## ABSTRACT

A Novel Perfused Cadaver Model for Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)

**Background:**
Uncontrolled hemorrhage still accounts for as much as 25% of death on the battlefield. Resuscitative endovascular balloon occlusion of the aorta (REBOA) has been posed as an alternative to resuscitative thoracotomy for non-compressible hemorrhage control. Recent analysis of combat casualties in OEF has suggested that 18.5% of those dying from exsanguinating hemorrhage may be temporarily controlled with the use of REBOA. Percutaneous endovascular procedures such as this have been limited to acute care surgeons, interventionalists and vascular surgeons. With the advent of new technology and the ability to place REBOA catheters through smaller endovascular sheaths, the procedure can now be performed by emergency medicine providers. Adequate training and simulation models are still in development for the use of the procedure.

**Objective**:
Create the ideal prehospital training simulator for REBOA catheter placement. The goals of design were to create a simple, easily reproducible, and realistic model to simulate placing REBOA in field/austere conditions.

**Design/Methods**:
We conducted a systematic review of the published literature on REBOA, conducted virtual reality simulator training, performed interviews with subject matter experts and visited the labs at the Centre for Health Sciences in Bulverde, TX, the Fresh Tissue Dissection Laboratory at Los Angeles County and USC Keck School of Medicine, CA.

**Results**:
We developed what we believe is the ideal simulation model for REBOA catheter placement using a perfused human cadaver model. Our model includes many elements from previously published models of perfused cadaver simulation as well as the unique aspects of placing extremity tourniquets and filling the venous side using a femoral intraosseus (IO) line.

**Conclusion**:
This model has been used in the lab setting with good results.

**Impact:**
The model described can be used in the field setting with minimal resources and accurately simulates the critical skills for REBOA catheter placement.

# A Novel Perfused Cadaver Model for Resuscitative Endovascular Balloon Occlusion of the Aorta

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## Introduction

Resuscitative endovascular balloon occlusion of the aorta (REBOA) has been posed as an alternative to resuscitative thoracotomy for non-compressible hemorrhage control. Percutaneous endovascular procedures such as this have been limited to acute care surgeons, interventionalists and vascular surgeons. With the advent of new technology and the ability to place REBOA catheters through smaller endovascular sheaths, the procedure can now be performed by emergency physicians. Adequate training and simulation models are still in development for the use of the procedure.

## Methods

In an effort to create the ideal prehospital training simulator for REBOA catheter placement, we conducted a systematic review of the published literature on REBOA, conducted virtual reality simulator training using the Mentice VIST G5 endovascular simulator, performed interviews with subject matter experts and visited the labs at the Centre for Health Sciences in Bulverde, TX, the Basic Endovascular Skills in Trauma laboratory in Baltimore, MD, and the Fresh Tissue Dissection Laboratory at Los Angeles County and USC Keck School of Medicine, CA. Goals of design were to create a simple, easily reproducible, and realistic model to simulate placing REBOA in field/austere conditions.

## Procedure

1. Place one tourniquet high on each extremity, for a total of four tourniquets. Allow space for introducer sheath on the appropriate limb and an IO needle distal to the tourniquet.
2. Place intraosseous needle into the right distal femur and infuse one liter of fluid.
3. Dissect down to and place large-bore catheter into right common carotid artery. Infuse one liter of fluid under pressure to distend aorta and femoral artery. Continue infusion until the model has been pressurized to 50mm Hg using in-line pressure monitor attached to the infusion tubing.
4. Maintain pressure using additional IV fluid bags connected with Y-connector tubing and using pressure infuser bags with inflation adjusted as needed to maintain arterial pressure during arterial cannulation and balloon inflation phase of the procedure.
5. Standard ER-REBOA percutaneous vascular access and catheter placement can now be performed under ultrasound visualization of the femoral artery and vein. Catheter position and balloon inflation can also be observed under ultrasound visualization.
6. Arterial pressure measurement and monitoring can be performed through in-line pressure monitor of ER-REBOA catheter to ensure concordance with pressure measured at carotid infusion site and to observe pressure changes with balloon inflation/deflation.

Pilot Study Pressure Changes

| Starting pressure (mmHg) | Balloon up | Balloon down |
|---|---|---|
| 40 | +2 | -10 |
| 50 | +8 | -12 |

## Limitations

This model does not currently have pulsatile flow, but could be adapted for same.

## Conclusion

This model described has been used in the lab setting with good results. The model described can be used in the field setting with minimal resources and accurately simulates the critical skills for REBOA catheter placement.