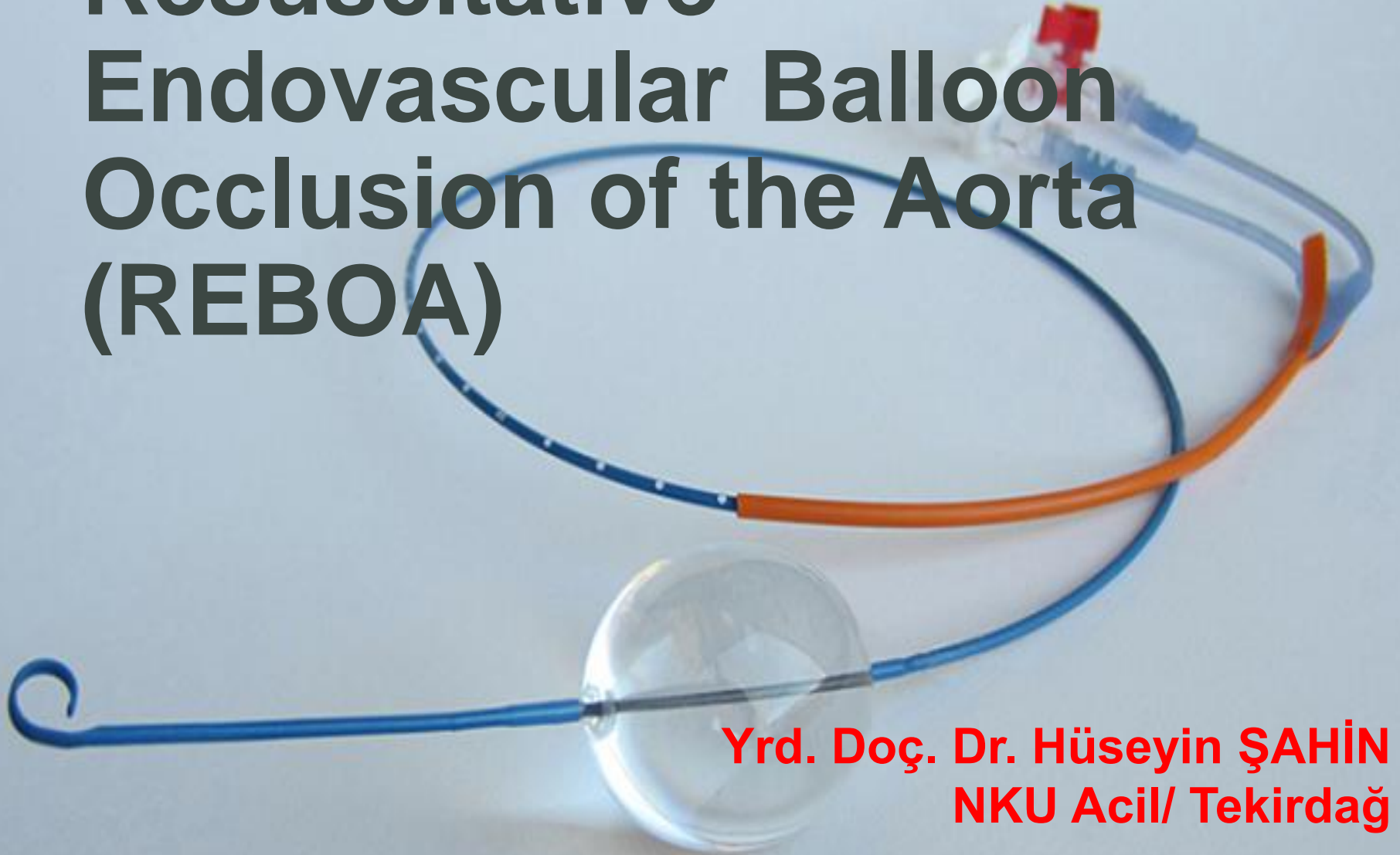


# Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)



**Yrd. Doç. Dr. Hüseyin ŞAHİN**  
**NKU Acil/ Tekirdağ**



Niçin

# Travma ile ilişkili ölüm dönemleri

- Travma nedeniyle kaybedilen Hastaların:
  - %50 si olay yerinde
    - Ciddi damar yaralanması, spinal hasar, havayolu tıkanıklığı
  - %30 saatler içinde
    - şok, hipovolemi, epidural, subdural kanama, karaciğer, dalak yaralanması, pelvis, uzun kemik kırıkları, kalp tamponatı, masif hematoraks
  - %20 günler ve haftalar içinde
    - sepsis, organ yetmezliği



# Yaralanmadan dolayı ölüm nedenleri



**1. Travmatik  
beyin injuri**



**2. Kanamalar**



**3. Sepsis /MODS**

# Kanamalar

...Potansiyel önlenebilir ölüm  
nedenlerinin en sık nedeni



# Travmatik hemorajik şokta hedef

- Kanamayı azaltmak/durdurmak
- Hayati organlara dolaşım/oksijenasyon sağlamak
- Organ disfonksiyonunu önlemek



# Kanamayı azaltmak/durdurmak

- Direkt bası
- Hemostatik tozlar
- Turnikeler





# Direkt bası



# Hemostatik ajanlar

- BioGlue
- Surgicel
- Floseal
- Ankaferd
- Protamin
- Desmopressin
- Tranexamik asit
- Vs...



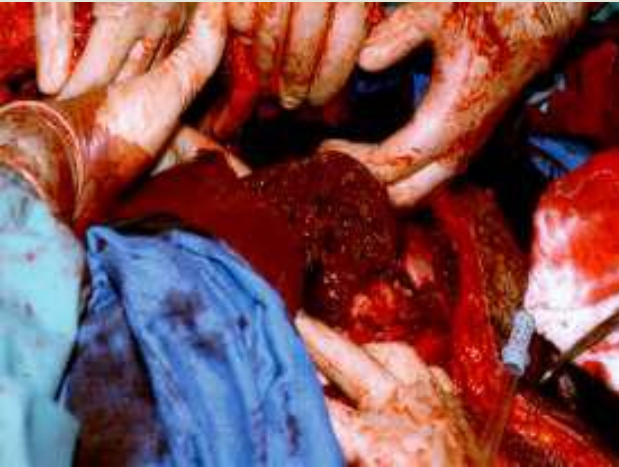
# Turnikeler





# Kanamayı azaltmak /durdurmak

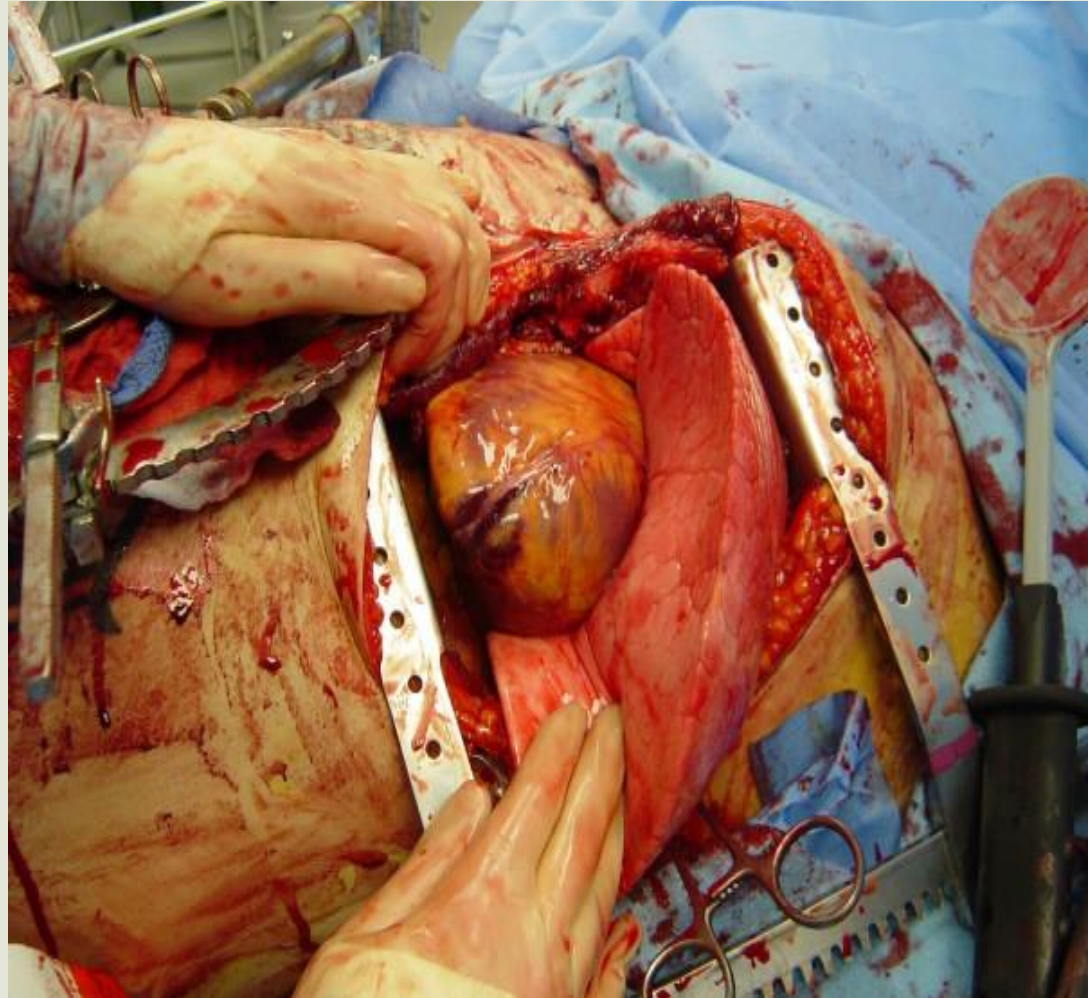
- Olay yerindeki önlenebilir ölümlerin yaklaşık % 85'i compres yapılamayan kanamalar oluşturmaktadır. Bunların da %80'i toraks /batın kanamaları oluşturur





# Kanamayı durdurmak/azaltmak

- Laparotomi
- Torakotomi
- Selektif embolizasyon



Daha iyi bir yol var mıdır?

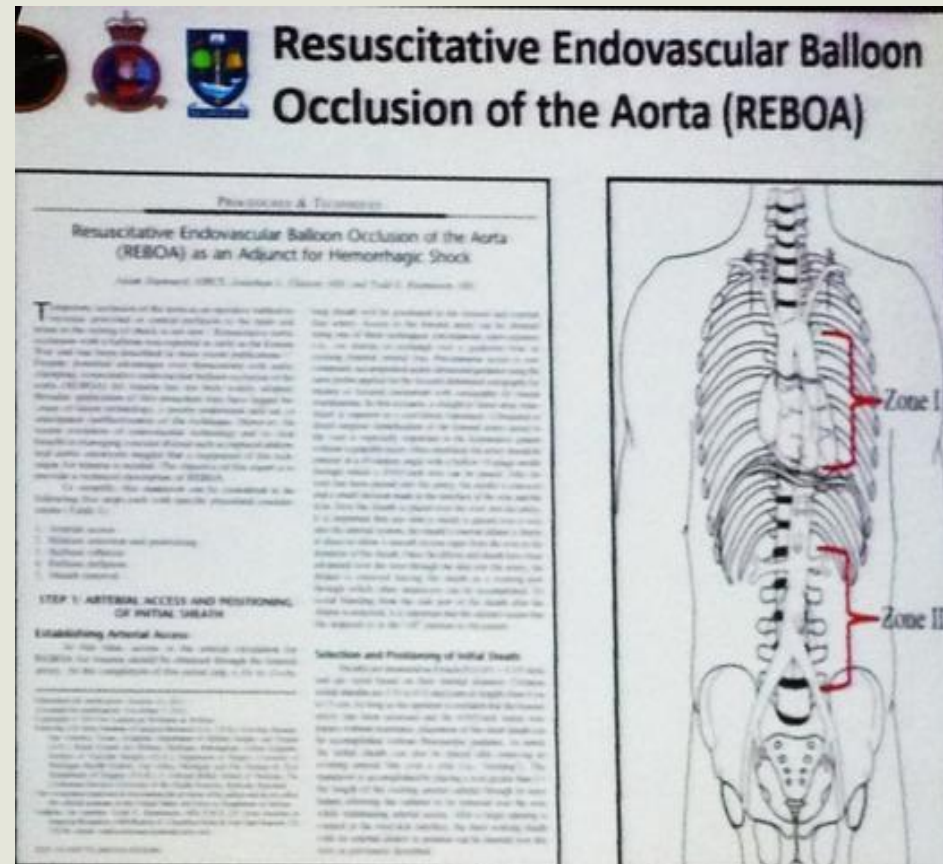




- Dışarıdan değil içinden aortun kapatılması !?

## REBOA:

- Resüsitatif
- Endovasküler
- Balon
- Oklüzyon
- Aort



Nedir



# REBOA

- Travmaya bağlı göğüs abdomen ve pelvisin ölümcül abondan kanamalarına hızla müdahale etmek için uygulanan bir tekniktir
- femoral arter aracılığıyla aortaya hızla esnek bir kateter yerleştirerek ucundaki bir balonu şişirmekten ibarettir

**Abdominal or  
Truncal  
Hemorrhage**

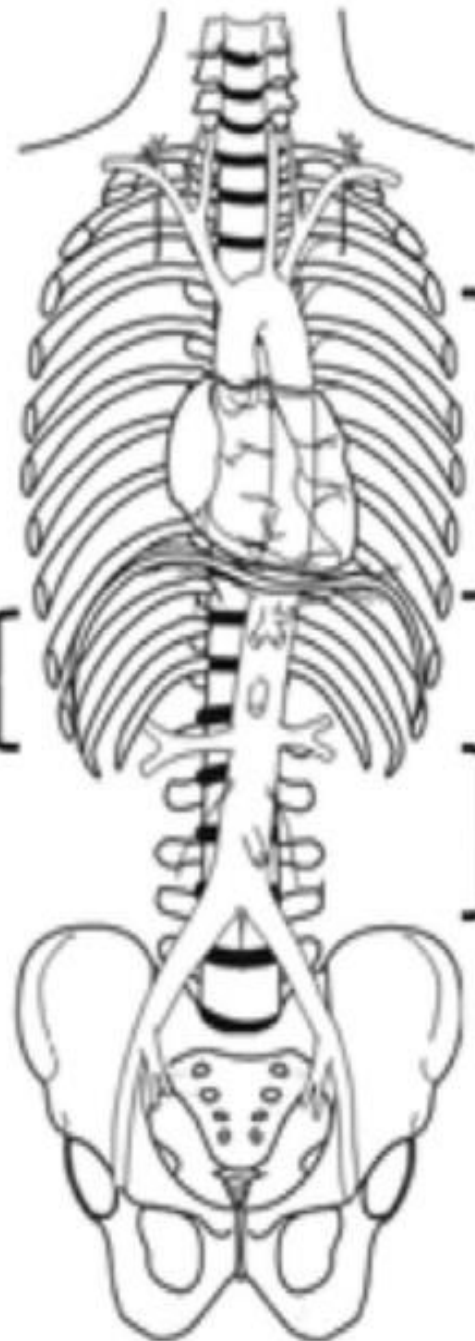
Aortic Zone I

Aortic Zone II

**Zone II: NO  
OCCLUSION**

Aortic Zone III

**Pelvic  
Hemorrhage**



Nasıl





# Tarihçe

- İlk uygulama 1954 Kore savaşı
  - Yarbay Carl Wilson Hughes
  - 2 askerde uygulanmış



USE OF AN INTRA-AORTIC BALLOON CATHETER TAMPONADE FOR  
CONTROLLING INTRA-ABDOMINAL HEMORRHAGE IN MAN

LIEUTENANT COLONEL CARL W. HUGHES, MEDICAL CORPS, UNITED STATES ARMY,  
WASHINGTON, D. C.

*(From the Division of Surgery, Army Medical Service Graduate School,  
Walter Reed Army Medical Center)*

# Tarihçe



## Annals of Emergency Medicine

Volume 15, Issue 12, December 1986, Pages 1466-1469



Special contribution

### Preliminary report on the use of the percluder® occluding aortic balloon in human beings

MD Ronald B Low <sup>\*</sup>✉, MD, FACEP Wayne Longmore <sup>†</sup>, MD, FACS Richard Rubinstein <sup>‡</sup>, MD, FACS Lucio Flores <sup>§</sup>, MA Sidney Wolvek <sup>¶</sup>

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[https://doi.org/10.1016/S0196-0644\(86\)80945-3](https://doi.org/10.1016/S0196-0644(86)80945-3)

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Management of massive exsanguinating hemorrhage is a major challenge in acute trauma care. The value of military antishock trousers (MAST) in this setting is controversial. In selected instances, thoracotomy with aortic cross-clamping may be effective and often is used as the “gold standard” to which new experimental therapy is compared. Previous animal research with an occluding aortic balloon catheter (Percluder®) has shown this technique to be physiologically similar to aortic cross clamping. The Percluder® was more effective than the MAST plus volume replacement in controlling hemorrhage and prolonging four-hour survival from blunt splenic trauma in an animal model. We have used the Percluder® in 23 patients with life-threatening hemorrhage. There were 15 trauma cases, five cases of ruptured

- Low RB et al. *Preliminary report on the use of the Percluter occluding aortic balloon in human beings.*  
Annals of emergency medicine. 1986 Dec;15(12):1466–9.

“13% survival in 15 trauma patients after REBOA”

- Gupta BK et al. *The Role of Intra-aortic Balloon Occlusion in Penetrating Abdominal Trauma.*  
The Journal of Trauma. 1989;29(6):861–5.

“35% survival in 20 trauma patients after REBOA”

# Tarihçe

- 90'lar ve 2000'lerin başında etkisini kaybetti
  - Uygun olmayan teknoloji
  - Yetersiz beceri
  - Beklenmedik etkisizlik



- Greenberg RK et al. *An endoluminal method of hemorrhage control and repair of ruptured AAA.*  
J Endovasc Ther 2000
- Malina M, Veith F. *Balloon occlusion of the aorta during endovascular repair of ruptured abdominal aortic aneurysm.*  
J Endovasc Ther. 2005 Oct;12(5):556–9.

- Bununla birlikte, son yıllarda REBOA'nın hem insanlardaki hem de hayvan modellerindeki endikasyonlarını, etkililiğini ve fizyolojik etkilerini tanımlayan giderek artan sayıda araştırma ortaya çıkmıştır.

- *Endovascular balloon occlusion of the aorta is superior to resuscitative thoracotomy with aortic clamping in a porcine model of hemorrhagic shock.*

White et al. Surgery 2011;150:400-9.

## REBOA vs EDT + clamping

- REBOA grup:
  - Daha az asidotik
  - düşük serum laktat
  - düşük pCO<sub>2</sub> düzeyi
  - Resusitasyon boyunca daha az sıvı gereksinimi

- *Forty-minute Endovascular Aortic Occlusion Increases Survival in an Experimental Model of Uncontrolled Hemorrhagic Shock caused by Abdominal Trauma.*

Avaro et al. J Trauma. 2011;71:720-5

## REBOA vs Sıvı resussitasyonu

- REBOA grup:
  - Daha fazla sağ kalım
  - Daha yüksek MAP
  - düşük laktat düzeyleri

No difference in bowel/renal ischemia between no REBOA and REBOA groups at 40 or 60 minutes



# Aortic balloon occlusion is effective in controlling pelvic hemorrhage

Jonathan J. Morrison, MRCS,<sup>a,b,c</sup> Thomas J. Percival, MD,<sup>a,b</sup> Nickolay P. Markov, MD,<sup>a,b</sup> Carole Villamaria, MD,<sup>a,b</sup> Daniel J. Scott, MD,<sup>a,b</sup> Kaylyn A. Saches, BS,<sup>a</sup> Jerry R. Spencer, BS,<sup>a</sup> and Todd E. Rasmussen, MD, FACS<sup>a,b,d,\*</sup>

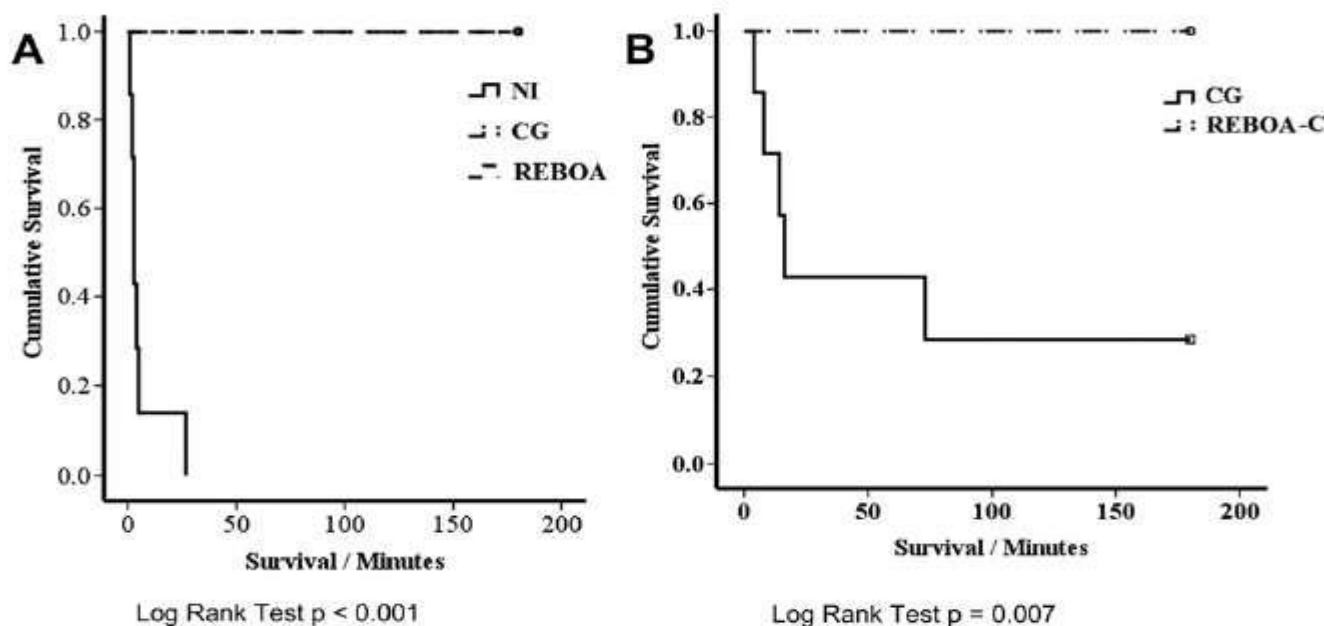


Fig. 2 – Kaplan-Meier survival curves of animals with (A) no coagulopathy, treated with either no intervention (NI), Combat Gauze (CG), or resuscitative endovascular balloon occlusion of the aorta (REBOA); and (B) dilution coagulopathy, undergoing treatment with either Combat Gauze (CG-C) or resuscitative endovascular balloon occlusion of the aorta (REBOA-C). Log rank test  $P < 0.001$  and  $P = 0.007$ , respectively.

# Implementation of Resuscitative Endovascular Balloon Occlusion of the Aorta as an Alternative to Resuscitative Thoracotomy for Non-compressible Truncal Hemorrhage

Moore LJ, Brenner M, Kozar RA, et al. *J Trauma Acute Care Surg.* 2015;79:523-532.

Jacob Nacht, MD

Denver Health Medical Center, Denver, CO

 PlumX Metrics

Among Deaths (n = 80)		RT Deaths (n = 65)	REBOA Deaths (n = 15)	<i>p</i>
All Deaths	% (n)	90.3 (65)	62.5 (15)	0.003
Died in ED	% (n)	69.2 (45)	26.7 (4)	<0.001
Died in OR	% (n)	9.2 (6)	20 (3)	0.69
Died in ICU	% (n)	21.6 (14)	53.3 (8)	0.17
Age	Median (P25–P75)	31 (24–46)	40.5 (24–66)	0.41
Male	% (n)	87.7 (57)	73.3 (11)	0.22
Blunt	% (n)	44.6 (29)	73.3 (11)	0.08
ISS	Median (P25–P75)	35.5 (22–67)	34 (20–45.5)	0.39



# The AAST prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) registry: Data on contemporary utilization and outcomes of aortic occlusion and resuscitative balloon occlusion of the aorta (REBOA).

DuBose JJ<sup>1</sup>, Scalea TM, Brenner M, Skiada D, Inaba K, Cannon J, Moore L, Holcomb J, Turay D, Arbabi CN, Kirkpatrick A, Xiao J, Skarupa D, Poulin N; AAST AORTA Study Group.

## ⊕ Author information

### Abstract

**INTRODUCTION:** Aortic occlusion (AO) for resuscitation in traumatic shock remains controversial. Resuscitative endovascular balloon occlusion of the aorta (REBOA) offers an emerging alternative.

**METHODS:** The American Association for the Surgery of Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery registry prospectively identified trauma patients requiring AO from eight ACS Level 1 centers. Presentation, intervention, and outcome variables were collected and analyzed to compare REBOA and open AO.

**RESULTS:** From November 2013 to February 2015, 114 AO patients were captured (REBOA, 46; open AO, 68). 80.7% were male, and 62.3% were blunt injured. Aortic occlusion occurred in the emergency department (73.7%) or the operating room (26.3%). Hemodynamic improvement after AO was observed in 62.3% [REBOA, 67.4%; open OA, 61.8%]; 36.0% achieving stability (systolic blood pressure consistently >90 mm Hg, >5 minutes); REBOA, 22 of 46 (47.8%); open OA, 19 of 68 (27.9%);  $p = 0.014$ . Resuscitative endovascular balloon occlusion of the aorta (REBOA) access was femoral cut-down (50%); US guided (10.9%) and percutaneous without imaging (28.3%). Deployment was achieved in Zones I (78.6%), II (2.4%), and III (19.0%). A second AO attempt was required in 9.6% [REBOA, 2 of 46 (4.3%); open OA, 9 of 68 (13.2%)]. Complications of REBOA were uncommon (pseudoaneurysm, 2.1%; embolism, 4.3%; limb ischemia, 0%). There was no difference in time to successful AO between REBOA and open procedures (REBOA,  $6.6 \pm 5.6$  minutes; open OA,  $7.2 \pm 15.1$ ;  $p = 0.842$ ). Overall survival was 21.1% (24 of 114), with no significant difference between REBOA and open AO with regard to mortality [REBOA, 28.2% (13 of 46); open OA, 16.1% (11 of 68);  $p = 0.120$ ].

**CONCLUSION:** Resuscitative endovascular balloon occlusion of the aorta has emerged as a viable alternative to open AO in centers that have developed this capability. Further maturation of the American Association for the Surgery of Trauma Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery database is required to better elucidate optimal indications and outcomes.

**LEVEL OF EVIDENCE:** Therapeutic/care management study, level IV.



## Fixed-Distance Model for Balloon Placement During Fluoroscopy-Free Resuscitative Endovascular Balloon Occlusion of the Aorta in a Civilian Population.

Pezy P<sup>1</sup>, Flaris AN<sup>2</sup>, Prat NJ<sup>3</sup>, Cotton F<sup>4</sup>, Lundberg PW<sup>5</sup>, Caillot JL<sup>6</sup>, David JS<sup>7</sup>, Voiglio EJ<sup>8</sup>.

### ⊕ Author information

### Abstract

**IMPORTANCE:** Resuscitative endovascular balloon occlusion of the aorta (REBOA) is an innovative procedure in the treatment of noncompressible truncal hemorrhage. However, readily available fluoroscopy remains a limiting factor in its widespread implementation. Several methods have been proposed to perform REBOA without fluoroscopic guidance, and these methods were adapted predominantly from the military theater.

**OBJECTIVE:** To develop a method for performing REBOA in a civilian population using a standardized distance from a set point of entry.

**DESIGN, SETTING, AND PARTICIPANTS:** A retrospective study of whole-body computed tomographic (CT) scans from a cohort of 280 consecutive civilian trauma patients from University Hospitals of Lyon, France, was used to calculate the endovascular distances from both femoral arteries at the level of the upper border of the symphysis pubis to aortic zone I (descending thoracic aorta) and zone III (infrarenal aorta). These whole-body CT scans were performed between 2013 and 2015. Data were analyzed from July 16 to December 7, 2015.

**MAIN OUTCOMES AND MEASURES:** Two segments (1 per zone) common to all CT scans were isolated, and their location, length, prevalence in the cohort, and predicted prevalence in the general population were calculated by inverting 99% certainty tolerance limits.

**RESULTS:** Among the 280 trauma patients (140 men and 140 women) in this study, the mean (SD) height was 170.7 (8.7) cm, and the mean (SD) age was 38.8 (16.5) years. The common segment in zone I (414-474 mm) existed in all CT scans. The common segment in zone III (236-256 mm) existed in 99.6% and 97.9% of CT scans from the right and left femoral arteries, respectively. These segments are expected to exist in 98.7% (zone I) and 94.9% (zone III) of the general population.

**CONCLUSIONS AND RELEVANCE:** Target distances for blind placement of REBOA exist with more than 94% prevalence in a civilian population. These findings support the expanded use of REBOA in emergency department and prehospital settings. Validation for safety and efficacy on cadaveric and clinical models is necessary.



# Use of Resuscitative Endovascular Balloon Occlusion of the Aorta for Proximal Aortic Control in Patients With Severe Hemorrhage and Arrest.

Brenner M<sup>1</sup>, Teeter W<sup>1</sup>, Hoehn M<sup>1</sup>, Pasley J<sup>1</sup>, Hu P<sup>1</sup>, Yang S<sup>1</sup>, Romagnoli A<sup>1</sup>, Diaz J<sup>1</sup>, Stein D<sup>1</sup>, Scalea T<sup>1</sup>.

## ⊕ Author information

### Abstract

**IMPORTANCE:** Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a percutaneous transfemoral balloon technique used in select centers for resuscitation and temporary hemostasis, often instead of emergency department thoracotomy. The ability to perform aortic occlusion (AO) with an intravascular device allows focused occlusion at the most distal level to perfuse proximal regions while slowing hemorrhage to injured areas.

**OBJECTIVE:** To describe what is to date the largest single-institution experience with REBOA in the United States.

**DESIGN, SETTING, AND PARTICIPANTS:** Use of REBOA at an urban tertiary care facility for severe traumatic hemorrhage, traumatic arrest (AR), or nontraumatic hemorrhage (NTH) was investigated from February 1, 2013, to January 31, 2017, among 90 patients who were not responsive or were transiently responsive to resuscitation measures, or were in arrest, from presumed hemorrhage below the diaphragm. Possible causes were trauma or nontrauma-related hemorrhage. Patients with ruptured aortic aneurysms were excluded.

**MAIN OUTCOMES AND MEASURES:** In-hospital mortality.

**RESULTS:** Of the 90 patients in the study (15 women and 75 men; mean [SD] age, 41.5 [17.4] years), 29 underwent REBOA for severe traumatic hemorrhage, 50 for AR, and 11 for NTH. For the patients with severe traumatic hemorrhage and AR, the median age was 36.2 years (interquartile range, 25.3-55.5 years), mean (SD) admission Glasgow Coma Scale score was 6 (5), and median Injury Severity Score was 39 (interquartile range, 10-75). The distal thoracic aorta was occluded in 73 patients (81%), and in all patients with AR. A total of 17 patients (19%) had distal abdominal AO. Mean (SD) systolic blood pressure improved in patients with severe traumatic hemorrhage, from 68 (28) mm Hg prior to AO, to 131 (12) mm Hg after AO ( $P < .001$ ). Percutaneous access was used in 30 patients (33%), including 13 patients with AR (26%), and groin cutdown in 60 patients (67%), including 37 patients with AR (74%). Overall 30-day mortality was 62% ( $n = 56$ ): 11 (39%) in patients with severe traumatic hemorrhage and 45 (90%) in patients with AR. Of the patients with AR, 29 (58%) had return of spontaneous circulation and 11 of those patients (38%) survived to the operating room. All patients who survived AR gained full neurologic recovery. No aortoiliac injury or limb loss occurred from REBOA use. Eleven patients underwent REBOA for NTH, 7 (64%) were in arrest. Overall in-hospital mortality for patients with NTH was 36% ( $n = 4$ ). No procedural complications occurred in this group.

**CONCLUSIONS AND RELEVANCE:** REBOA is a minimally invasive alternative to emergency department thoracotomy with aortic cross-

Kimlere ?



<https://doi.org/10.1016/j.jemermed.2018.01.005>



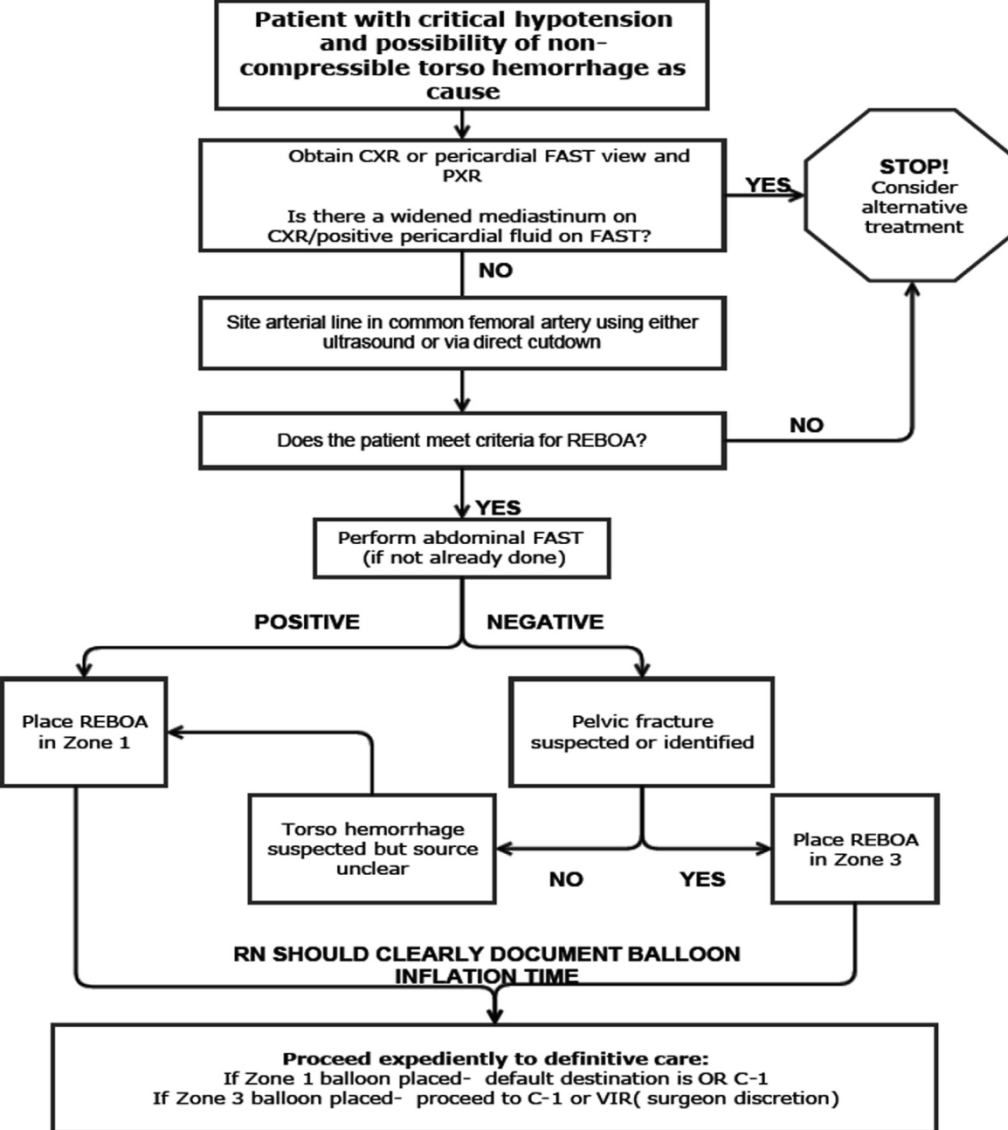
## **Original Contributions**

# **SUCCESSFUL INTERPROFESSIONAL APPROACH TO DEVELOPMENT OF A RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA PROGRAM AT A COMMUNITY TRAUMA CENTER**

Zaffer Qasim, MBBS, FRCEM, FRCP(c), EDIC,\* Kevin Bradley, MD, FACS,†  
Heather Panichelli, AGCNS-BC, MSN, RN, CEN, CPEN,\* Josie Robinson, RN, CEN,\* and  
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Reprint Address: Zaffer Qasim, MBBS, FRCEM, FRCP(c), EDIC, Department of Emergency Medicine, University of Pennsylvania School of Medicine, Ground Floor Ravdin, 3400 Spruce Street, Philadelphia, PA 19104



#### Indications:

Patients with torso hemorrhage AND

1. refractory hypotension despite all damage control resuscitation techniques

**OR**

2. Traumatic cardiac arrest either witnessed or within 5 minutes of arrival to the trauma bay

#### Contraindications

1. Age < 18 years
2. Suspected thoracic aortic injury
3. Suspected pericardial tamponade
4. Suspected severe peripheral vascular disease eg previous groin scars
5. Personnel unskilled in technique

resuscitative endovascular balloon of the aorta.

CXR = chest x-ray;

FAST = focused assessment with sonography in trauma;

PXR = pelvis x-ray;

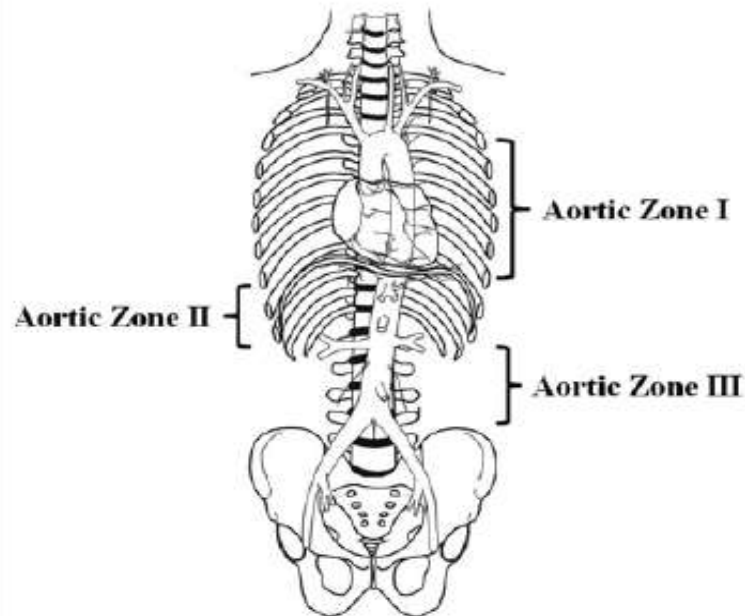
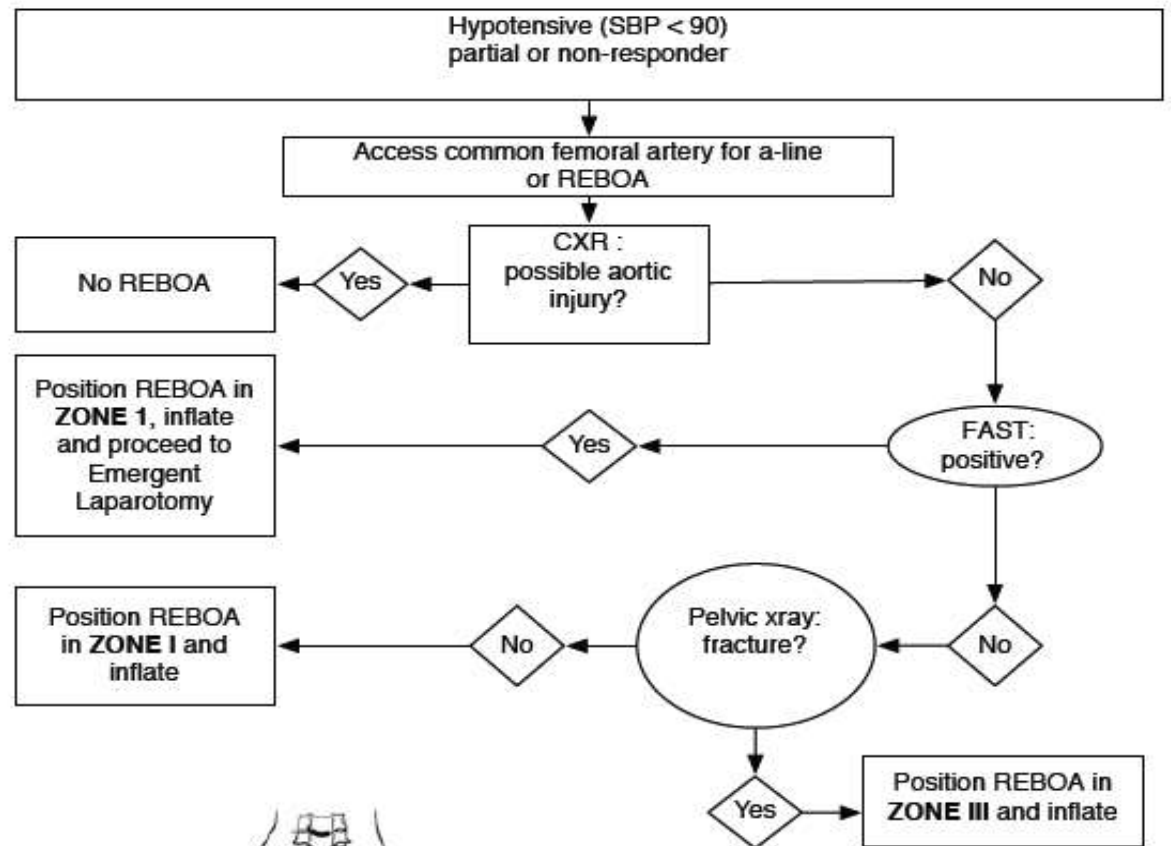
REBOA = resuscitative endovascular balloon occlusion of the aorta;

VIR = vascular interventional radiology.

*Successful Interprofessional Approach to Development of a Resuscitative endovascular Balloon Occlusion of the Aorta Program at a Community Trauma Center*  
 Qasim, Zaffer et al. Journal of Emergency Medicine



# REBOA



**Zone I** = Origin of left subclavian artery to the celiac artery

**Zone III** = Lowest renal artery to aortic bifurcation

# Nerede ?

- Abdominal ve pelvik kanamalı vakalarda
- Hasta acile gelmeden hemen öncesinde veya acilde arrest olduğunda
- arrest olmak üzereyken
- hastane öncesi
- travma bölümünde

# Daha az belirgin endikasyonlar

- abdominal travmalılarda acil ameliyat sırasında kanamayı azaltmak için
- acil pre-op uygulama veya geçici cevapta embolizasyona yardımcı olmak
- Uterin rüptürler
- Ektopik gebelik.

# Resuscitative Endovascular Balloon Occlusion of the Aorta

- Abdominal- pelvik travmalı hastalarda Torakotomi'nin faydalarını (serebral ve koroner kan akımını arttırmak, kanamayı azaltmak) sağlarken,
- Torakotomiden kaçınma olanağı verir.
- Hastayı definitif cerrahi öncesi stabil hale getirme fırsatı yaratır.



TEŞEKKÜRLER