# Combining Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) and a Median Sternotomy in Hemodynamically Unstable Non-Compressible Torso Hemorrhage patients' with penetrating chest trauma: Is this feasible?

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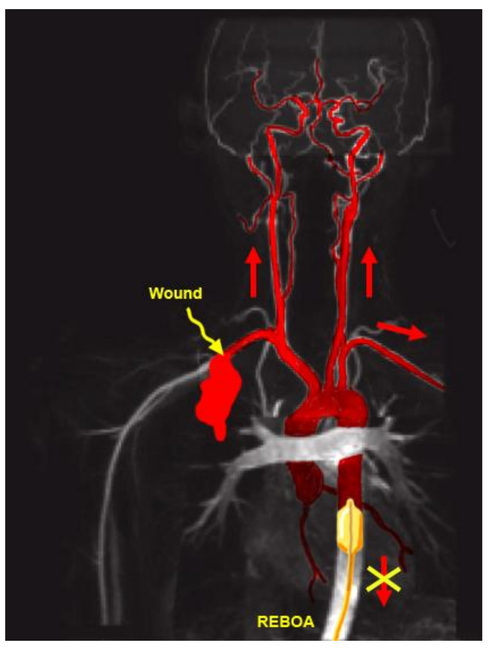
## ABSTRACT

**Introduction:** REBOA has emerged as an alternative for bleeding control in hemodynamically unstable NCTH patients. However, penetrating chest trauma remains an absolute contraindication for the use of REBOA. Distal aortic occlusion with REBOA in cases of proximal penetrating injury to the site of aortic occlusion offers both myocardial and cerebral perfusion support with the associated downside of potentially increasing the rate of bleeding from the injury site. That is why we propose that a median sternotomy be performed in conjunction with REBOA as a feasible and effective means of hemorrhage control in patients suffering from penetrating chest trauma who present hemodynamically unstable. The objective of our study was to present our initial experience with this approach. **Methods:** A prospectively collected case series of the use of REBOA (10 French catheters) in conjunction with a median sternotomy from January, 2015 to December, 2016 at a Level I Trauma Center. **Results:** A total of 68 trauma related emergent thoracic surgeries were performed at our institution during the study period. Of these, eight underwent REBOA plus median sternotomy (Table). REBOA was placed in zone I of the aorta. The median (range) ISS/NISS was 25/41 (9-59/18-57). The median base deficit was 16 (4.6-21). Seven out of the eight patients suffered intra-thoracic vascular injuries: 2 subclavian arteries (one of them was at the point of origin), 2 internal mammary arteries, 2 aortic arch and 5 mayor central venous injuries. Four patients had an associated lung injury with AIS > 3, of which two suffered a pulmonary hilar vessel disruption. One patient had a right ventricular injury with an associated cardiac tamponade. Median systolic blood pressures significantly increased after REBOA placement (50 vs. 123 mmHg, p=0.01). The median time of aortic occlusion was 40 minutes (20-60). REBOA-related complications included one case of upper gastrointestinal bleeding secondary to gastric ischemia that resolved after standard medical treatment. One patient died in the operating room from coagulopathy and exsanguination. Overall 30-day survival was 87%. No adverse neurologic outcomes or deficits were observed in survivors. **Conclusion:** The use of REBOA in conjunction with a median sternotomy can be a feasible approach for hemorrhage control in selected hemodynamically unstable NCTH patients' secondary to penetrating chest trauma. However, further study is required prior to widely adopting this approach.

## INTRODUCTION

REBOA has gained popularity as an alternative to resuscitative thoracotomy (RT) in patients suffering severe torso trauma. Furthermore, recent evidence suggests that REBOA provides a survival benefit among NCTH patients over RT. This is because REBOA has been thought to be an efficient and minimally invasive method of obtaining proximal hemorrhage control while at the same time restoring perfusion to proximal vascular beds. However, the deployment of a REBOA with the subsequent balloon occlusion of the aorta below the source of bleeding entails an associated increase in the proximal arterial blood flow and pressure which in turn can exacerbate hemorrhage from proximal thoracic injuries. We hypothesized that despite the associated downside of potentially increasing the rate of bleeding from the injury site, REBOA could effectively restore proximal blood flow to essential organs and improve cerebral and cardiac perfusion and provide crucial time for the treating surgeon to access and control the source of hemorrhage.




## RESULTS

| Case | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Age/Gender | 19/M | 34/M | 35/M | 46/M | 19/M | 22/M | 34/F | 18/F |
| Mechanism of Injury | GSW | GSW | SW | SW | SW | GSW | SW | GSW |
| ISS | 25 | 59 | 16 | 25 | 13 | 25 | 9 | 25 |
| NISS | 48 | 50 | 57 | 36 | 34 | 41 | 18 | 50 |
| Base Deficit | 4.6 | 21 | 21 | 18 | 12 | 8 | 14 | 19 |
| pH | 7.2 | 6.8 | 7.01 | 7.23 | 7.3 | 7.1 | 7.26 | 7.24 |
| Injuries | Left Subclavian Artery | IV, IJV, RSV Grade IV Lung Grade IV Liver | Right Subclavian Artery | MV, MA Grade V Lung | RV with Cardiac Tamponade Grade III Liver | RSV, AA Grade IV Lung | MA Grade II Lung | AA, ICA Grade V Lung |
| SBP Before & After REBOA | 80/123 | 33/65 | 78/131 | 46/100 | 70/NA* | 50/130 | NM/127 | 60/100 |
| Time of Occlusion | 40 min | 40 min | 26 min | 60 min | NA* | 57 min | 53 min | 20 min |
| Complications | None | None | None | Gastric Ischemia | NA* | None | None | None |
| Outcome | Alive | Death | Alive | Alive | Alive | Alive | Alive | Alive |

M= Male; F= Female; GSW= Gunshot Wound; SW= Stab Wound; ISS= Injury Severity Score; NISS= New Injury Severity Score; IV= Innominate Vein; IJV= Internal Jugular Vein; RSV= Right Subclavian Vein; RSA= Right Subclavian Artery; MV= Mammary Vein; MA= Mammary Artery; RV= Right Ventricle; AA= Aortic Arch; ICA= Intercostal Artery; SBP= Systolic Blood Pressure; NM= Non Measurable; NA= Not Applicable; *The REBOA was not inflated

## REFERENCES

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2. Morrison JJ, Galgon RE, Jansen JO, Cannon JW, Rasmussen TE, Eliason JL, et al. **A systematic review of the use of resuscitative endovascular balloon occlusion of the aorta in the management of hemorrhagic shock.** J Trauma Acute Care Surg. 2016 Feb;80(2):324–34.

## CONCLUSIONS

The combined use of REBOA and a median sternotomy could be a feasible and effective alternative to hemorrhage control in patients with NCTH secondary to penetrating chest trauma. These findings challenge the recommendation against the use of REBOA in penetrating intra-thoracic injuries. Future studies with stronger designs and bigger sample size should confirm our results.