the zone and elapsed time of aortic balloon occlusion (zone 1, supraceliac aorta; zone 3, infrarenal aorta), so that the surgical team are clear on the remaining time to achieve haemorrhage control and balloon deflation.
2. One individual in the team should be given the task of tracking occlusion time (total or partial occlusion) and updating the surgeons at 5 minute intervals (for zone 1 inflation) and 10 minute intervals (for zone 3 inflation).
Rationale: It is easy for the surgical team to become overly task focused and lose track of occlusion times, but updating and relay of information should guide ongoing surgical activity.
3. Two consultant surgeons should be in attendance if possible. One will be “looking in” (as primary operator, focused on delivery of surgery) and one will be “looking out” (as secondary operator, focused on assisting the surgery and updating/communicating with the other elements of the surgical-anaesthetic team).
Rationale: These complex and critically unwell patients require senior procedural and decision making, working together to optimise human factors of the team. The primary surgeon should be given the space to focus on moment-to-moment technical delivery of dissection, definition of anatomy, vascular clamping, suture and/or tissue packing. The secondary surgeon is responsible for updating other elements of the team, co-ordinating concomitant activity and anticipating the mustering of other required elements (kit, personnel, etc).
4. A dedicated member of the team must control the sheath at all times when the balloon is in an inflated state to avoid displacement and loss of control. This can be a member of the ED or PH team if necessary (scrubbed into the field).
Rationale: One dedicated person should be responsible for maintaining the safety of the catheter and sheath. The REBOA balloon may move as circulating volume is restored and vascular tone changes, with untoward displacement distally.
5. Gain expedited haemorrhage control as soon as possible.
Rationale: For zone 1 inflation the balloon must be deflated as soon as possible (within 30 minutes and preferably sooner), and ideally within 60 minutes for zone 3 inflation, whether this represents deflation and normal distal perfusion or partial deflation with sub-occlusive aortic control (P-REBOA) where there is an intention to allow distal flow of a circumferential rim of blood between the inflated balloon and the inner aortic wall, analogous to partial aortic declamping. The minimum set of surgical manoeuvres required to get surgical haemostatic control is sufficient – ie, clamping a pedicle to a bleeding solid organ or proximal control of a bleeding vessel.
6. Deflate balloon with control.
Rationale: It is important to graduate deflation to prevent sudden circulatory collapse and to allow the anaesthetic team to maintain circulatory competence via blood product administration and judicious use of intravenous calcium and other vasoactive agents. Incremental deflation should be performed (0.5 mL every 30 seconds) and it is vital to understand how much fluid is in the inflated balloon.
7. Be prepared to re-establish haemorrhage control once the balloon is deflated and distal perfusion is restored.
Rationale: The initial surgical manoeuvres to gain haemorrhage control whilst the balloon is inflated (such as clamping of the splenic hilum) may not be sufficient once full perfusion is re-established. Proceed to perform haemorrhage control procedures on previously unrecognised areas of trauma and, if bleeding is not swiftly controllable, consider balloon re-inflation, warning the anaesthetic team.
8. Balloon catheter removal – leave the sheath in.
Rationale: To reduce the burden of endovascular instrumentation (and reduce the likelihood of thrombotic complications), the deflated balloon and its catheter should be removed as soon as the surgeon is satisfied that definitive haemorrhage control has been obtained. The sheath can be left in a little longer as an access point for catheter re-introduction if there is doubt whilst the laparotomy or other surgical interventions (bowel resection, washout, debridement, etc) are completed.

9. Femoral vessel exposure and removal of the sheath under vision, with thrombectomy and potential fasciotomy.

Rationale: Exposure of the femoral vessels allows for removal of the sheath under vision and embolectomy of inflow and outflow, with confirmation that there is no access vessel thrombus. Prolonged zone 3 inflation may lead to thrombosis of contralateral vessels and should be sought out via scrupulous assessment of the relevant limb. If in doubt, consider contralateral exposure and thrombectomy. Four-compartment calf fasciotomy is recommended for any limb where access vessel thrombosis has been observed.

10. Vigilance for rebleeding.

Rationale: REBOA patients represent the most physiologically disturbed subset of Code Red (shocked, bleeding) patients. More bleeding may become apparent during rewarming/resuscitation. Surgical vigilance for ongoing bleeding as manifested by ongoing physiological distress, transfusion requirement, or bloody discharge from drains and topical negative dressings will allow early re-intervention or transfer for other modalities of therapy such as embolisation. Accompanying the patient to ITU, in-person handover to the critical care team and confirmation of response to surgery and resuscitation is advisable.

Conclusion

The institutional learning of the London Major Trauma Network in managing patients with REBOA, represents perhaps the greatest UK experience in this area of trauma care. Reflecting on these experiences, it is clear that vascular surgeons have an important role to play in the care of these critically injured patients and it is crucial that this learning is shared.

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