



ハイケッセ イー グンラ
ベニム アディム ヨウスケ マツムラ
ジャポニヤダン ゲーディム

Invasive procedures: New weapons at hand

REBOA in ED



Yosuke Matsumura

Dept. of Emergency and CCM Chiba University
Japanese Society of DIRECT
EVTM Society Regional Director (Asia)

Former Clinical advisory board of **Tokai Medical Products**

Patent of “**BackBoard Tree®**” and patent royalty from **SISM**

Grant-in-Aid

-Young Scientists (2019-2020), **Japan Society for the Promotion of Science (JSPS), JP19KK18344**

-Scientific Research (C), Co-applicant (2018-2020), **Japan Society for the Promotion of Science (JSPS), JP18K08881**

-Research Activity Start-up (2017-2018), **Japan Society for the Promotion of Science (JSPS), JP18K08881**

REBOA Practice in Japan



Resuscitative Endovascular Balloon Occlusion of the Aorta

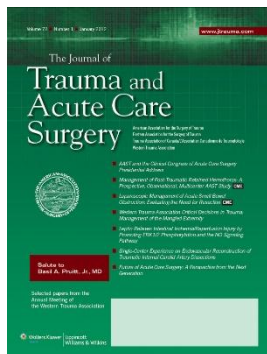


Volume 71, Number 6, December 2011

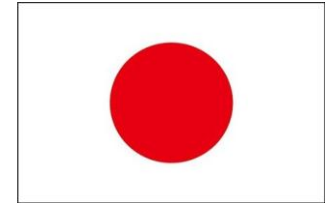
PROCEDURES & TECHNIQUES

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as an Adjunct for Hemorrhagic Shock

Adam Stannard, MRCS, Jonathan L. Eliason, MD, and Todd E. Rasmussen, MD

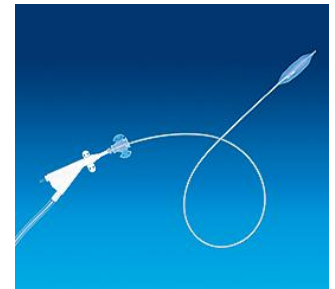


Intra- Aortic Balloon Occlusion



日本外傷学会雑誌 第12巻(1998年)

臨床検討	鈍的腹部外傷の出血制御を目的とした 専用大動脈遮断カテーテルの臨床応用	石原 晋	県立広島病院 救命救急センター	Vol.12 No.1
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RESEARCH PAPER



2003

Transbrachial arterial insertion of aortic occlusion balloon catheter in patients with shock from ruptured abdominal aortic aneurysm

Hitoshi Matsuda, MD, Yosuke Tanaka, MD, Yutaka Hino, MD, Ritsu Matsukawa, MD, Nobuchika Ozaki, MD, Kenji Okada, MD, Takuro Tsukube, MD, Yoshihiko Tsuji, MD, and Yutaka Okita, MD, Kobe, Japan

Objective: Of 125 surgical patients with abdominal aortic aneurysm (AAA) treated from 1999, 11 patients with deep shock from ruptured AAAs who underwent aortic occlusion balloon catheter (AOBC) insertion before laparotomy were studied.

Methods: With the patients under local anesthesia, the brachial artery was exposed and the balloon catheter was inserted into the thoracic aorta. The balloon was inflated halfway and pulled back gently to the orifice of the left subclavian artery, and was advanced with the aid of blood flow down to the abdominal aorta. After full inflation of the balloon, the catheter was pulled until the balloon was fixed at the proximal shoulder of the AAA.

Results: AOBC insertion was completed within 16.1 ± 5.1 minutes. Systolic blood pressure at presentation was 84.1 ± 31.7 mm Hg, deteriorated to 60.9 ± 15.4 mm Hg on arrival in the operating room, and increased significantly ($P < .0001$) to 123.4 ± 25.3 mm Hg after AOBC insertion. The balloon burst in three patients. Embolic complications were observed in two patients. There were three deaths, two associated with the balloon bursting. In nine patients whose shock was successfully controlled by AOBC, operative mortality was 11%.

Conclusion: Transbrachial arterial insertion of an AOBC may be useful to ameliorate hemorrhagic shock in patients with ruptured AAAs. (J Vasc Surg 2003;38:1293-6.)

Transbrachial arterial insertion of aortic occlusion balloon catheter in patients with shock from ruptured abdominal aortic aneurysm

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Ozaki, MD, Ken
Kobe, Japan

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observed in two pa
was successfully co

Conclusion: Transt
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Gynecologic and
Obstetric Investigation

Case Report

Gynecol Obstet Invest 2009;67:92–95

DOI: [10.1159/000164685](https://doi.org/10.1159/000164685)

Elective Use of Aortic Balloon Occlusion in Cesarean Hysterectomy for Placenta Previa Percreta

Hitoshi Masamoto^a Hiroyuki Uehara^a Masaki Gibo^b Eiko Okubo^a
Kaoru Sakumoto^a Yoichi Aoki^a

^aDepartment of Obstetrics and Gynecology, Faculty of Medicine, University of the Ryukyus, and

^bDepartment of Radiology, Faculty of Medicine, University of the Ryukyus, Okinawa, Japan

2009

Transbrachial arterial insertion of aortic occlusion balloon catheter in patients with shock from ruptured abdominal aortic aneurysm

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Ozaki, MD, Ken
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DOI: [10.1159/000164685](https://doi.org/10.1159/000164685)

Elective Use of Aortic Balloon Occlusion in Cesarean Hysterectomy for Placenta

Irahara et al. World Journal of Emergency Surgery 2015; 10:1
<http://www.wjes.org/content/10/1/1>

2015



WORLD JOURNAL OF
EMERGENCY SURGERY

Hitoshi Masamoto^a H
Kaoru Sakumoto^a Yoi

^aDepartment of Obstetrics and

^bDepartment of Radiology, Facu

RESEARCH ARTICLE

Open Access

Retrospective study of the effectiveness of Intra-Aortic Balloon Occlusion (IABO) for traumatic haemorrhagic shock

Takayuki Irahara¹, Norio Sato^{2*}, Yuuta Moroe³, Reo Fukuda³, Yusuke Iwai³ and Kyoko Unemoto³



silence

Only small case series were published
from **Japan** until 2015....

AAST 2014 PLENARY PAPER

Evaluation of the **safety and feasibility** of resuscitative endovascular balloon occlusion of the aorta

Nobuyuki Saito, MD, Hisashi Matsumoto, MD, PhD, Takanori Yagi, MD, Yoshiaki Hara, MD, Kazuyuki Hayashida, MD, Tomokazu Motomura, MD, Kazuki Mashiko, MD, Hiroaki Iida, MD, Hiroyuki Yokota, MD, PhD, and Yukiko Wagatsuma, MD, MPH, DrPH, Inzai, Japan

*Saito N, et al. J Trauma Acute Care Surg 2015;78:897-904.

Evaluation of the safety and feasibility of resuscitative endovascular balloon occlusion of the aorta

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TABLE 2. A Comparison of the Patients' Characteristics, Clinical Data, and Treatment Between Groups 1 and 2

Variable	Group 1 (n = 14)	Group 2 (n = 10)	p
Age, y	65 (41–73)	47 (32–65)	0.16
Male/female	6/8	7/3	0.36
ISS	40 (34–50)	50 (45–54)	0.06
Lower limb ischemia	2 (14.2)	0	0.21
Arterial injury caused by puncture	1 (7.1)	0	0.38
Lower limb amputation	3 (21.3)	0	0.11

Group 1 is the 24-hour survivor group (n = 14), and Group 2 is the 24-hour nonsurvivor group (n = 10). The data are presented as median values with an interquartile range or as a n (%). AIS, Abbreviated Injury Scale; TAE, transarterial embolization.

Lower limb ischemia	2 (14.2)
Arterial injury caused by puncture	1 (7.1)
Lower limb amputation	3 (21.3)



*Saito N, et al. J Trauma Acute Care Surg 2015;78:897–904.

AAST 2015 PLENARY PAPER

Resuscitative endovascular balloon occlusion of the aorta might
be dangerous in patients with severe torso trauma:
A propensity score analysis

**Junichi Inoue, MD, Atsushi Shiraishi, MD, PhD, Ayako Yoshiyuki, MD, Koichi Haruta, MD,
Hiroki Matsui, MPH, and Yasuhiro Otomo, MD, PhD, Tokyo, Japan**

*Inoue J, et al. J Trauma Acute Care Surg 2016;80:559-67.

Resuscitative endovascular balloon occlusion of the aorta might
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Hiroki Matsui, MPH, and Yasuhiro Otomo, MD, PhD, Tokyo, Japan

Outcome	With REBOA	Without REBOA
Primary outcome		
In-hospital mortality, %	61.8 (57.9–65.7)	45.3 (41.3–49.3)
Secondary outcomes		
ED mortality, %	17.1 (14.1–20.1)	9.7 (7.3–12.1)
Door-to-blood transfusion time, median, min	50 (44–57)	64 (58–71)
Door-to-primary surgery time, median, min	97 (90–104)	110 (102–119)

*Inoue J, et al. J Trauma Acute Care Surg 2016;80:559-67.



Research

JAMA Surgery | Original Investigation

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

Propensity score matching

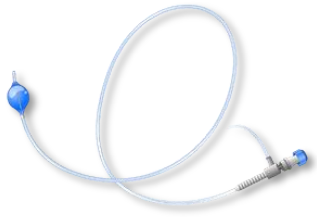
Joseph B et al. JAMA surg 2019

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

AKI Amputation High 24-h mortality

Variable	Patients, No. (%)		P Value
	No-REBOA Group (n = 280)	REBOA Group (n = 140)	
Complications			
Acute kidney injury	9 (3.2)	15 (10.7)	.02
Amputation of lower limb	2 (0.7)	5 (3.6)	.04
Deep venous thrombosis	14 (5.0)	6 (4.3)	.42
Pulmonary embolism	5 (1.8)	2 (1.4)	.28
Stroke	3 (1.1)	2 (1.4)	.37
Myocardial infarction	1 (0.4)	0	.51
Extremity compartment syndrome	2 (0.7)	1 (0.7)	.39
Overall mortality	53 (18.9)	50 (35.7)	.01
Mortality in the ED	5 (1.8)	4 (2.9)	.35
24-h Mortality	33 (11.8)	37 (26.4)	.01
In-hospital mortality after 24 h	15 (5.4)	9 (6.4)	.21





Lower limb **amputation** ?



12 Fr

11 Fr

10 Fr

7 Fr

7 Fr



AAST 2014 PLENARY PAPER

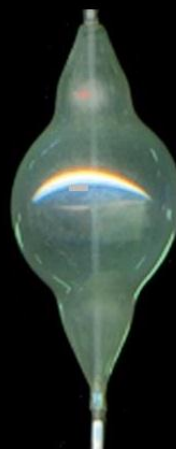
Evaluation of the safety and feasibility of resuscitative endovascular balloon occlusion of the aorta



Research

JAMA Surgery | Original Investigation

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma



12 Fr

11 Fr

10 Fr

7 Fr

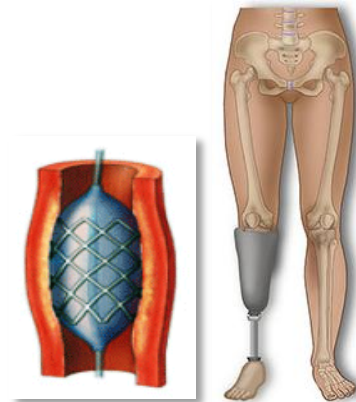
7 Fr



Small profile REBOA

Fewer REBOA complications with smaller devices and partial occlusion: evidence from a multicentre registry in Japan

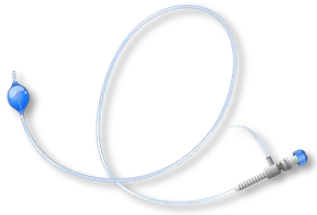
Yosuke Matsumura,¹ Junichi Matsumoto,² Hiroshi Kondo,³ Koji Idoguchi,⁴ Tokiya Ishida,⁵ Yuri Kon,⁶ Keisuke Tomita,⁷ Kenichiro Ishida,⁸ Tomoya Hirose,⁹ Kensuke Umakoshi,¹⁰ Tomohiro Funabiki,¹¹ DIRECT-IABO Investigators



Fewer complications in **Small sheath**

Table 3 Procedures and complications among groups according to sheath size in 24-hour survivors

Procedures and complications	Small group (n=53)	Large group (n=25)	Unusual group (n=3)
Access-related complications, n (%)			
Dissection	1 (1.9)	0 (0)	0 (0)
Pseudoaneurysm	0 (0)	0 (0)	0 (0)
Massive haematoma	1 (1.9)	0 (0)	0 (0)
Retroperitoneal haematoma	0 (0)	0 (0)	0 (0)
Thromboembolism	0 (0)	1 (4.0)	0 (0)
Leg ischaemia	0 (0)	0 (0)	2 (67)
Treatment for complication, n (%)			
Fasciotomy	0 (0)	0 (0)	2 (67)
Amputation	0 (0)	0 (0)	2 (67)
PTA	0 (0)	1 (4.0)	0 (0)



Higher mortality?

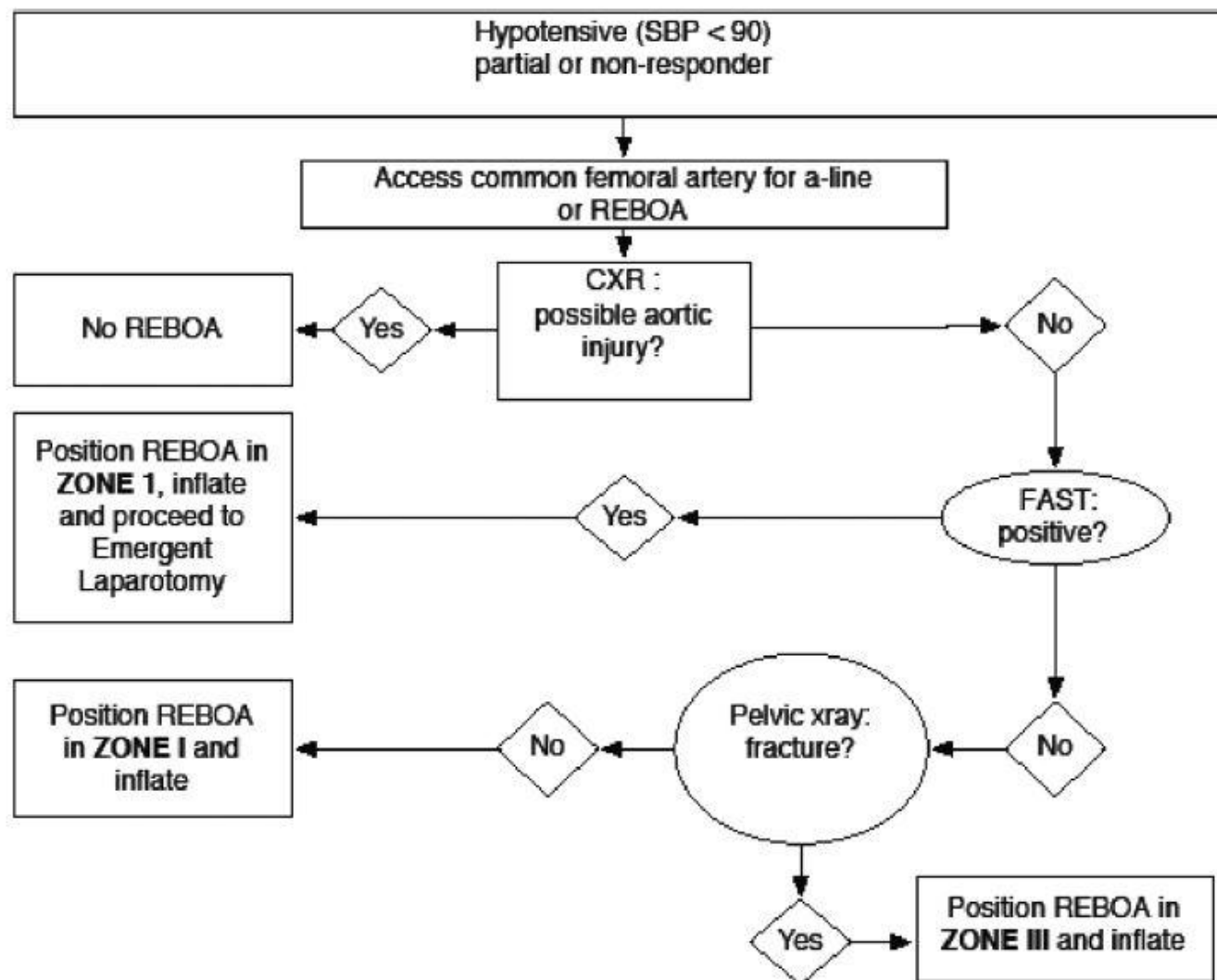


How should we use REBOA ?

REBOA Algorithms

Basic endovascular skills for trauma course: Bridging the gap between endovascular techniques and the acute care surgeon

Megan Brenner, MD, MS, RPVI, Melanie Hoeft, MD, Jason Pasley, DO, Joseph Dubose, MD, Deborah Stein, MD, MPH, and Thomas Scalea, MD, Baltimore, Maryland



The role of REBOA in the control of exsanguinating torso hemorrhage

Walter L. Biffl, MD, Charles J. Fox, MD, and Ernest E. Moore, MD, *Denver, Colorado*



DENVER HEALTH
est. 1860
FOR LIFE'S JOURNEY

Algorithm for Control of Torso Hemorrhage

Localize Hemorrhage with CXR, FAST, Pelvis X-Ray

		A	B	C	D
	SBP	CPR	<60	60-80	> 80
1	Thoracic Hemorrhage	EDT	EDT	EDT vs OR	OR Thoracotomy
2	Abdominal Hemorrhage	EDT	EDT vs REBOA	OR vs REBOA	OR Laparotomy
3	Pelvic Hemorrhage	EDT	REBOA vs EDT	REBOA	OR Pelvic Packing

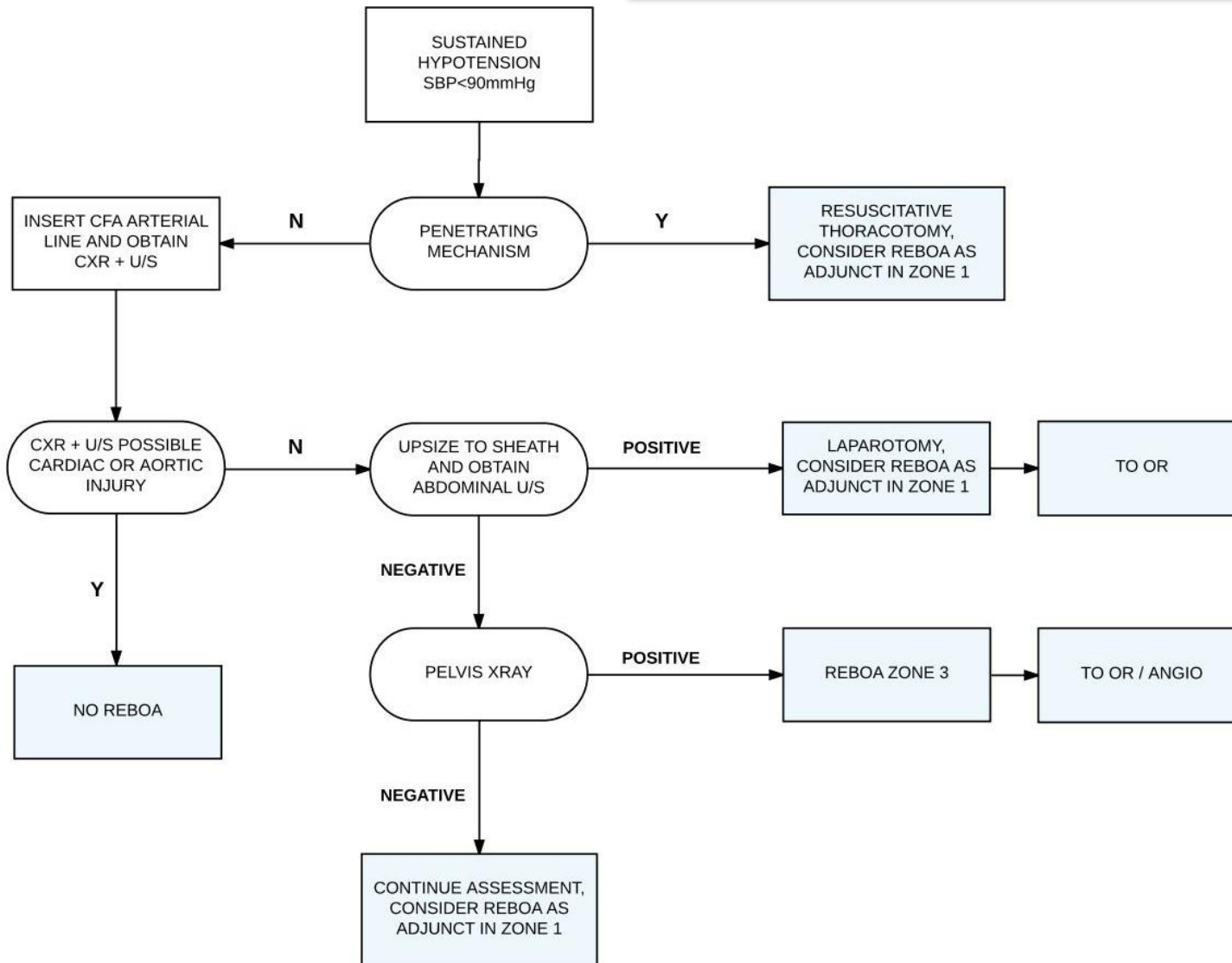
ALGORITHM 2 - REBOA

Presenter: Kenji Inaba



Physicians of all specialties committed to improving trauma care

Western Trauma Association



How many **REBOA Algorithms**
do we have to learn ?



Trauma Strategy > REBOA Algorithms



1. RT+REBOA

2. Early access, Undelayed & Short occlusion

3. Education & Research

Case

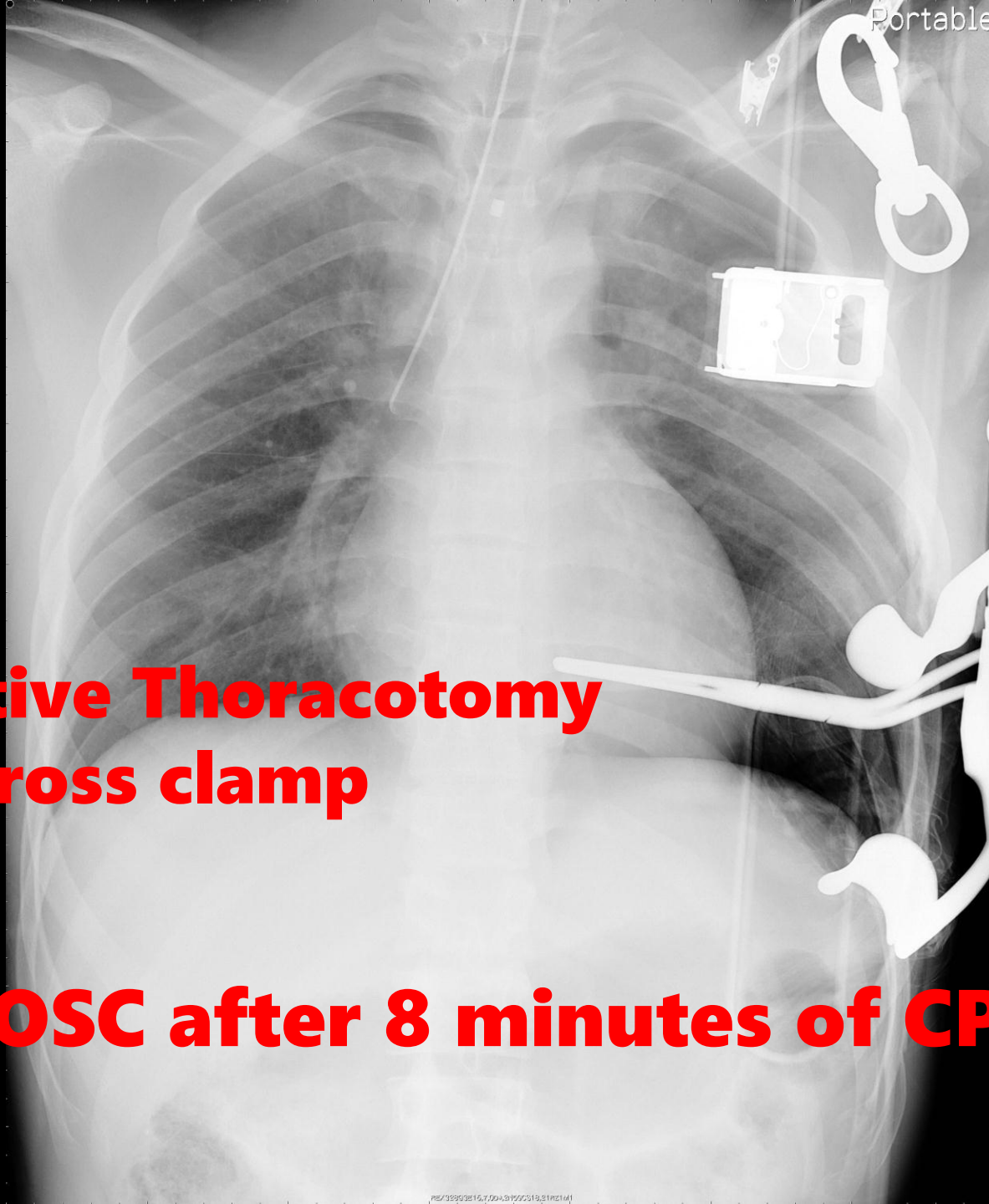
17M, Fall from 11th story

Collapsed 5 mins before arrival
CPR initiated

ER
OR
Angio
CT
ICU

**Resuscitative Thoracotomy
& Aortic cross clamp**

ROSC after 8 minutes of CPR



ER

OR

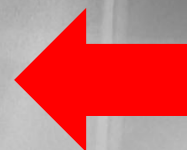
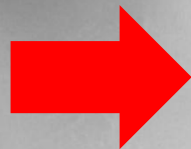
Angio

CT

ICU

FAST exam negative

ER
OR
Angio
CT
ICU



Pelvic Fx
(Bilateral Sacral Fx.)



ER
OR
Angio
CT
ICU

Bilateral arterial access

4Fr

9Fr

7Fr

Large venous access

MTP initiated

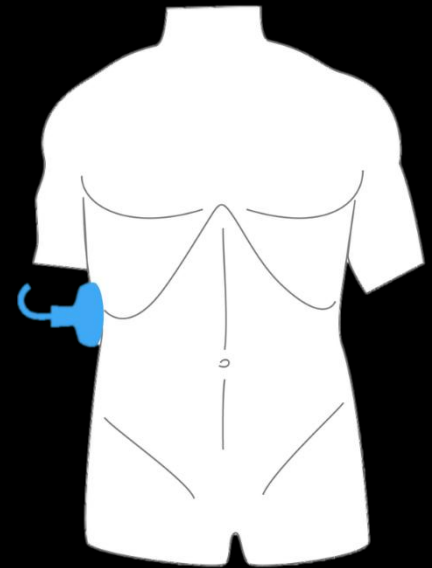
ER
OR

Angio

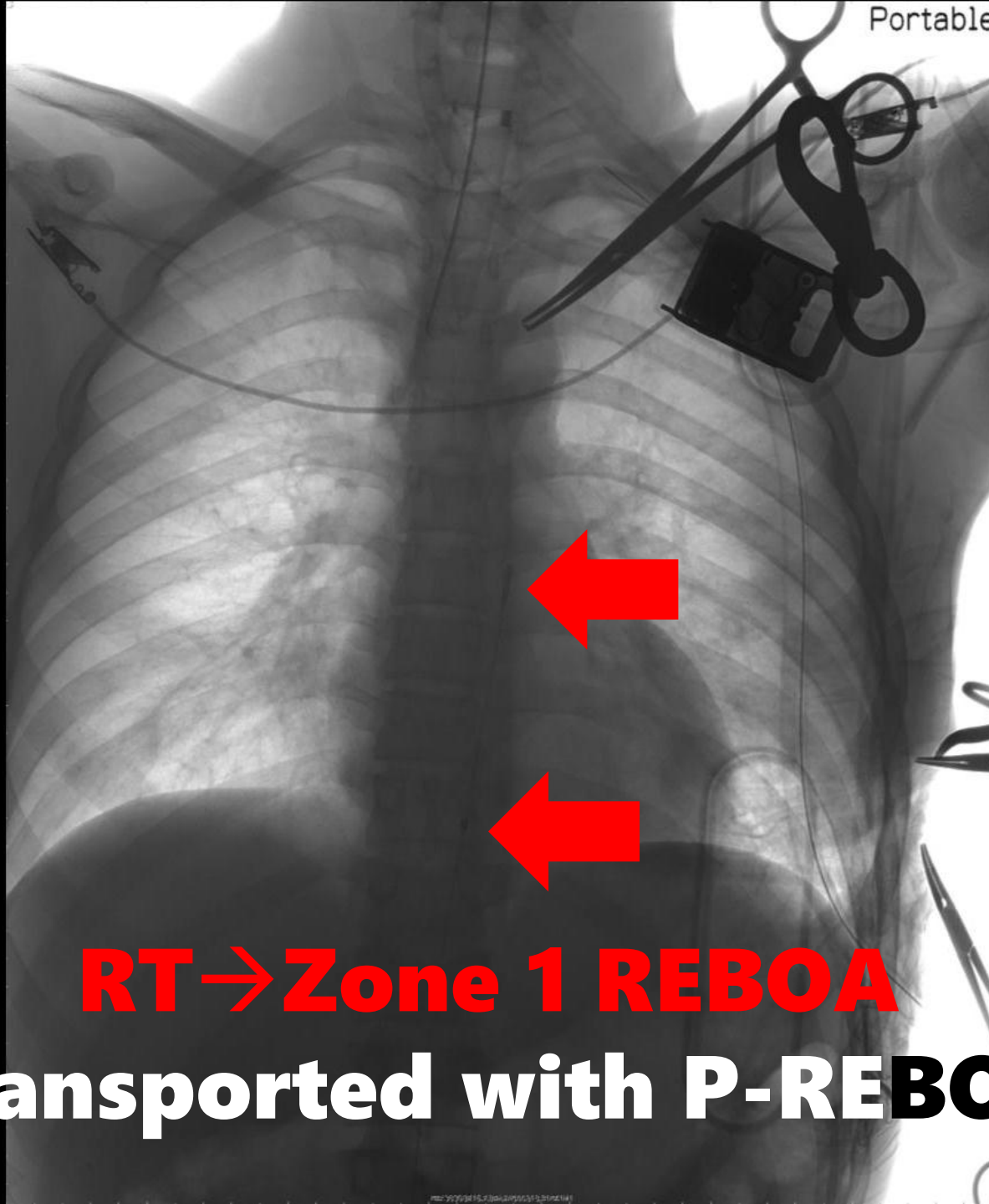
CT

ICU

FAST positive@RUQ
→ Laparotomy First



ER
OR
Angio
CT
ICU



RT→Zone 1 REBOA

Transported with P-REBOA

ER
OR

P-REBOA <20min

Angio
CT
ICU

Liver injury (Grade II)

-bleeding at round lig.

-No other organ injury

Retroperitoneal hematoma

Expanding

**→ Perihepatic Packing
& Open abdomen**

Embolization



Lt. IIA



“DCIR”



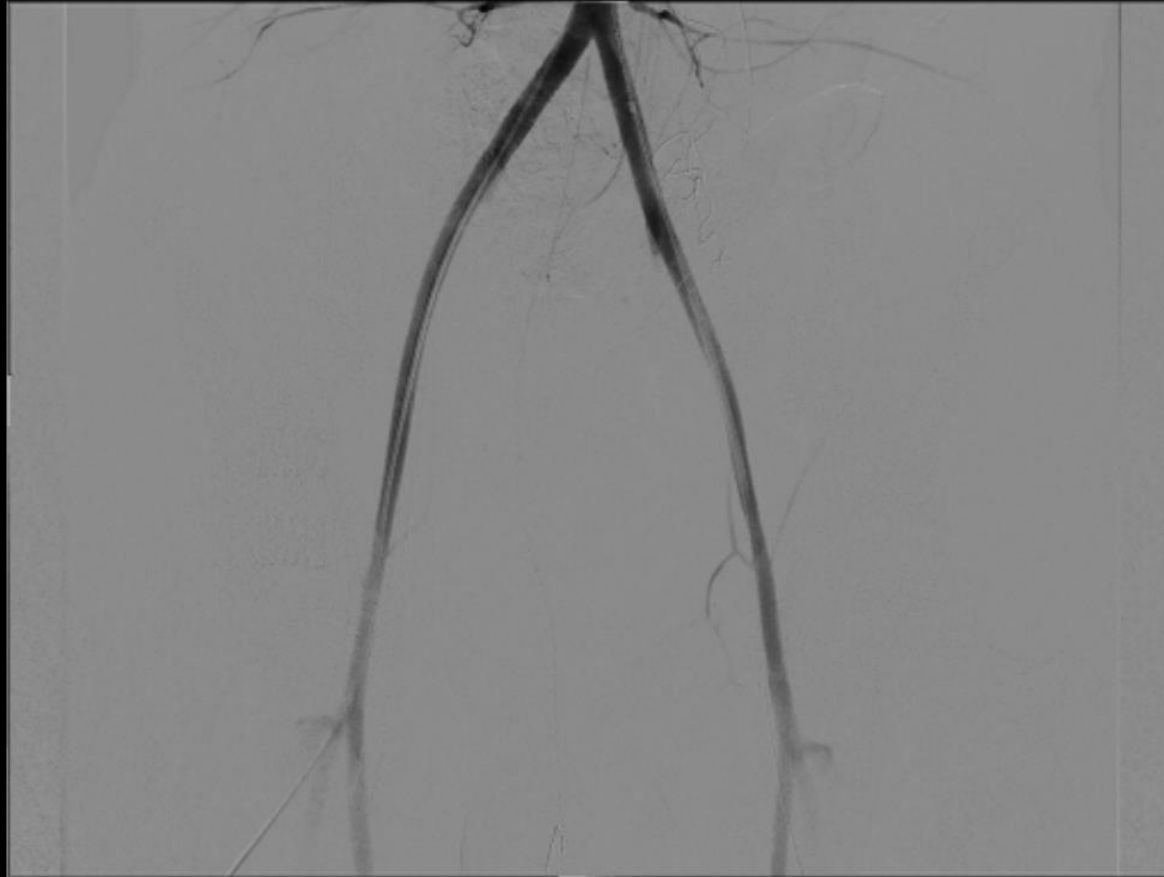
Rt. IIA

ER
OR
Angio
CT
ICU



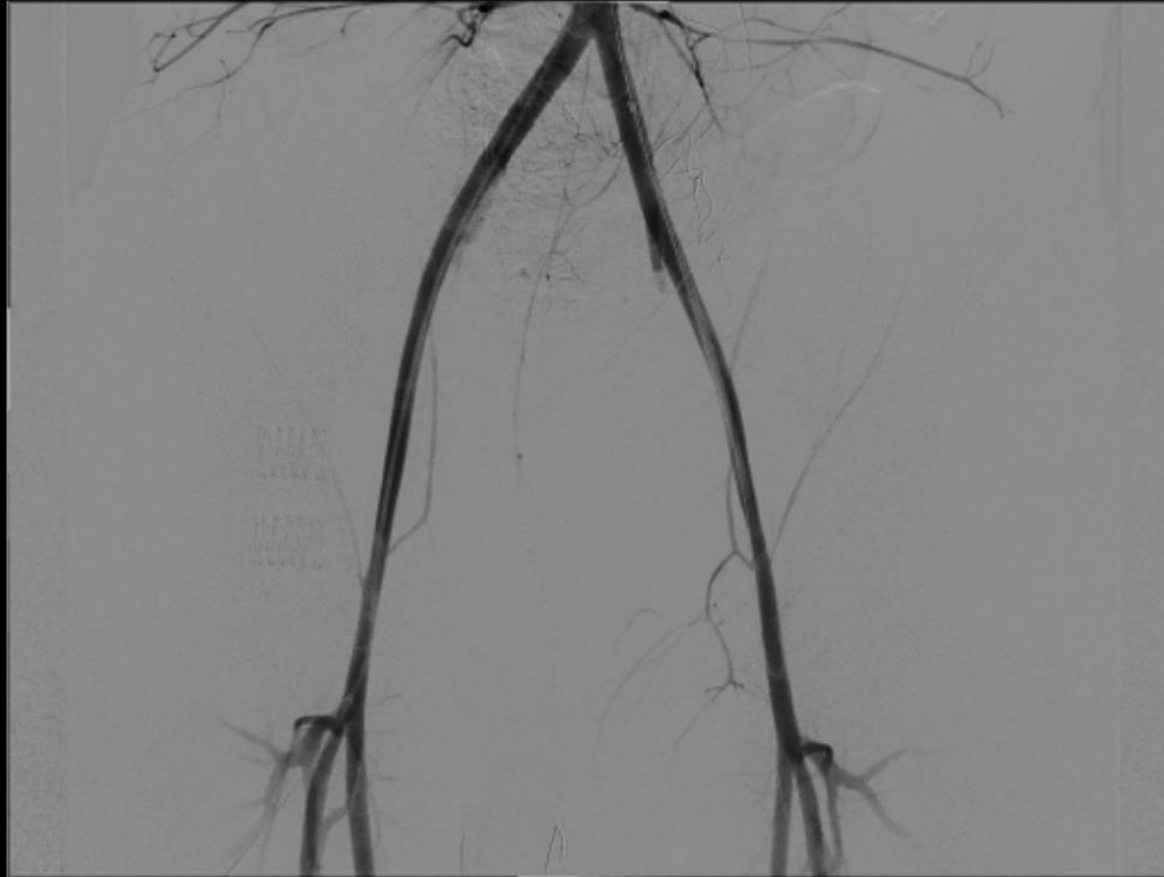
Pelvic Angiography: Ev (-)

ER
OR
Angio
CT
ICU



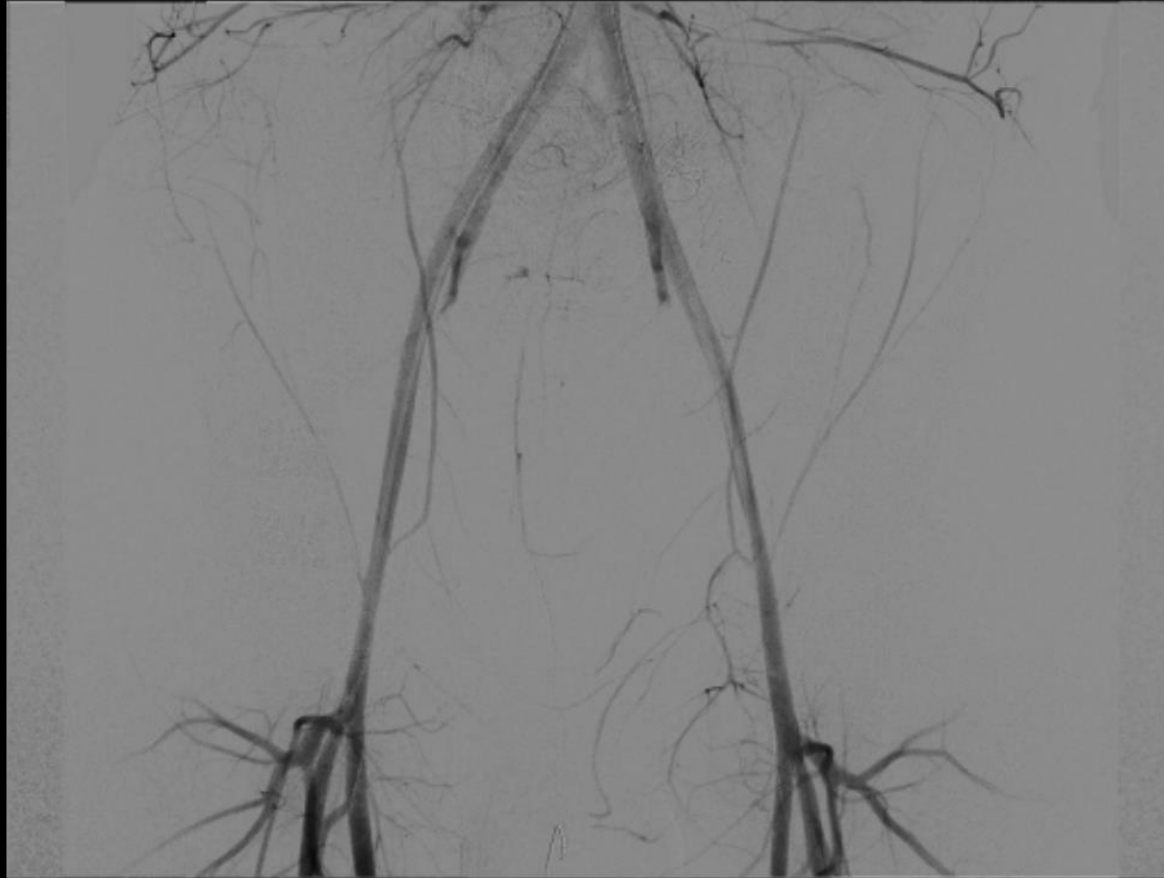
Pelvic Angiography: Ev (-)

ER
OR
Angio
CT
ICU



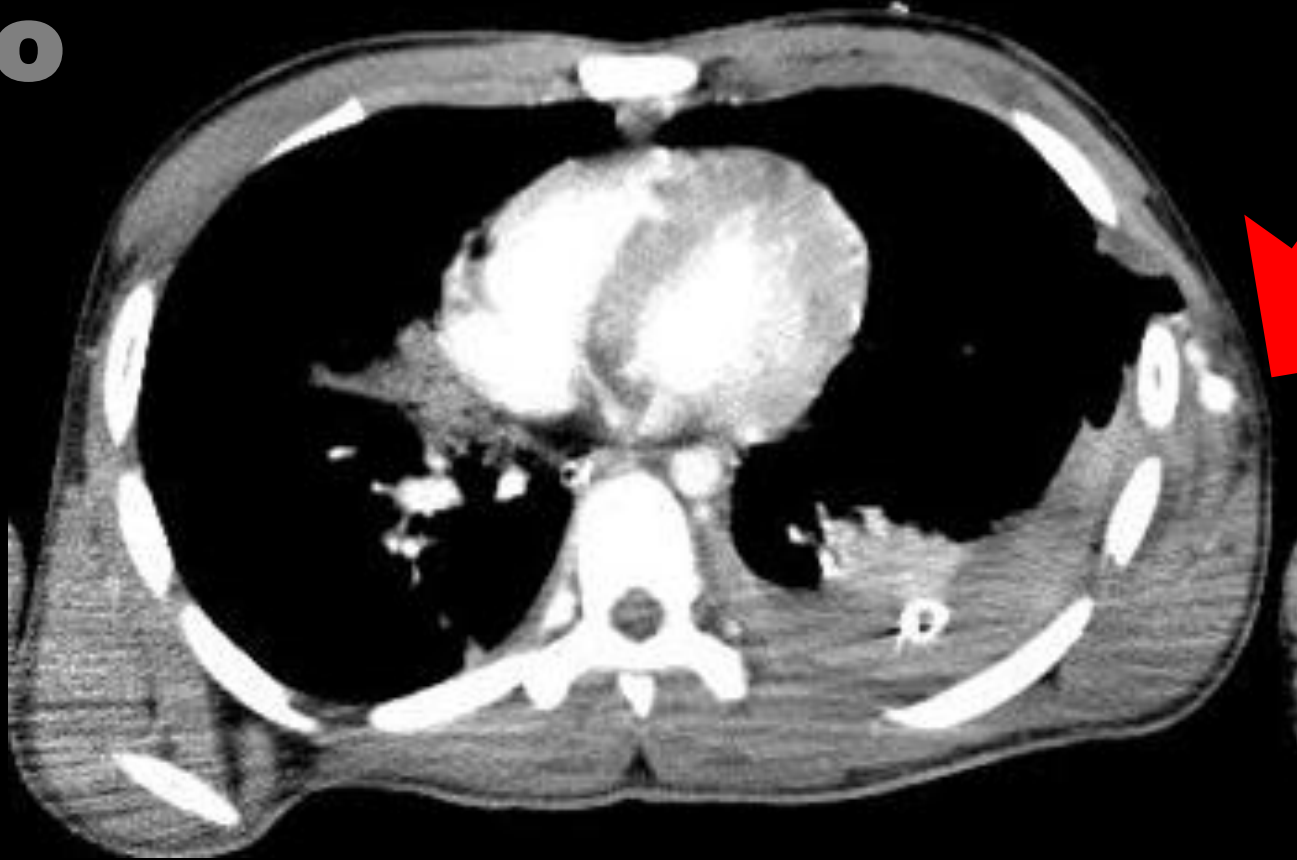
Pelvic Angiography: Ev (-)

ER
OR
Angio
CT
ICU

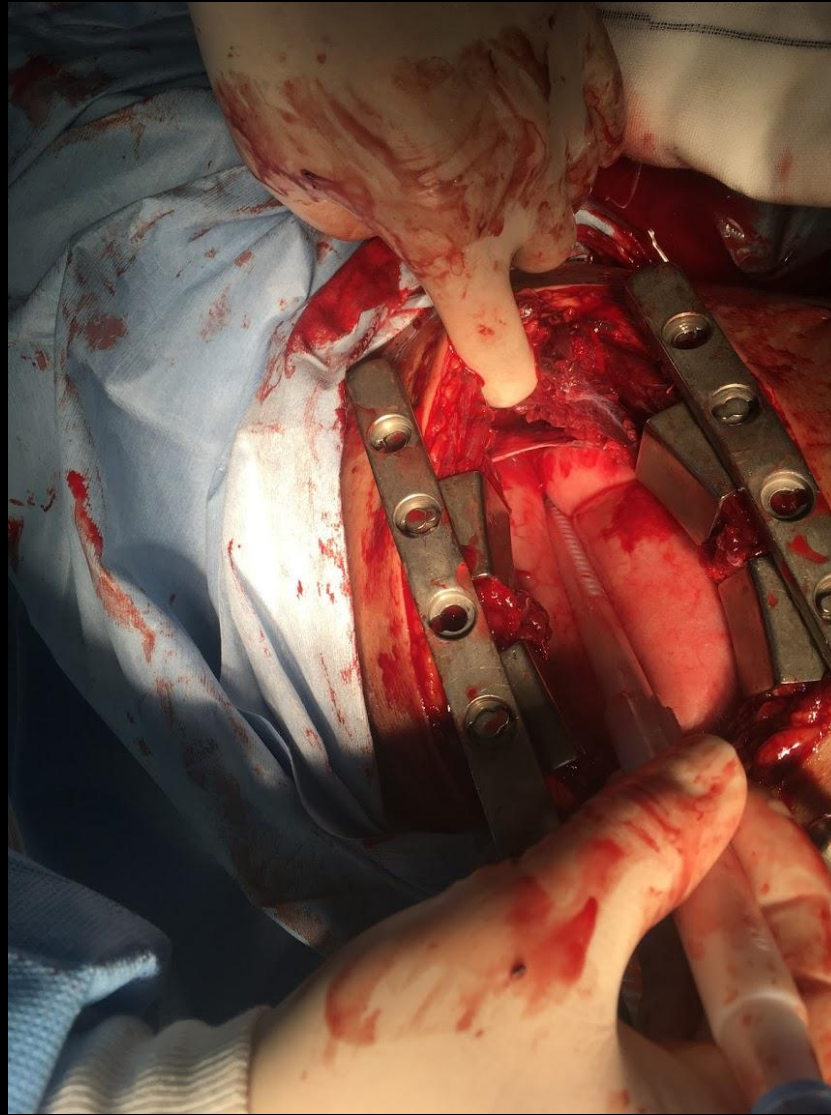


Pelvic Angiography: Ev (-)

ER
OR
Angio
CT
ICU



ER
OR
Angio
CT
ICU



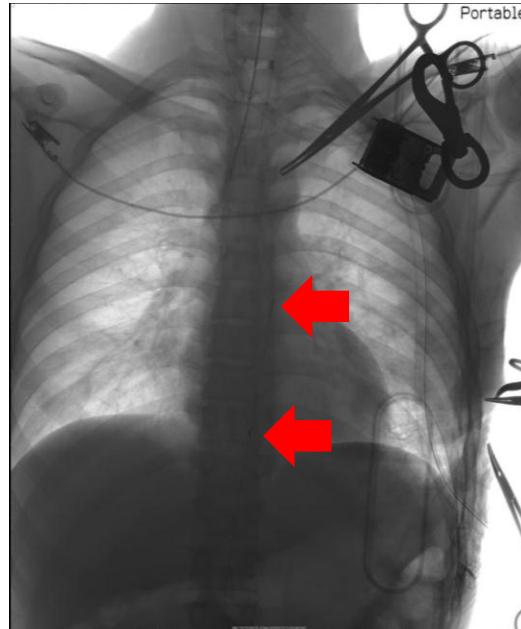
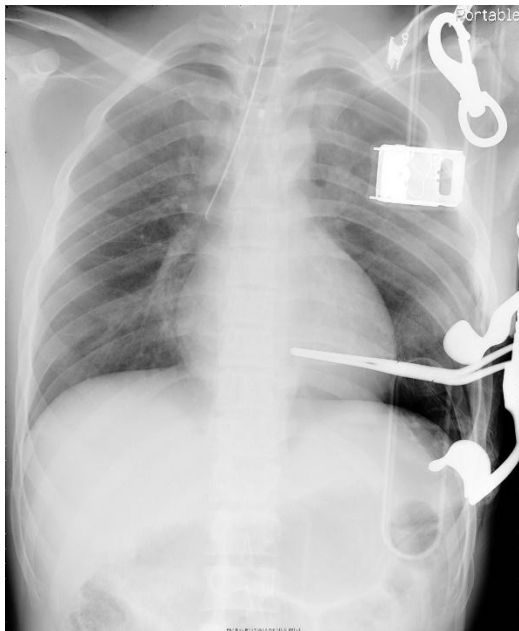
Re-closure of Chest wall

1. RT+REBOA

2. Early access, Undelayed & Short occlusion

3. Education & Research

ER **RT + Access → REBOA**
OR **P-REBOA → Deflation <20min**
Angio **Damage Control IR**
CT **Reassessment: Chest**
ICU **Reclosure**



RT

Speedy & Definite

Invasive

New chest wound

Chest wall bleeding

Spinal artery injury

Hypothermia

Pyothorax



REBOA

Less invasive &
Adjustable

Less speedy
CFA puncture
Tortuous Aorta

Leg ischemia
Visceral artery injury
Balloon migration

RT

Speedy & Definite



Invasive

New chest would



Chest wall bleeding
Spinal artery injury
Hypothermia
Pyothorax



REBOA

Less invasive &
Adjustable

Less speedy
CFA puncture
Tortuous Aorta

Leg ischemia
Visceral artery injury
Balloon migration

S^{STT}
D/Reef

Hemodynamic Instability → Start CFA Access

Impending CA

N

CFA Access placed

Y

Y

N

Consider

REBOA

Resuscitative Thoracotomy



Uncertainty in **Tortuous aorta**
Advanced age

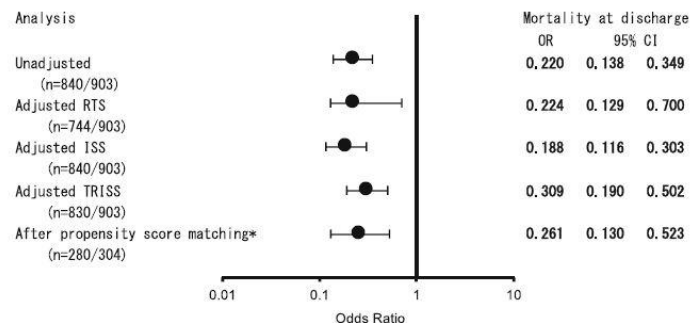


Resuscitative endovascular balloon occlusion of the aorta versus aortic cross clamping among patients with critical trauma: a nationwide cohort study in Japan

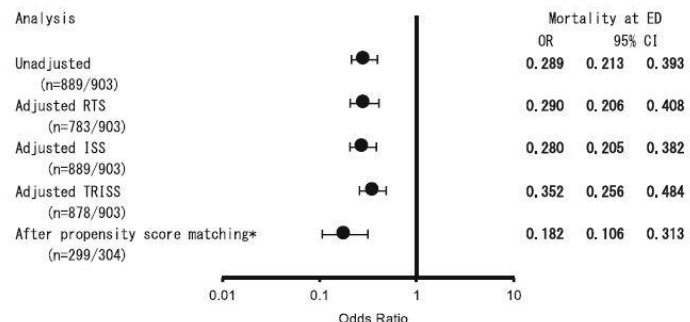
Toshikazu Abe^{1,2*}, Masatoshi Uchida¹, Isao Nagata¹, Daizoh Saitoh³ and Nanako Tamiya¹

REBOA > RT

a



b



Diagnosis Procedure Combination Database



ORIGINAL ARTICLE

Resuscitative endovascular balloon occlusion of the aorta or resuscitative thoracotomy with aortic clamping for noncompressible torso hemorrhage: A retrospective nationwide study

N.S.

in ICU-free days (χ^2 test, $p = 0.1935$) (Table 2). In the propensity score-adjusted Cox regression analysis, there was no significant difference between the REBOA and RT groups with respect to in-hospital mortality (hazard ratio, 0.94; 95% confidence interval [CI], 0.60–1.48; $p = 0.7917$). In the propensity

Abe T et al. Crit Care 2016;20:400

Aso S et al. J Trauma Acute Care Surg 2017;82:910

Resuscitative Endovascular Balloon Occlusion of the Aorta and Resuscitative Thoracotomy in Select Patients with Hemorrhagic Shock: Early Results from the American Association for the Surgery of Trauma's Aortic Occlusion in Resuscitation for Trauma and Acute Care Surgery Registry



No CPR
SBP <90mmHg



REBOA > RT

[9.1% (26/285)]

[RT = 65.4% (17/26); REBOA = 34.6% (9/26)]

Survival beyond ED

RT = 47.1% (8/17)

REBOA = 100% (9/9)

p = 0.009

Survival to discharge

RT = 0% (0/17)

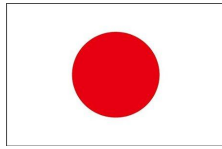
REBOA = 44.4% (4/9)

p = 0.008

RT vs. REBOA ?

Partial occlusion, conversion from thoracotomy, undelayed but shorter occlusion: resuscitative endovascular balloon occlusion of the aorta strategy in Japan

Yosuke Matsumura^{a,b}, Junichi Matsumoto^c, Hiroshi Kondo^d, Koji Idoguchi^e and Tomohiro Funabiki^f;DIRECT-IABO investigators



RT+REBOA !

*Matsumura Y, et al. Eur J Emerg Med 2018;25:348-354.



An evidence-based approach to patient selection for emergency department thoracotomy: A practice management guideline from the Eastern Association for the Surgery of Trauma

In patients who present pulseless to the Emergency Department with signs of life after blunt injury, we **conditionally recommend** resuscitative Emergency Department thoracotomy. **Conditional Recommendation**

In patients who present pulseless to the Emergency Department without signs of life after blunt injury, we **conditionally recommend against** resuscitative Emergency Department thoracotomy.² **Conditional Recommendation**

RT is not strongly recommended in
pulseless blunt trauma

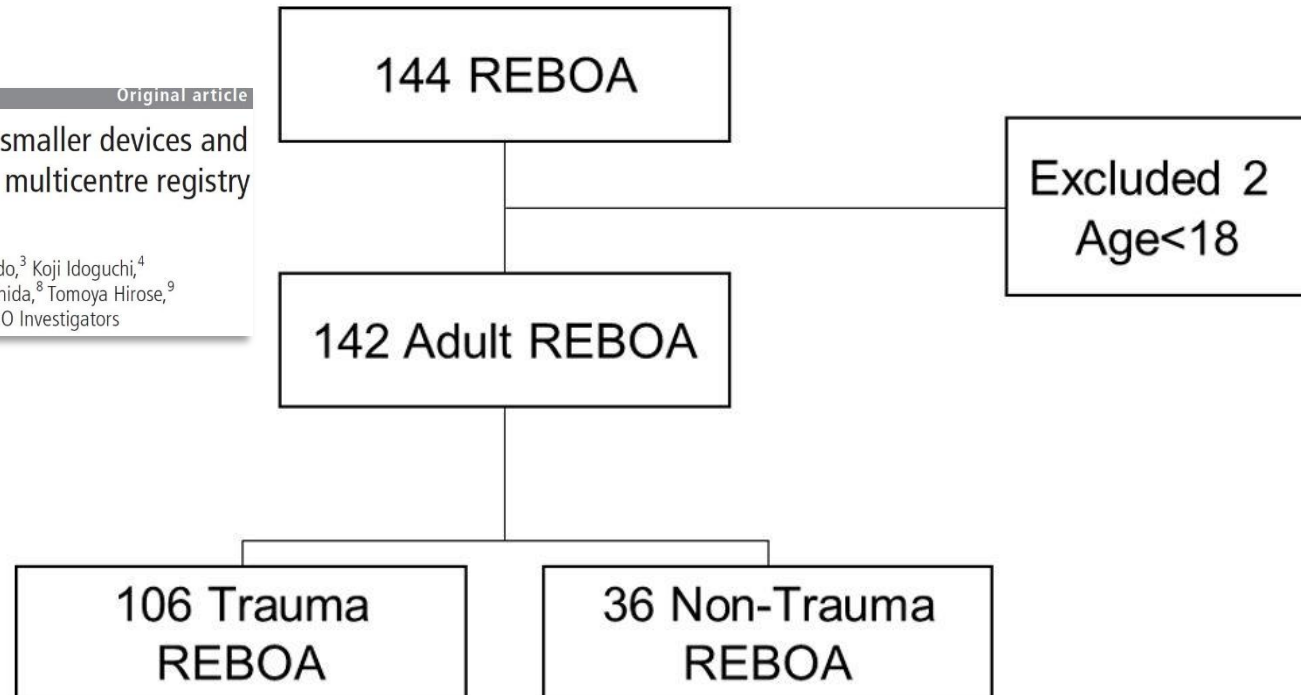
*Seamon MJ et al. J Trauma Acute Care Surg. 2015;79:159-73.

Aug 2011-Dec 2015, 18 Hospitals

Original article

Fewer REBOA complications with smaller devices and partial occlusion: evidence from a multicentre registry in Japan

Yosuke Matsumura,¹ Junichi Matsumoto,² Hiroshi Kondo,³ Koji Idoguchi,⁴ Tokiya Ishida,⁵ Yuri Kon,⁶ Keisuke Tomita,⁷ Kenichiro Ishida,⁸ Tomoya Hirose,⁹ Kensuke Umakoshi,¹⁰ Tomohiro Funabiki,¹¹ DIRECT-IABO Investigators



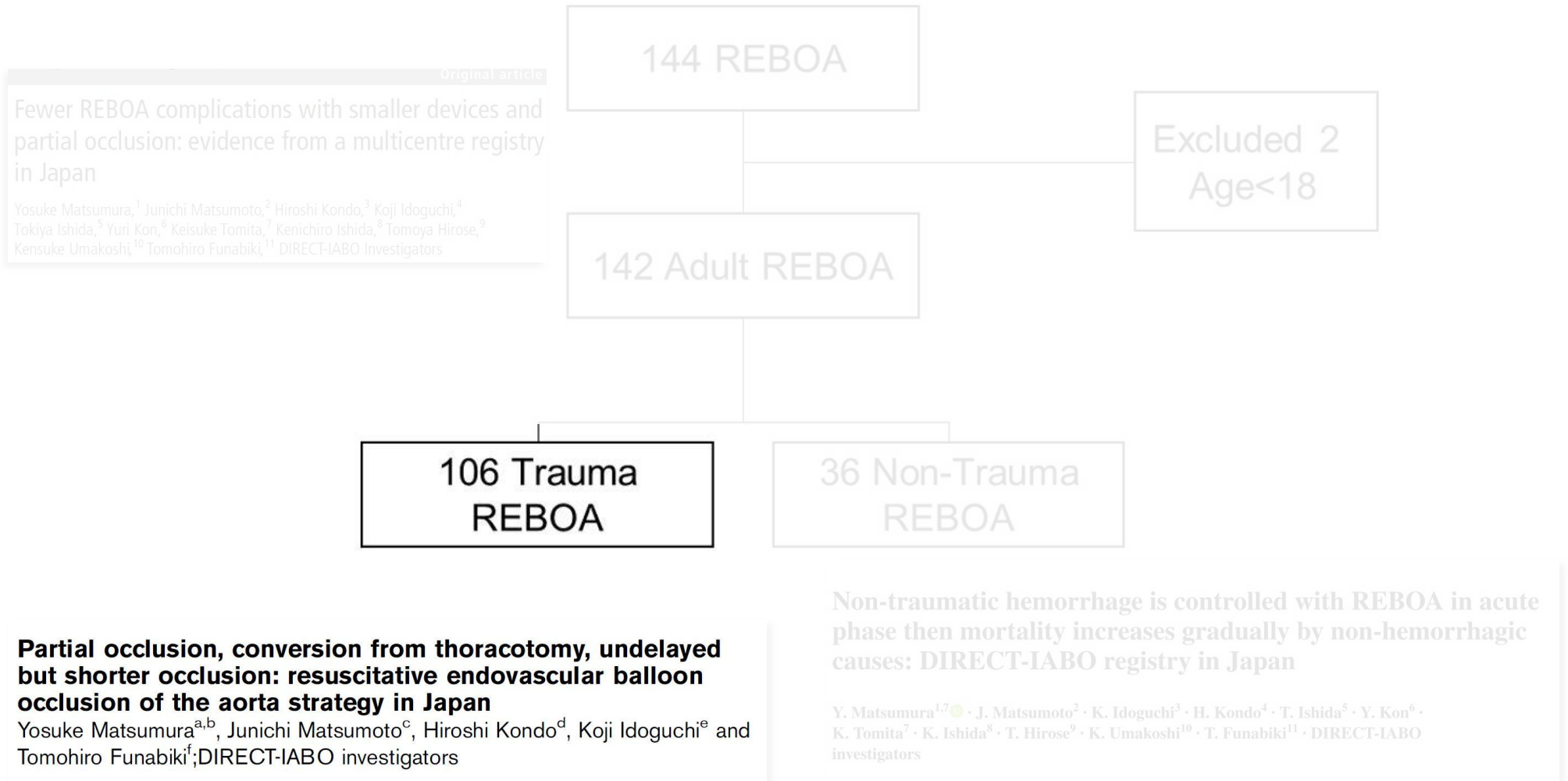
Partial occlusion, conversion from thoracotomy, undelayed but shorter occlusion: resuscitative endovascular balloon occlusion of the aorta strategy in Japan

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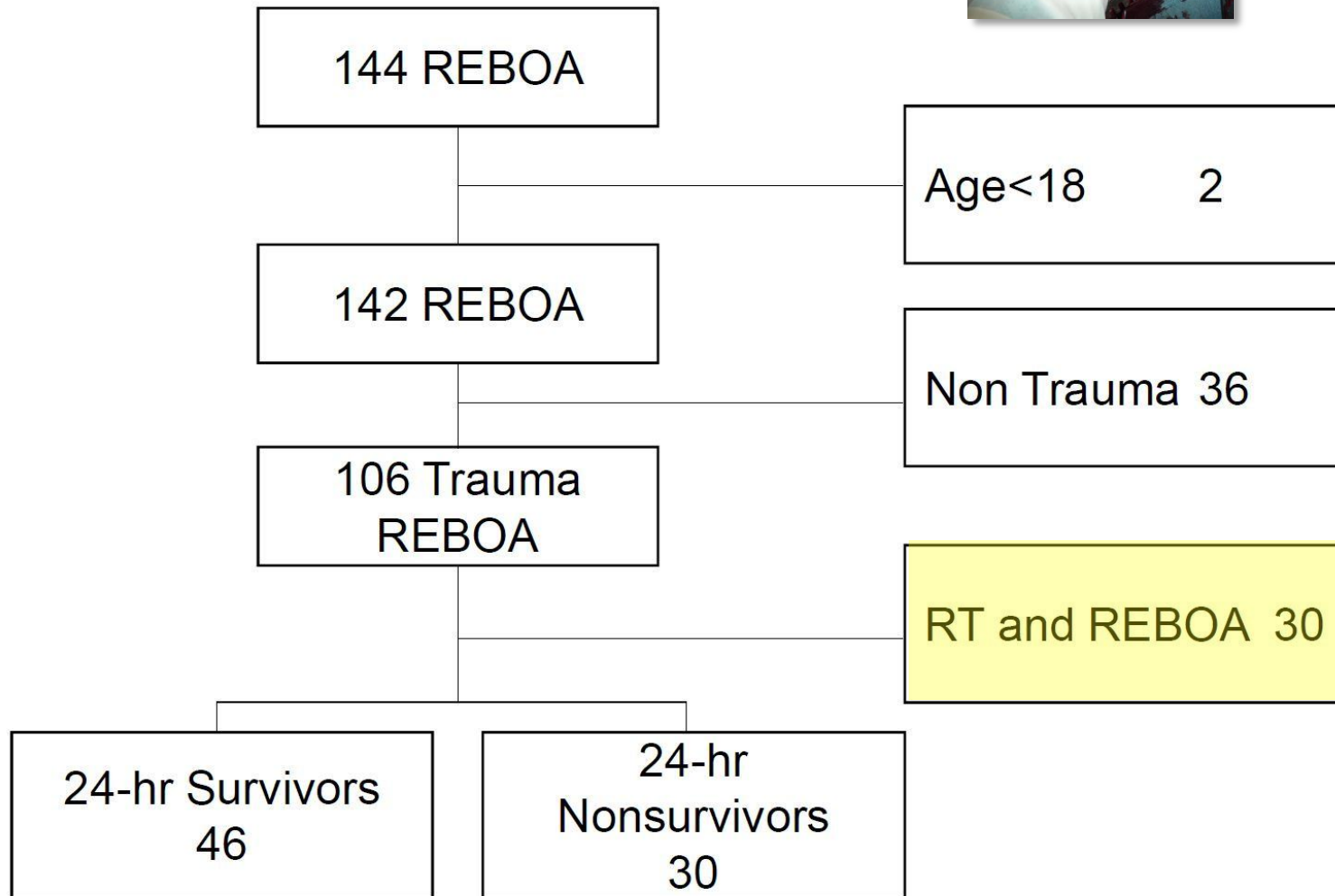
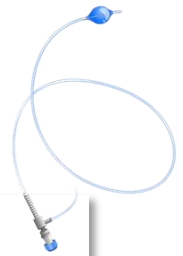
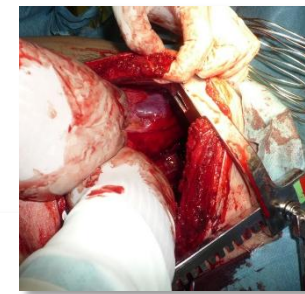
Non-traumatic hemorrhage is controlled with REBOA in acute phase then mortality increases gradually by non-hemorrhagic causes: DIRECT-IABO registry in Japan

Y. Matsumura^{1,7} · J. Matsumoto² · K. Idoguchi³ · H. Kondo⁴ · T. Ishida⁵ · Y. Kon⁶ · K. Tomita⁷ · K. Ishida⁸ · T. Hirose⁹ · K. Umakoshi¹⁰ · T. Funabiki¹¹ · DIRECT-IABO investigators

Aug 2011-Dec 2015, 18 Hospitals

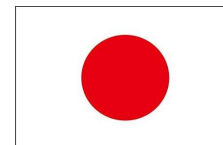


RT+REBOA population



Partial occlusion, conversion from thoracotomy, undelayed but shorter occlusion: resuscitative endovascular balloon occlusion of the aorta strategy in Japan

Yosuke Matsumura^{a,b}, Junichi Matsumoto^c, Hiroshi Kondo^d, Koji Idoguchi^e and Tomohiro Funabiki^f;DIRECT-IABO investigators



	24-h nonsurvivors (n = 24)	24-h survivors (n = 6)	P
CPR before REBOA	16 (67)	6 (100)	0.16
At field	12 (50)	5 (83)	
On arrival	8 (33)	3 (50)	
Preocclusion	11 (46)	3 (50)	

RT + REBOA may give a chance
even in **pulseless blunt** trauma

Conversion prevents **hypothermia**

Closing chest prevents **chest wall** bleeding



*Matsumura Y, et al. Eur J Emerg Med 2018;25:348-354.

1. RT+REBOA

2. Early access, Undelayed & Short occlusion

3. Education & Research

**ER
OR
Angio
CT
ICU**

**RT + Access → REBOA
P-REBOA → Deflation <20min
Damage Control IR
Reassessment: Chest
Reclosure**



Bilateral arterial access

4Fr

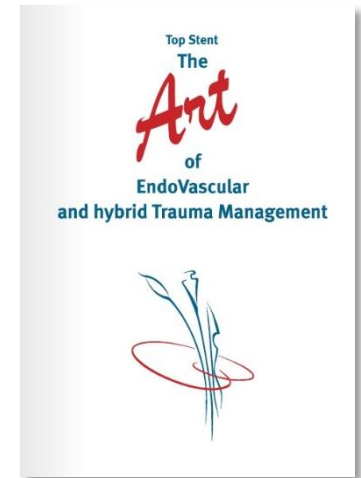
9Fr

7Fr

Large venous access

MTP initiated

"TOP STENT"

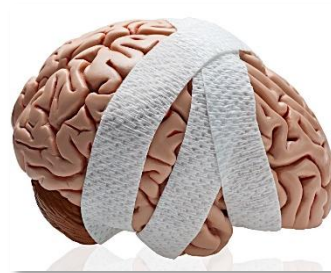
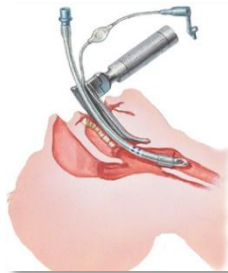


Chapter 1

It is all about the vascular access

*Yosouke Matsumura, Junichi Matsumoto, Lauri Handolin, Lars Lönn,
Jonny Morrison, Joe DuBose and Tal Hörer*

As a modification of the traditional “ABCDE” mnemonic advocated in the ATLS protocol approach to initial trauma evaluation and treatment, an EVTM enabled provider might consider using an “**AABCDE**” (airway **and simultaneous vascular access**, breathing, circulation etc.). Why might the use of the AABCDE-centered thought process prove useful? Very simply: this



Arterial access

Advantage



Disadvantage

Upsize to REBOA

Early IR

A-line

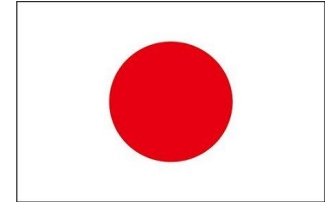
Blood sampling

Vascular injury

Hematoma

Delayed access can lead a catastrophe

- ...Less palpable
- ...Cardiac arrest
- ...Hematoma



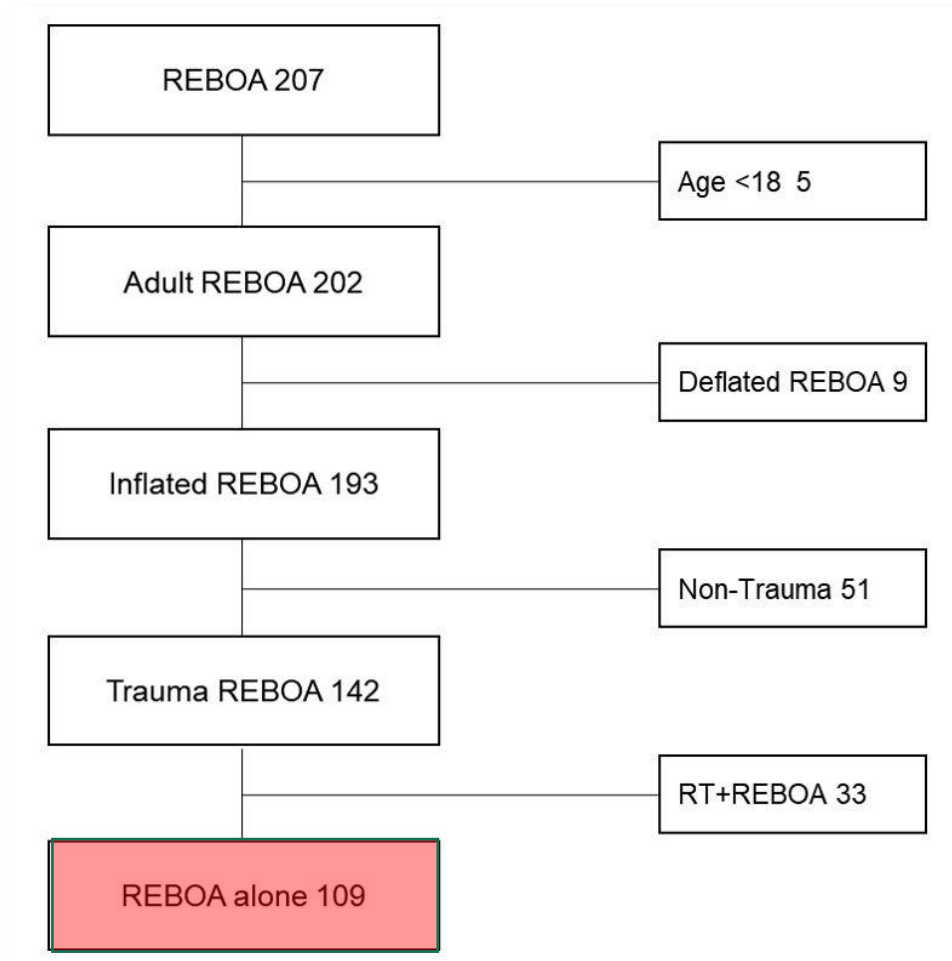
ORIGINAL ARTICLE

Early arterial access for resuscitative endovascular balloon occlusion of the aorta is related to survival outcome in trauma

Yosuke Matsumura, MD, PhD, Junichi Matsumoto, MD, PhD, Hiroshi Kondo, MD, PhD, Koji Idoguchi, MD, Tokiya Ishida, MD, Yohei Okada, MD, Yuri Kon, MD, Kazuyuki Oka, MD, Kenichiro Ishida, MD, Yukitoshi Toyoda, MD, Tomohiro Funabiki, MD, PhD, and DIRECT-IABO Investigators, Chiba, Japan

*Matsumura Y, et al. J Trauma Acute Care Surg 2018;85:507-511.

From Aug 2011-Dec 2016, 23 Hospitals



Characteristics	Nonsurvivors (n = 49)	Survivors (n = 60)	<i>p</i>
ISS	43 (34–50)	33 (21–42)	<0.001
Head AIS score	3 (0–5)	0 (0–3)	0.11
Chest AIS score	4 (2–4)	3 (0–4)	0.14
Abdomen AIS score	2 (0–3)	3 (0–4)	0.10
Extremities or pelvis AIS score	4 (2–5)	3 (0–4)	0.039
CPR, n (%)			
Prehospital	5 (10.2)	1 (1.7)	0.088
Arrival	6 (12.2)	1 (1.7)	0.045
Occlusion	6 (12.2)	3 (5.1)	0.29
Vital signs on arrival			
RR, /min	24 (13–30)	24 (16–30)	0.95
HR, /min	100 (80–128)	105 (90–126)	0.75
SBP, mm Hg	74 (48–100)	90 (72–115)	0.20
Preocclusion SBP, mm Hg (n = 108)	58 (40–80)	76 (61–90)	0.018
Postocclusion SBP, mm Hg (n = 108)	102 (83–124)	116 (102–137)	0.023
P-REBOA, n (%) (n = 89)	21 (55.3)	40 (78.4)	0.023
Duration of aortic occlusion, min			
Total duration of occlusion (n = 89)	63 (40–99)	35 (20–70)	0.014
Duration of P-REBOA (n = 89)	5.5 (0–74)	20 (1.5–47)	0.30

Characteristics	Nonsurvivors (n = 49)	Survivors (n = 60)	<i>p</i>
Injury to arrival, min (n = 108)	35 (29–50)	45 (32–54)	0.019
Arrival to access, min (n = 95)	47 (23–83)	25 (10–57)	0.052
Arrival to inflation, min (n = 106)	61 (28–97)	58 (30–101)	1.00
Arrival to definitive hemostasis, min (n = 97)	88 (56–113)	78 (55–121)	0.77

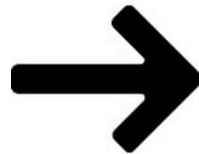
*Matsumura Y, et al. J Trauma Acute Care Surg 2018;85:507-511.

	OR	95% CI	<i>p</i>
Arrival to access, min	0.989	0.979–0.999	0.034
ISS	0.944	0.907–0.982	0.0039

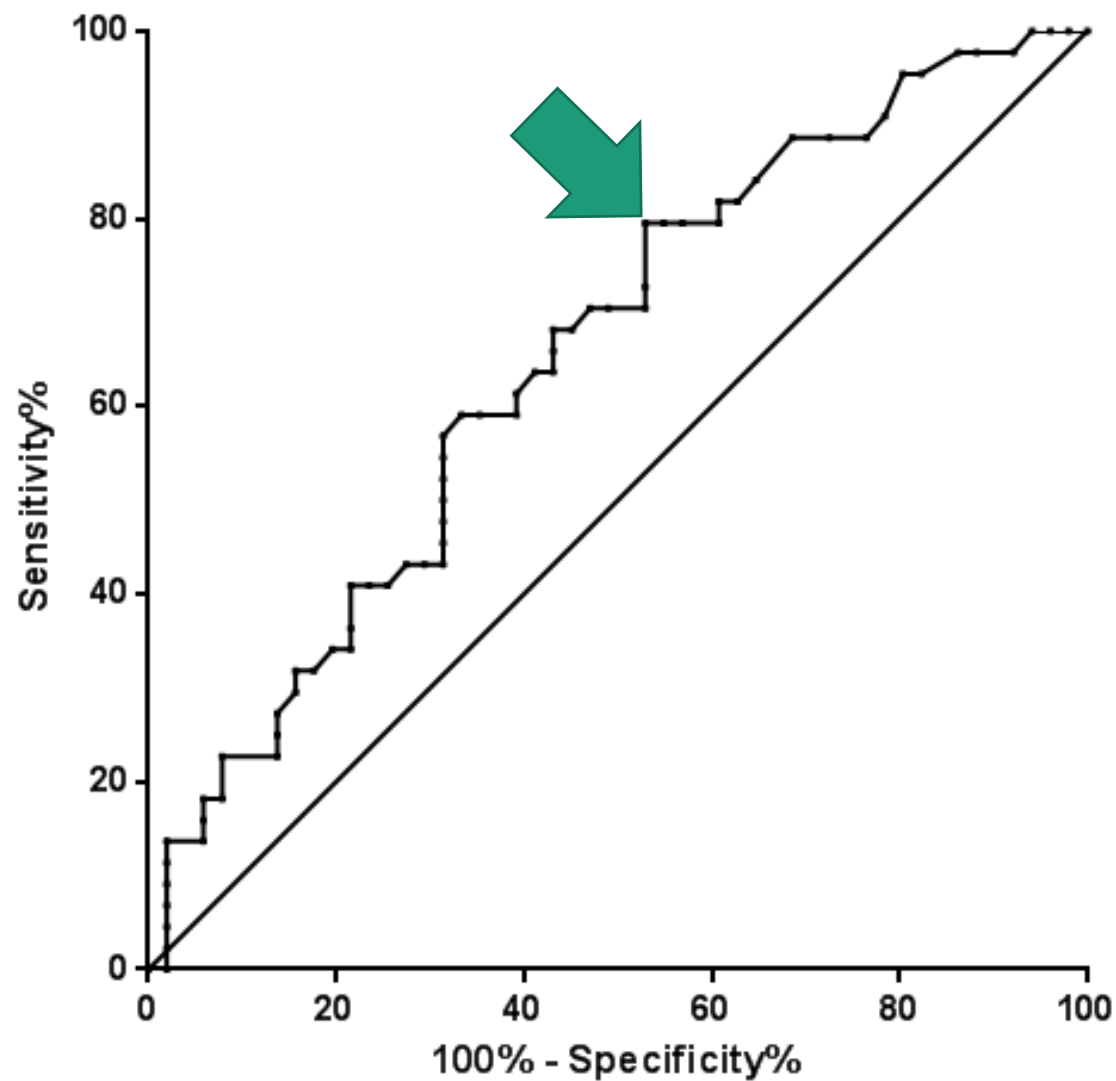
Binary logistic regression analysis was conducted with 30-day survival as the dependent variable and preocclusion SBP, total duration of occlusion, arrival to access, arrival to definitive hemostasis, and ISS as the independent variables.

*Matsumura Y, et al. J Trauma Acute Care Surg 2018;85:507-511.

$$0.989^{10} = 90\%$$



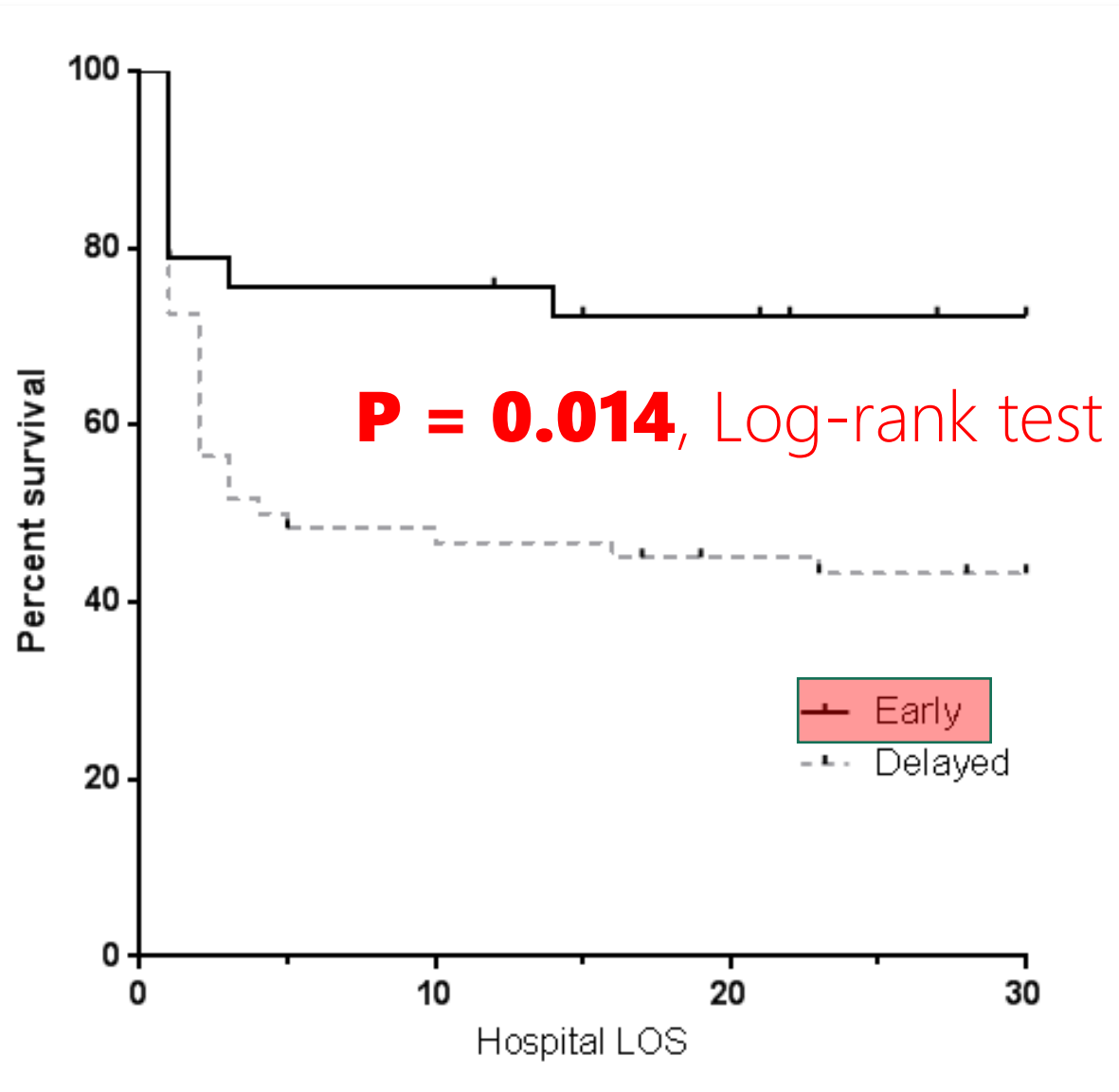
*Matsumura Y, et al. J Trauma Acute Care Surg 2018;85:507-511.



AUC 0.654
Sensitivity 79.5%
Specificity 47.1%

Cutoff
21.5 min

*Matsumura Y, et al. J Trauma Acute Care Surg 2018;85:507-511.



Benefit of Early Access in REBOA patients



1. RT+REBOA

2. Early access, **Undelayed & Short occlusion**

3. Education & Research

**ER
OR
Angio
CT
ICU**

**RT + Access → REBOA
P-REBOA → Deflation <20min
DCIR
Reassessment: Chest&Liver
Reclosure & VPC**



REBOA patient: **Who survived ? Who benefit ?**

Characteristics before and during occlusion	24-h nonsurvivors (n = 30)	24-h survivors (n = 46)	P
Characteristics before and during occlusion			
Age (years)	68 (41–77)	58 (43–65)	0.10
Male	16 (53)	35 (76)	0.048
Preocclusion status			
Injury severity score	37 (34–51)	34 (22–48)	0.037
Head AIS	0 (0–5.0)	2.5 (0–4.0)	0.96
Chest AIS	3.0 (3.0–4.0)	3.0 (0–4.0)	0.13
Abdominal AIS	2.0 (0–3.0)	3.0 (0–4.0)	0.071
Extremity or pelvis AIS	4.0 (2.0–5.0)	3.0 (0–4.0)	0.054
Arrival to occlusion (min)	60 (28–92)	60 (26–83)	0.73
CPR before REBOA	7 (23)	4 (8.7)	0.10
Preocclusion SBP (mmHg)	43 (40–80)	72 (55–91)	0.002
Postocclusion SBP (mmHg)	100 (90–120)	120 (100–145)	0.007
Hemodynamics after REBOA			
Improvement in hemodynamics	25 (83)	42 (91)	0.31
Achievement of stability	18 (60)	44 (96)	<0.001



Characteristics before and during occlusion	24-h nonsurvivors (<i>n</i> = 30)	24-h survivors (<i>n</i> = 46)	<i>P</i>
Management during occlusion			
Partial occlusion	14 (54)	26 (70)	0.20
Duration of aortic occlusion (min)			
Total duration of occlusion	60 (40–99)	31 (11–70)	0.010
Duration of partial occlusion	5 (0–35)	11 (0–44)	0.47



*Matsumura Y, et al. Eur J Emerg Med 2018;25:348-354.

Undelayed (SBP **70mmHg)**
Shorter (30** min)** occlusion




70
mmHg



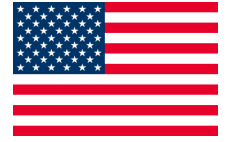
30
MINUTES





			
Patient	Advanced	Middle-advanced	Young
Mechanism	Blunt >>> Penetrating	Blunt >> Penetrating	Blunt > Penetrating
Trauma team	Multi-disciplinary	Multi-disciplinary	Surgeon-centered
Resuscitation	EM	EM	Surgeon, EM

Acute Care Surgeon should perform ?

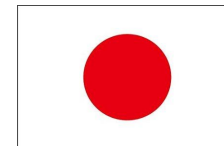


GUIDELINES FOR REBOA USE AND IMPLEMENTATION

- ▶ REBOA protocols should be developed in conjunction with vascular surgery.
- ▶ REBOA should be performed by an acute care surgeon or an interventionalist (vascular surgeon or interventional radiologist) trained in REBOA.
- ▶ An acute care surgeon must be immediately available to definitively address the specific cause of hemorrhage to avert the dire complications of truncal and or spinal cord ischemia from prolonged aortic occlusion.¹⁰⁻¹²
- ▶ Emergency medicine (EM) physicians with added certification in critical care (EMCC) trained in REBOA, may train and perform REBOA in conjunction with an acute care surgeon or vascular surgeon trained in REBOA, as long as the surgeon(s) is/are immediately available to definitively control the focused source of bleeding.

Joint statement from the American College of Surgeons Committee on Trauma (ACS COT) and the American College of Emergency Physicians (ACEP) regarding the clinical use of Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)

*Brenner M, et al. Trauma Surgery & Acute Care Open 2018;3:e000154.



EM performs REBOA

Operator specialty, n (%)

EM familiar with **access**

62 (44)

EM-IR

71 (50)

IR

6 (4.2)

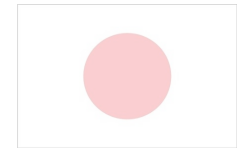
Others

3 (2.1)

Fewer REBOA complications with smaller devices and partial occlusion: evidence from a multicentre registry in Japan

Yosuke Matsumura,¹ Junichi Matsumoto,² Hiroshi Kondo,³ Koji Idoguchi,⁴
Tokiya Ishida,⁵ Yuri Kon,⁶ Keisuke Tomita,⁷ Kenichiro Ishida,⁸ Tomoya Hirose,⁹
Kensuke Umakoshi,¹⁰ Tomohiro Funabiki,¹¹ DIRECT-IABO Investigators

*Matsumura Y, et al. Emerg Med J 2017;34:793



EM performs REBOA

Operator specialty, n (%)

EM familiar with **access**

62 (44)

EM-IR

71 (50)

IR

6 (4.2)

Others

3 (2.1)

**First Responder
should perform REBOA**

Fewer REBOA complications with smaller devices and partial occlusion: evidence from a multicentre registry in Japan

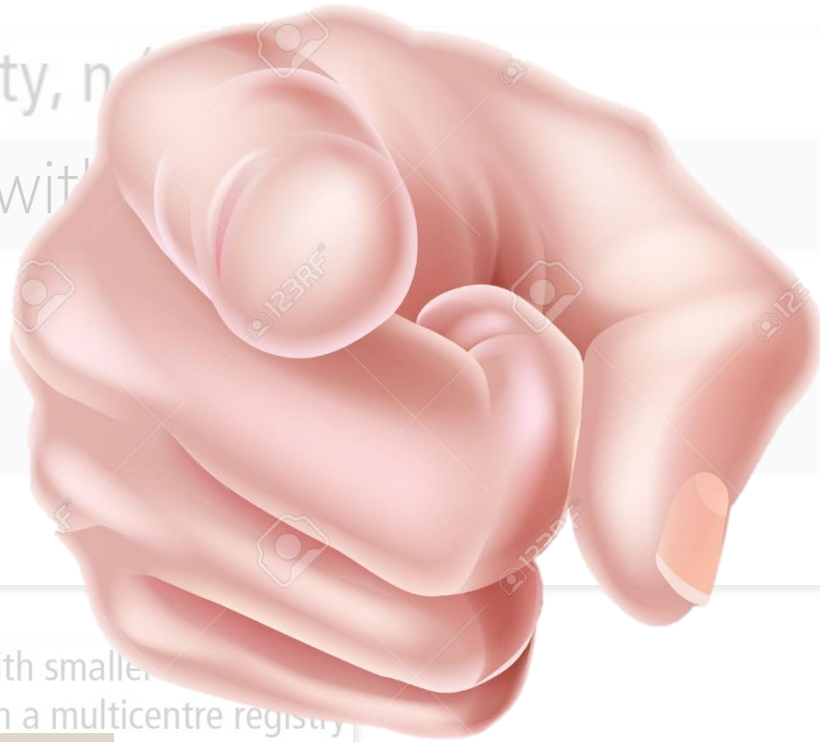
Yosuke Matsumura,¹ Junichi Matsumoto,² Hiroshi Kondo,³ Koji Idoguchi,⁴
Tokiya Ishida,⁵ Yuri Kon,⁶ Keisuke Tomita,⁷ Kenichiro Ishida,⁸ Tomoya Hirose,⁹
Kensuke Umakoshi,¹⁰ Tomohiro Funabiki,¹¹ DIRECT-IABO Investigators

*Matsumura Y, et al. Emerg Med J 2017;34:793



EM performs REBOA

Operator specialty, n (%)	
EM familiar with REBOA	62 (44)
EM-IR	71 (50)
IR	6 (4.2)
Others	3 (2.1)



Fewer REBOA complications with smaller
partial occlusion: evidence from a multicentre registry



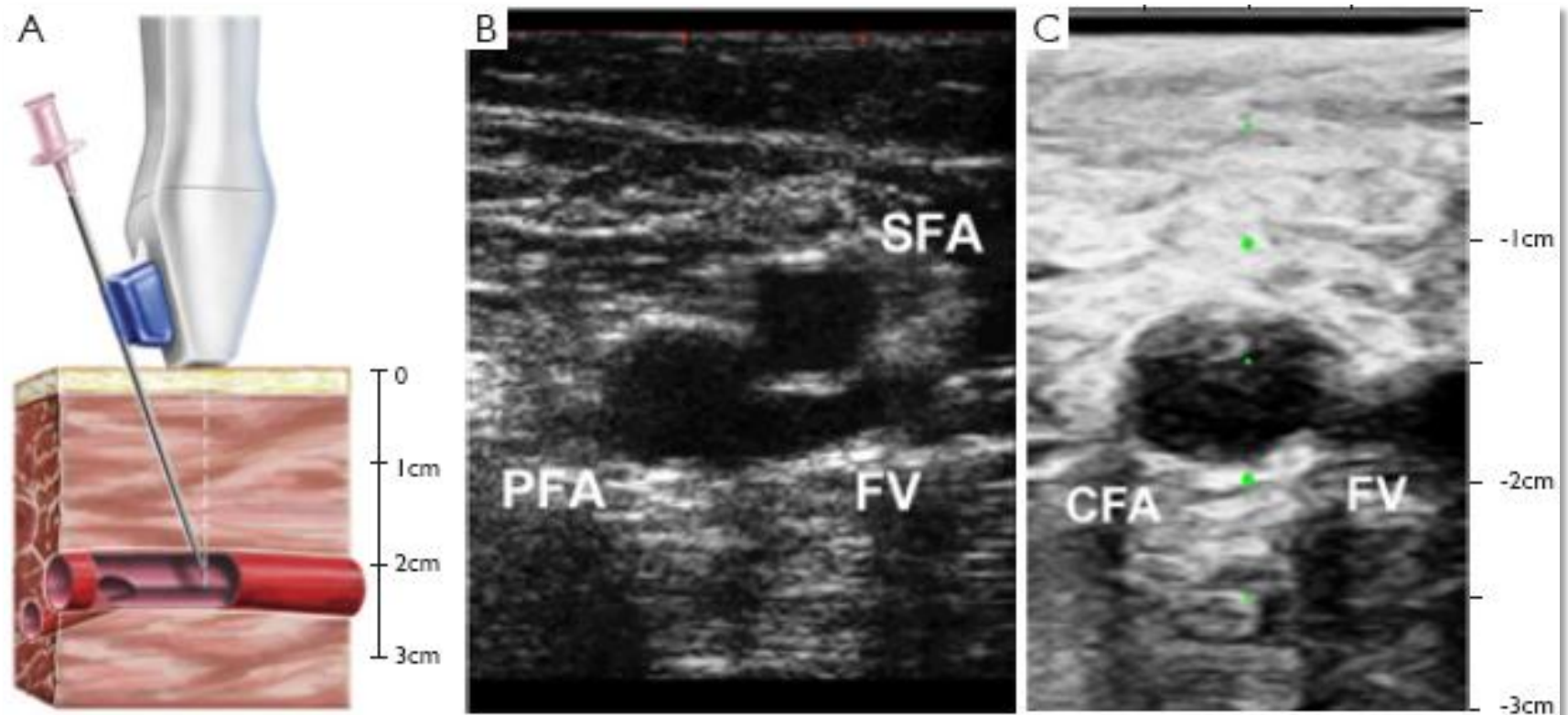
Idoguchi,⁴
Tomoya Hirose,⁹
Investigators

*Matsumura Y, et al. Emerg Med J 2017;34:793

See **Bifurcation** with **US**

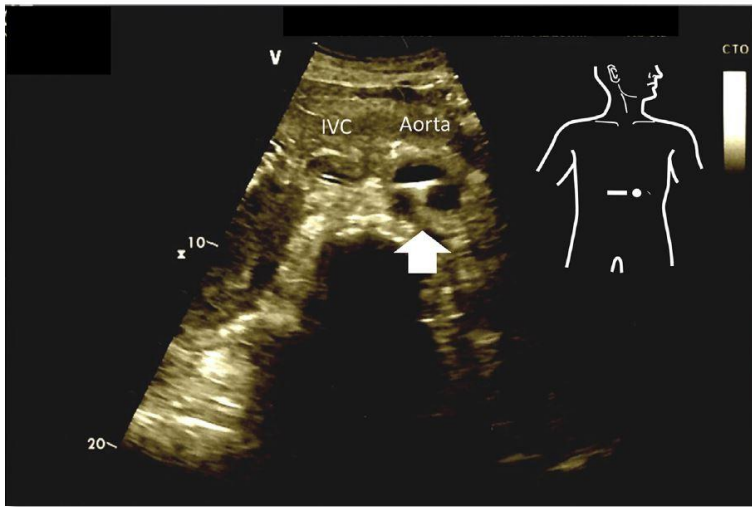
Review Article

Echocardiographic guidance for diagnostic and therapeutic percutaneous procedures



*Nguyen CT, et al. Cardiovasc Diagn Ther 2011;1:11-36.

See **Guidewire** in **Aorta**

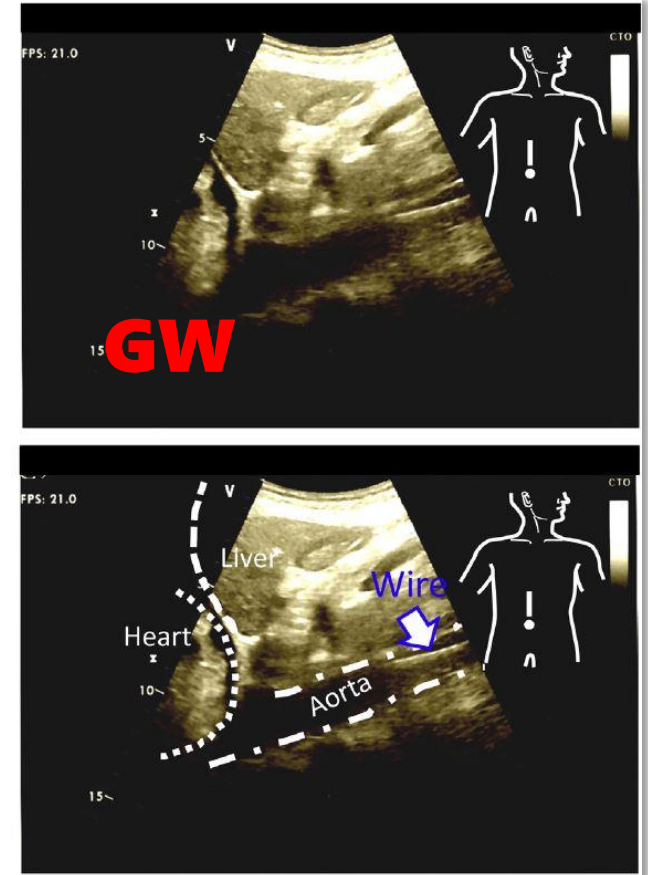
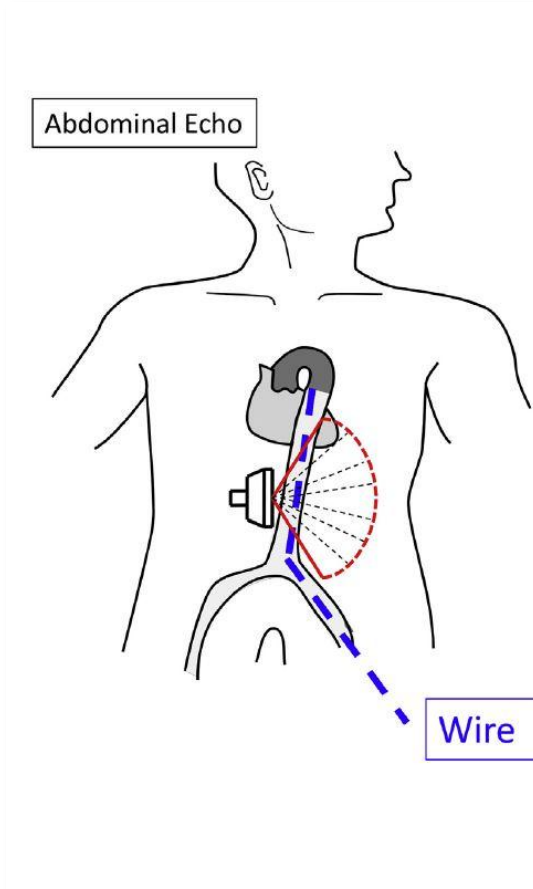


Techniques and Procedures



ULTRASOUND-GUIDED RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA IN THE RESUSCITATION AREA

Takayuki Ogura, MD,*† Alan Kawarai Lefor, MD, MPH, PhD,‡ Mitsunobu Nakamura, MD, PhD,* Kenji Fujizuka, MD,*
Kousuke Shiroto, MD,* and Minoru Nakano, MD, PhD*



*Ogura T, et al. J Emerg Med 2017;52:715-22



Patient

Advanced

**Middle-
advanced**

Young

Mechanism

Blunt >>>
Penetrating

Blunt >>
Penetrating

Blunt >
Penetrating

Trauma team

Multi-
disciplinary

Multi-
disciplinary

Surgeon-
centered

Resuscitation

EM

EM

Surgeon, EM



**Geriatric
Blunt**

**Coagulopathy
Tortuous aorta**

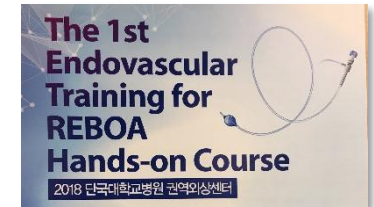
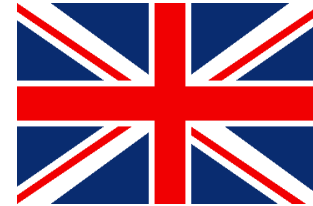
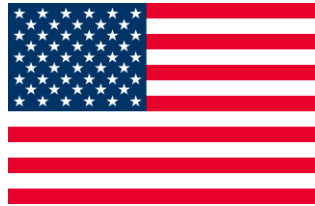
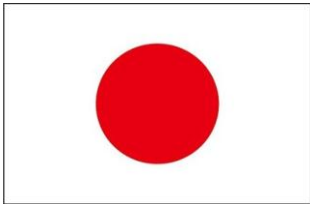


1. RT+REBOA

2. Early access, Undelayed & Short occlusion

3. Education & Research

Endovascular workshop



2011 -

2013 -

2014 -

2016 -

2018 -

EM, IR,
Surgeon

Surgeon

Surgeon

EM,
Paramed

Surgeon



Creating an Educational Program in the Endovascular and Hybrid Intervention; Experiences from the Japanese Society of Diagnostic and Interventional Radiology in Emergency, Critical Care, and Trauma (DIRECT)

Tomohiro Funabiki MD PhD¹, Yosuke Matsumura MD PhD²,
Hiroshi Kondo MD PhD³, Koji Idoguchi MD⁴, Junichi Matsumoto MD PhD⁵;
Japanese Society of Diagnostic and Interventional Radiology in Emergency,
Critical Care, and Trauma (DIRECT)

¹ Emergency and Critical Care Center, Saiseikai Yokohamashi Tobu Hospital, Japan

² Department of Emergency and Critical Care Medicine, Chiba University Graduate School of Medicine, Japan

³ Department of Radiology, Teikyo University School of Medicine, Japan

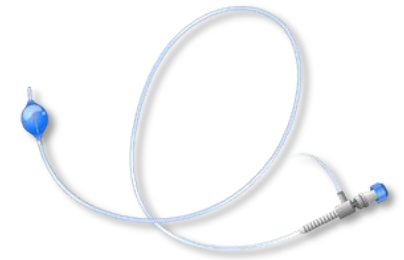
⁴ Osaka Prefecture Senshu Trauma and Critical Care Medical Center, Rinku General Medical Center, Japan

⁵ Department of Emergency and Critical Care Medicine, St. Marianna University School of Medicine, Japan



REBOA & catheter technique

Virtual fluoroscopy
3D vessel model
Over-the-wire technique





“Hybrid” simulation

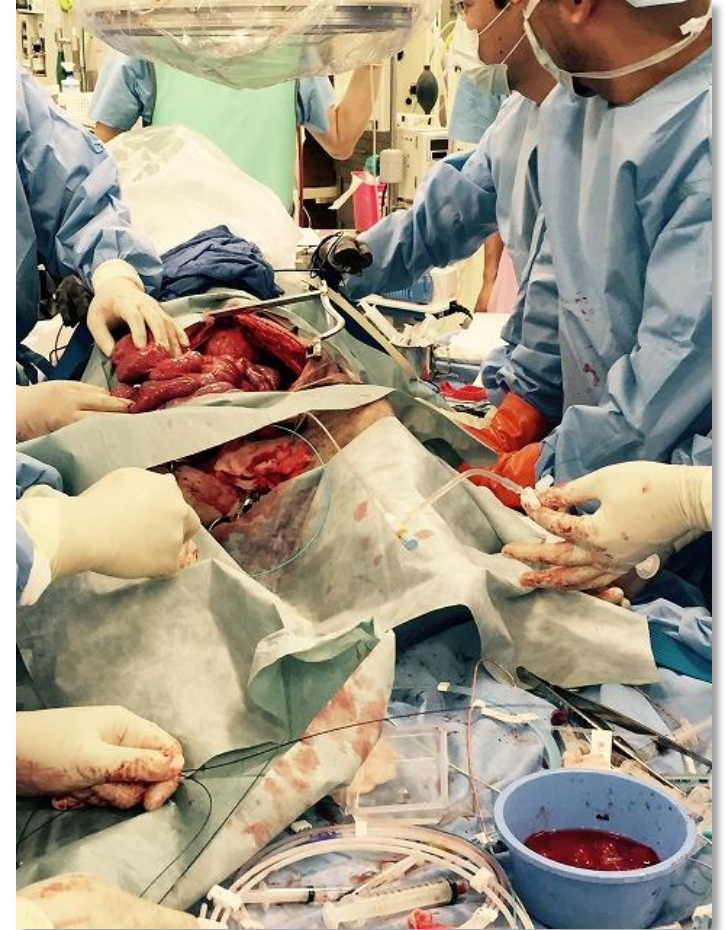



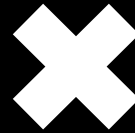
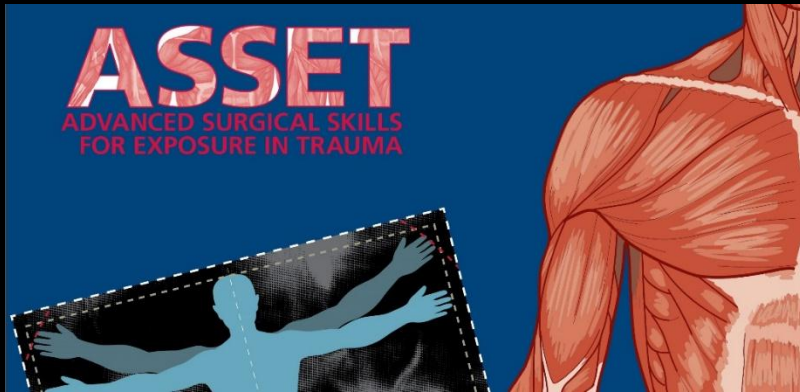
REBOA

Selective **balloon** catheter

NBCA embolization

Combined with **surgery**







**Advanced Surgical Skills
for Exposure
in Trauma Course**

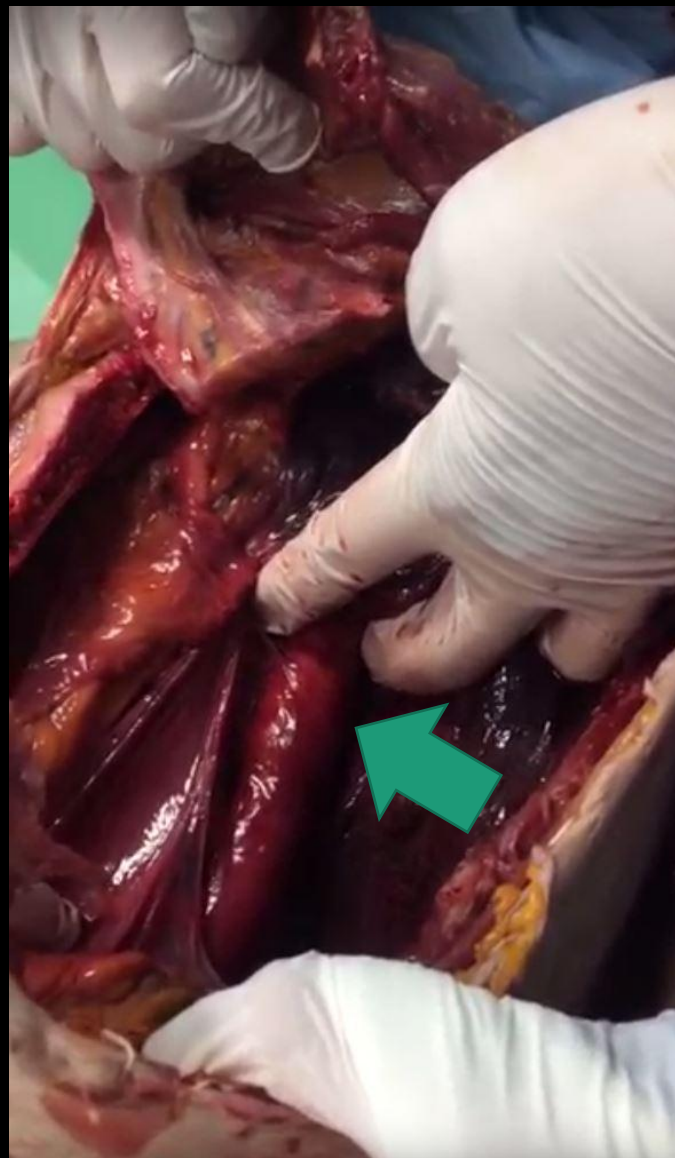
Jointed with Japanese Society of DIRECT

**Vascular Access and Placement
of REBOA Catheter;
-vascular anatomy
& safe procedure**

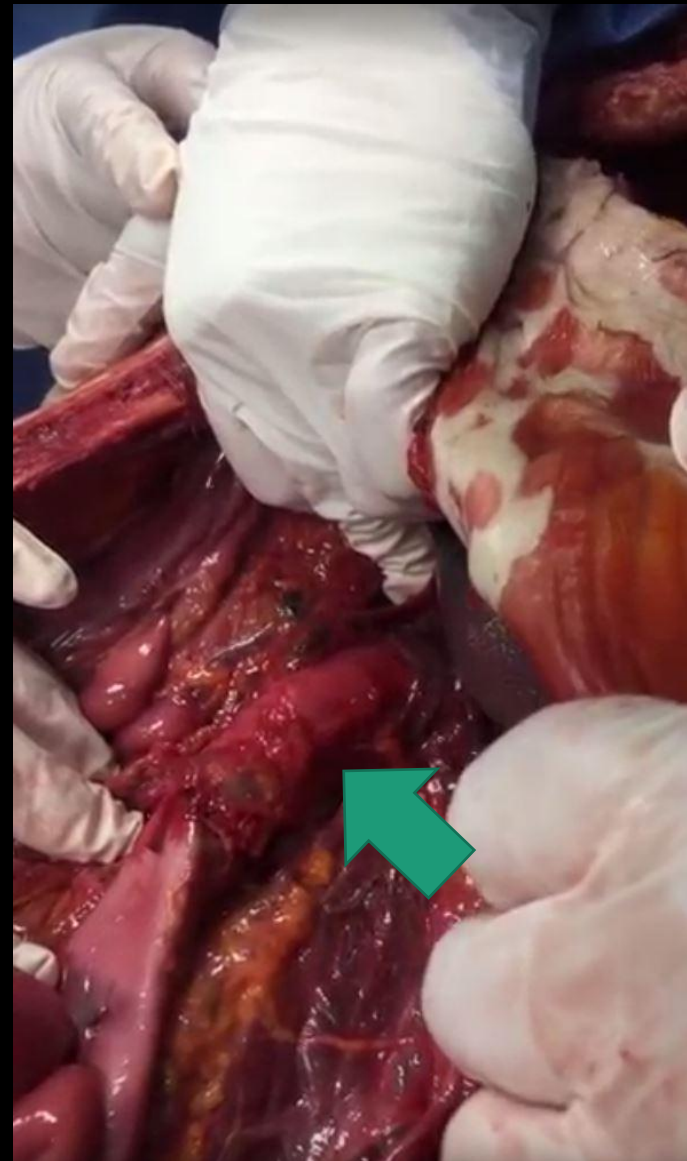


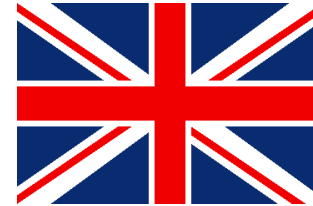
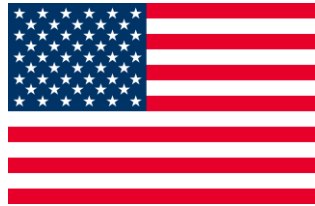
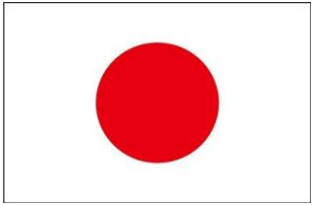
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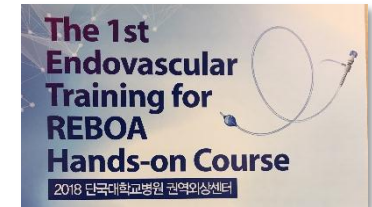








PEER (Pre-Hospital and Emergency Department
Endovascular Resuscitation) Course



2011 -

2013 -

2014 -

2016 -

2018 -

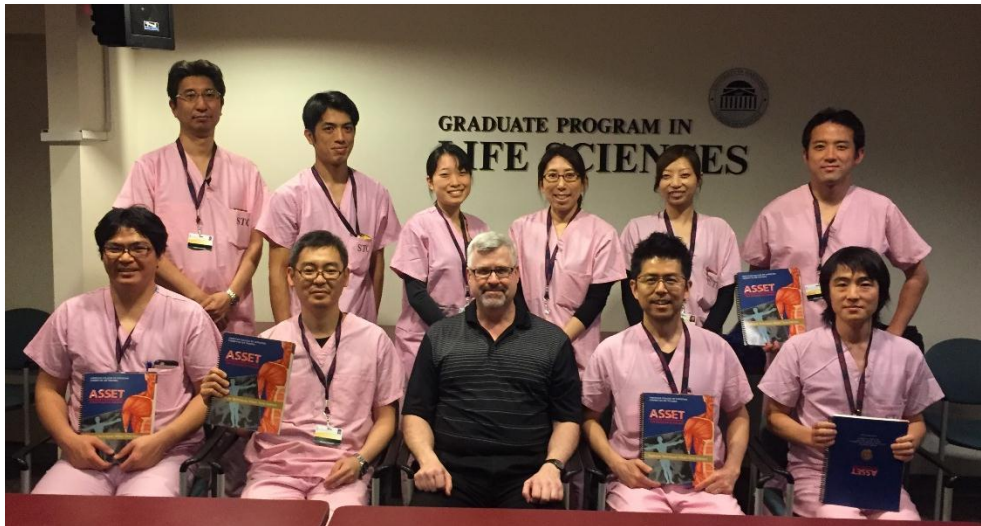
EM, IR,
Surgeon

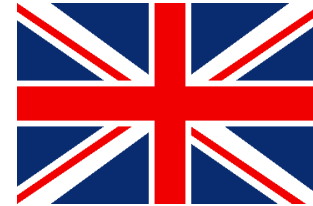
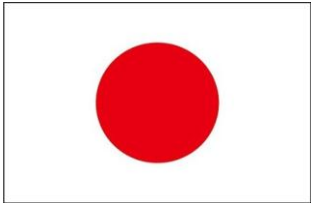
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Surgeon

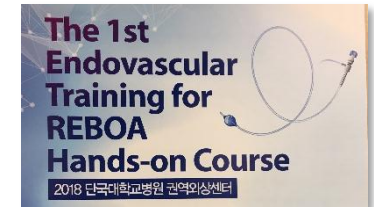
EM,
Paramed

Surgeon





PEER (Pre-Hospital and Emergency Department
Endovascular Resuscitation) Course



2011 -

2013 -

2014 -

2016 -

2018 -

EM, IR,
Surgeon

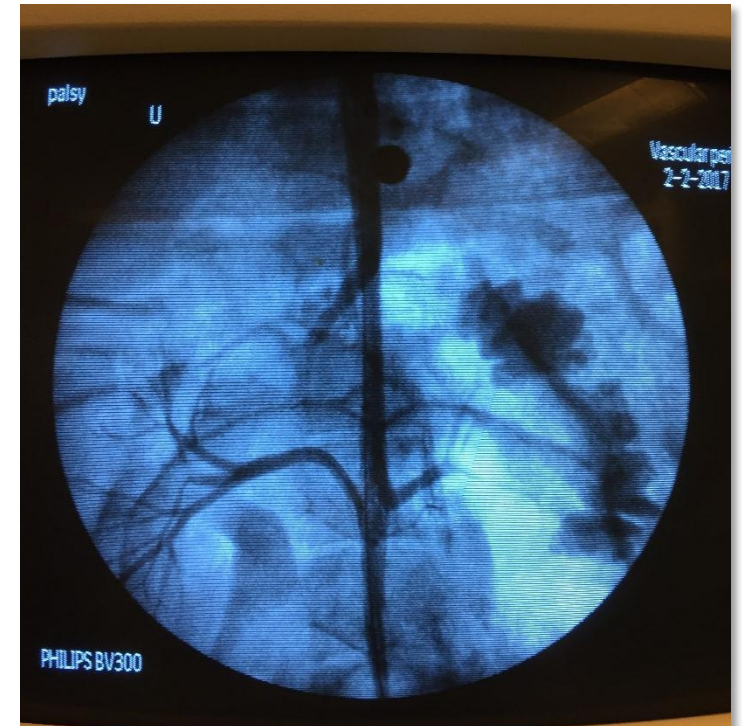
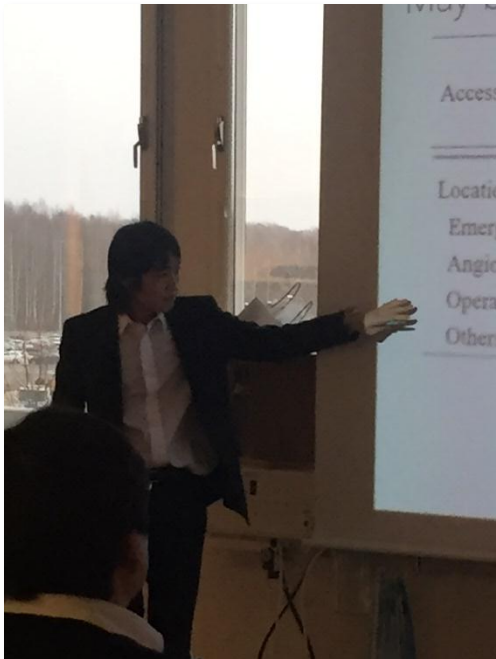
Surgeon

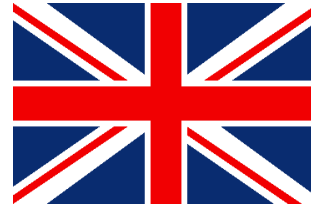
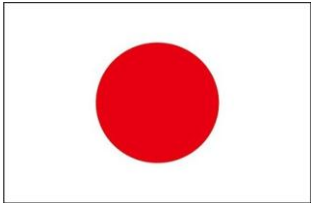
Surgeon

EM,
Paramed

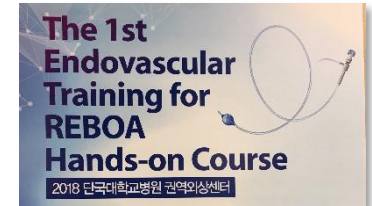
Surgeon

Endovascular Resuscitation and Trauma Management





PEER (Pre-Hospital and Emergency Department Endovascular Resuscitation) Course



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2013 -

2014 -

2016 -

2018 -

EM, IR,
Surgeon

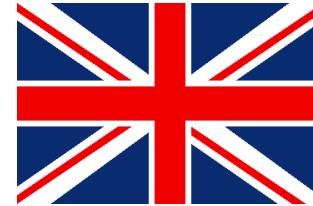
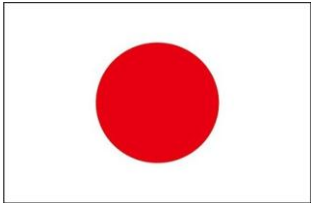
Surgeon

Surgeon

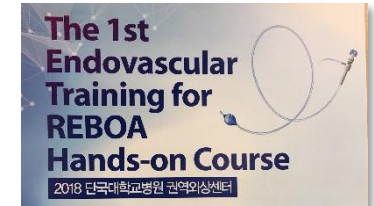
**EM,
Paramed**

Surgeon





PEER (Pre-Hospital and Emergency Department
Endovascular Resuscitation) Course



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2013 -

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2016 -

2018

EM, IR,
Surgeon

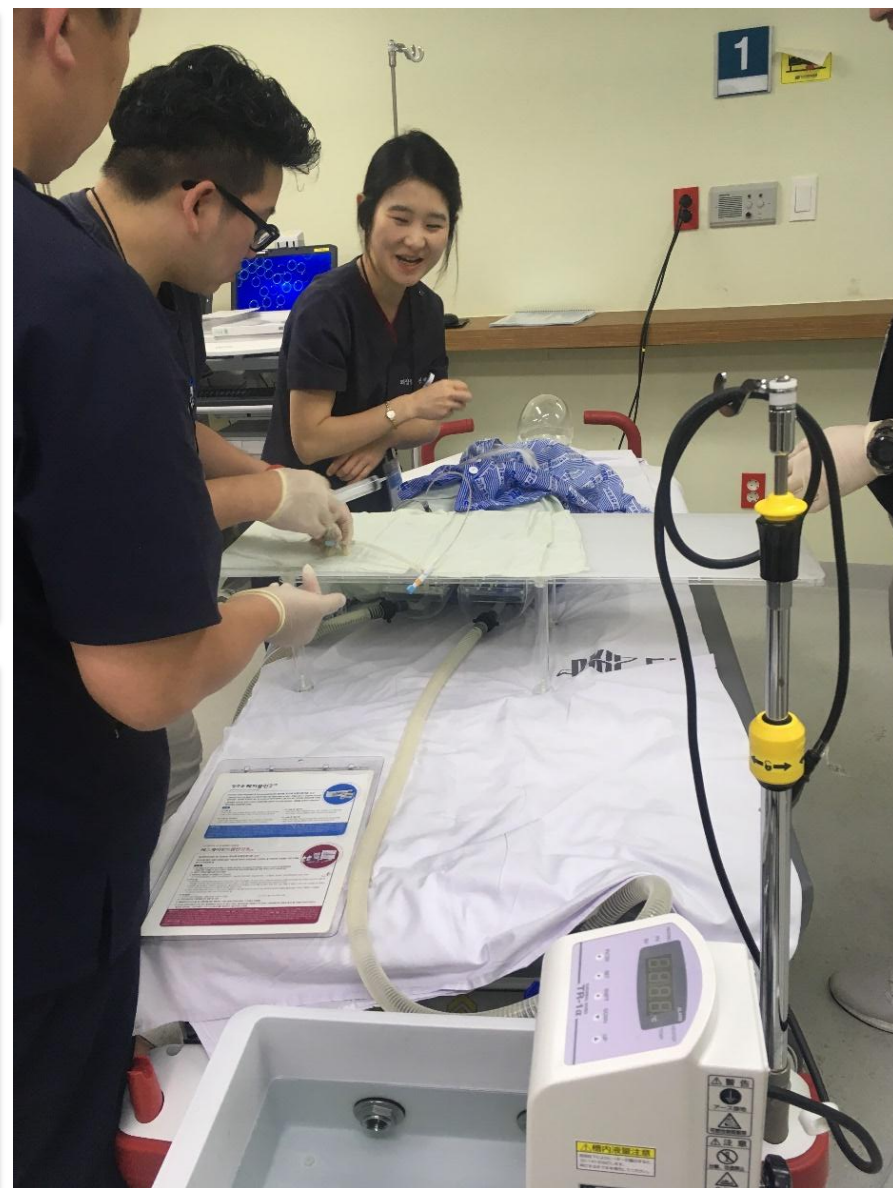
Surgeon

Surgeon

EM,
Paramed

Surgeon

The 1st
Endovascular
Training for
REBOA
Hands-on Course
2018 대한응급의학 학회 춘계학술대회

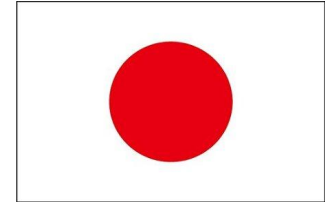


1. RT+REBOA

2. Early access, Undelayed & Short occlusion

3. Education & **Research**





AAST 2015 PLENARY PAPER

Resuscitative endovascular balloon occlusion of the aorta might
be dangerous in patients with severe torso trauma:
A propensity score analysis

**Junichi Inoue, MD, Atsushi Shiraishi, MD, PhD, Ayako Yoshiyuki, MD, Koichi Haruta, MD,
Hiroki Matsui, MPH, and Yasuhiro Otomo, MD, PhD, Tokyo, Japan**





Research

JAMA Surgery | **Original Investigation**

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma



Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

AKI Amputation High 24-h mortality

Variable	Patients, No. (%)		P Value
	No-REBOA Group (n = 280)	REBOA Group (n = 140)	
Complications			
Acute kidney injury	9 (3.2)	15 (10.7)	.02
Amputation of lower limb	2 (0.7)	5 (3.6)	.04
Deep venous thrombosis	14 (5.0)	6 (4.3)	.42
Pulmonary embolism	5 (1.8)	2 (1.4)	.28
Stroke	3 (1.1)	2 (1.4)	.37
Myocardial infarction	1 (0.4)	0	.51
Extremity compartment syndrome	2 (0.7)	1 (0.7)	.39
Overall mortality	53 (18.9)	50 (35.7)	.01
Mortality in the ED	5 (1.8)	4 (2.9)	.35
24-h Mortality	33 (11.8)	37 (26.4)	.01
In-hospital mortality after 24 h	15 (5.4)	9 (6.4)	.21



Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma



Letter to the Editor

Comments & Response

Complete manuscript title: Minimizing the bias in the observational study in the REBOA patients

Authors: Yosuke Matsumura, MD, PhD¹, Atsushi Shiraishi, MD, PhD²

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

SBP 109 mmHg GCS 14

Variables	Patients, No. (%)		P Value
	No-REBOA Group (n = 593 678)	REBOA Group (n = 140)	
Age, mean (SD), y	53 (21)	44 (20)	<.001
Male sex	379 954 (64.0)	104 (74.3)	.01
White race	436 353 (73.5)	89 (63.6)	.003
Vital signs in ED			
SBP, mean (SD), mm Hg	138.0 (27.0)	108.8 (32.7)	<.001
HR, mean (SD), bpm	88.8 (20.0)	102.0 (30.0)	<.001
GCS score, median (IQR)	15 (15-15)	14 (3-15)	<.001
Injury parameters			
Blunt MOI	565 181 (95.2)	129 (92.1)	.11
ISS, median (IQR)	15 (9-17)	29 (18-38)	<.001
h-AIS score, median (IQR)	0 (0-2)	0 (0-3)	<.001

Joseph B et al. JAMA surg 2019

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

SBP 114 mmHg
GCS 15 vs. 3
Head AIS 0 vs.2

Variable	Patients, No. (%)		P Value
	Survived (n = 90)	Died (n = 50)	
Age, mean (SD), y	42 (19)	48.2 (19)	.12
Male sex	57 (63.3)	32 (64.0)	.20
Vital signs in the ED			
SBP, mean (SD), mm Hg	114 (32)	98 (31)	.006
HR, mean (SD), bpm	99.0 (27.0)	109.4 (25.0)	.02
GCS score, median (IQR)	15 (13-15)	3 (3-13)	.04
Injury parameters			
Blunt MOI	82 (91.1)	47 (94.0)	.54
ISS, median (IQR)	27 (17-34)	38 (26-50)	.043
h-AIS, median (IQR)	0 (0-2)	2 (0-4)	.002

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

1 unit of Transfusion < 24h

Variable	Patients, No. (%)		P Value
	Survived (n = 90)	Died (n = 50)	
Transfusion requirements, median (IQR), U			
PRBCs			
4 h	0 (0-5)	12 (7-19)	<.001
24 h	1 (1-6)	14 (9-22)	<.001
Platelets			
4 h	0 (0-1)	2 (1-3)	<.001
24 h	1 (0-2)	3 (2-6)	<.001
Plasma			
4 h	0 (0-3)	9 (4-15)	<.001
24 h	1 (1-5)	13 (6-20)	<.001

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

First, the **patients were too stable** to require REBOA, This suggests **unnecessary REBOA placement** in a stable population, leading to unnecessary amputation and AKI.

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

Physiological derangement in REBOA cases might increase the apparent mortality rate, while the **resuscitation time bias** might decrease the apparent mortality in the REBOA group

Nationwide Analysis of Resuscitative Endovascular Balloon Occlusion of the Aorta in Civilian Trauma

Ideally, **time-dependent propensity-score-matching** analysis should be performed, with use of sensitivity analysis, e.g., instrumental variable analysis, to adjust for unmeasured confounders.



FUTURE

Prospective observational study on the effectiveness and safety of resuscitative endovascular balloon occlusion of the aorta in traumatic shock due to torso hemorrhage

PI: Yosuke Matsumura

The Japanese Association for The Surgery of Trauma

Conclusion

1. RT+REBOA

Chance in Blunt Cardiac Arrest

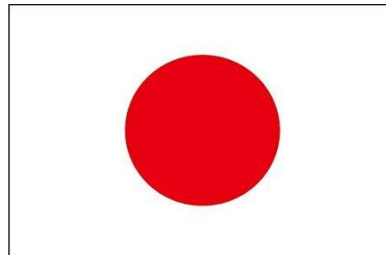
2. Early access, Undelayed & Short occlusion

Access <20min, SBP70mmHg, <30min

3. Education & Research

Endo. workshop & International Multicenter study

Let's Proceed **Education & Research together !**

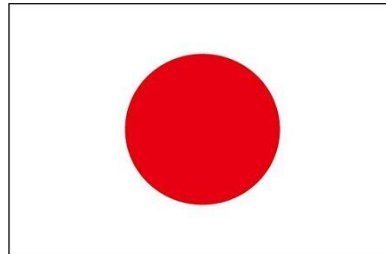


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Let's Proceed
Education & Research together !

İlginiz için teşekkür ederim !



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