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LONGITUDINAL OUTCOMES OF TEVAR FOR RUPTURED THORACIC AORTIC ANEURYSMS

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BACKGROUND

Much is known about the short term outcomes of thoracic endovascular aortic repair (TEVAR) for ruptured thoracic aortic aneurysm.[1] Long-term data is more scarce and often includes patients with concomitant aortic conditions (e.g. dissection, intramural hematoma).[2-4]

No research to-date has stratified the long-term outcomes by hemodynamic stability of the patients upon arrival to the operating room.

Objective: To characterize the longitudinal outcomes of emergent TEVAR for ruptured thoracic aortic aneurysm patients, and to compare the longitudinal outcomes of these by hemodynamic stability on arrival to the operating room.

METHODS

Inclusion	Exclusion	Follow-up
Elective TEVAR for intact aortic aneurysms (iTAA) Emergent TEVAR for ruptured aortic aneurysm (rTAA)	Concomitant intramural hematoma, aortic dissection, or associated trauma. Prior debranching for elective TEVAR	Lost to follow up if mortality event not known: 4.6 years for ruptured aneurysm and 5.6 years for intact aneurysm

PRE-OPERATIVE/OPERATIVE CHARACTERISTICS

Table 1. Pre-Operative Characteristics

	rTAA (n=65)	iTAA (n=256)	*P*
Age	74.4 (11.9)	74.7 (9.1)	.87
Female	33 (50.8)	114 (44.5)	.37
Connective Tissue Disorder	1 (1.5)	3 (1.2)	>.99
Smoking	14 (21.5)	56 (21.9)	.95
Diabetes	15 (23.1)	42 (16.4)	.14
Lung Disease	16 (24.6)	121 (47.3)	**<.001**
Hypertension	56 (86.2)	232 (90.6)	.29
Dialysis	7 (10.8)	6 (2.3)	**.01**
Base Creatinine*	1.3 (0.6)	1.2 (0.6)	.07
Peripheral Arterial Disease	33 (50.8)	161 (62.9)	.07
Prior Stroke	11 (16.9)	33 (12.9)	.40

Values are *n* (%), except for age: years(SD) and base creatinine: mg/dL (SD)
*Base creatinine exluding patients who are on on dialysis

Table 2. Operative Characteristics

	rTAA (n=65)	iTAA (n=256)	*P*
Access			
Femoral	62 (95.4)	222 (86.7)	.08
Iliac	5 (7.7)	42 (16.4)	.08
Proximal Landing Zone			.10
Distal Landing Zone			.32
Distal Landing Zone in Dacron	1 (1.6)	7 (2.7)	>.99
Pre-TEVAR Lumbar Drain Placed	8 (12.3)	104 (40.6)	**<.001**
Carotid-Subclvian Bypass	3 (4.6)	62 (24.2)	**<.001**
Subclavian Artery Coiled*	3 (12.5)	53 (79.1)	**<.001**

Values are *n* (%).
*Only comparing those with TEVAR covering subclavian artery

30-DAY OUTCOMES

Table 3. 30 -Day Outcomes

	rTAA (n=65)	iTAA (n = 256)	*P*
30-Day Mortality	20 (30.8)	8 (3.1)	**<.001**
Hours in ICU (n = 41, 219)*	184.6 (223.6)	65.1 (60.2)	**<.001**
Length of Stay (n=48, 244) **	16.0 (13.4)	7.5 (5.4)	**<.001**
Stroke	9 (13.8)	11 (4.3)	**.001**
Spinal Cord Ischemia	10 (15.4)	24 (9.4)	.16
Transient	5 (7.7)	17 (6.6)	.78
Permanent	5 (7.7)	7 (2.7)	.07
Post-Operative Lumbar Drain	5 (7.7)	5 (2.0)	**.03**
New Diaylsis	1 (1.5)	7 (2.7)	>.99
Ileus	1 (1.5)	9 (3.5)	.69
Pneumonia	7 (10.8)	7 (2.7)	**.01**
Prolonged Ventilation	11 (16.9)	12 (4.7)	**.001**
Limb ischemia	4 (6.2)	7 (2.7)	.24
Non-Aortic Intervention	3 (4.6)	23 (9.0)	.25
30-Day Aortic Re-intervention	6 (9.2)	6 (2.3)	**.02**
Discharge Home (n=48, 246)	24 (50)	193 (78.5)	**<.001**
30-Day Readmission (n=48, 246)	6 (12.5)	32 (13.0)	.92

Values are *n* (%).

* Hours in ICU: mean (SD), some data missing

** Days in hospital: mean (SD), some data missing

AORTIC RE-INTERVENTION

Table 4. Indication for Unplanned Aortic Re-intervention

Cause for Re-intervention*	rTAA (n=8)	iTAA (n=42)	*P*
Endoleak	4 (50.0)	26 (61.9)	.70
Type I	2 (25.0)	15 (35.7)	.41
Endoleak from Stent Migration	0	4 (9.5)	>.99
New Aneurysm or Degeneration	0	13 (31.0)	.09
Rupture	2 (25.0)	3 (7.1)	.18
Aortic Pseudoaneursym	0	2 (4.8)	>.99
Dissection	1 (12.5)	1 (2.4)	.29
Subclavian Ischemia	1 (12.5)	0	.16

Values are n (%)
*Multiple indications allowed for each re-intervention

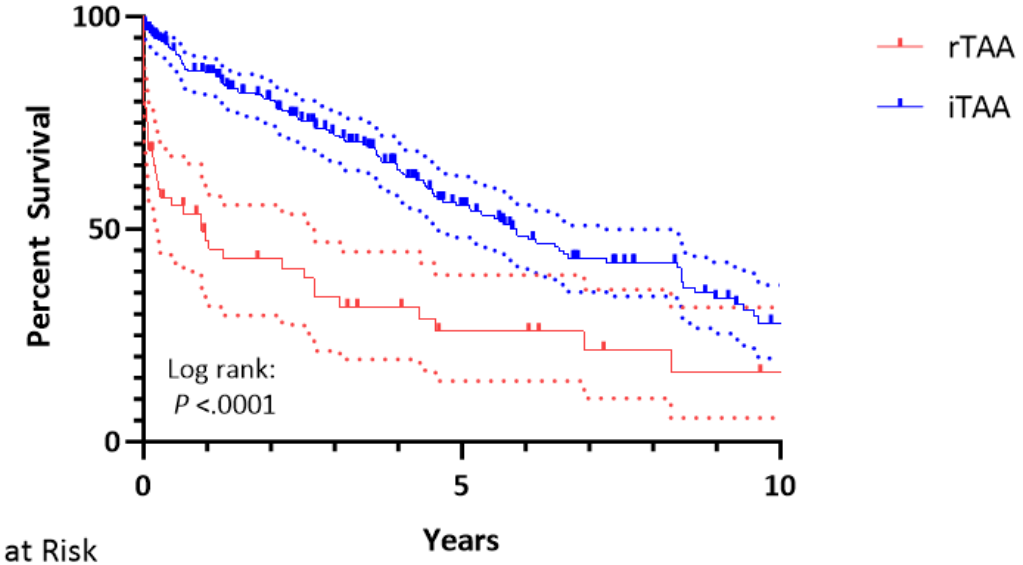
Table 5. Aortic Re-interventions

	rTAA (n=65)	iTAA (n=256)	*P*
Total Re-interventions	8 (12.3)	42 (16.4)	.42
Within 30-Days	6 (9.2)	6 (2.3)	**.02**
After 30-Days*	2 (4.2)	36 (14.5)	.06
TEVAR	5 (7.7)	23 (9.0)	.74
EVAR	0	3 (1.2)	>.99
Open AAA	0	5 (2.0)	.59
Artery Embolization	1 (1.5)	5 (1.9)	>.99
Arch Repair	1 (1.5)	2 (.8)	.49
Other	1 (1.5)	4 (1.6)	>.99

Values are n(%)
*Only comparing among patients alive at 30 days

LONG-TERM SURVIVAL RTAA VS ITAA

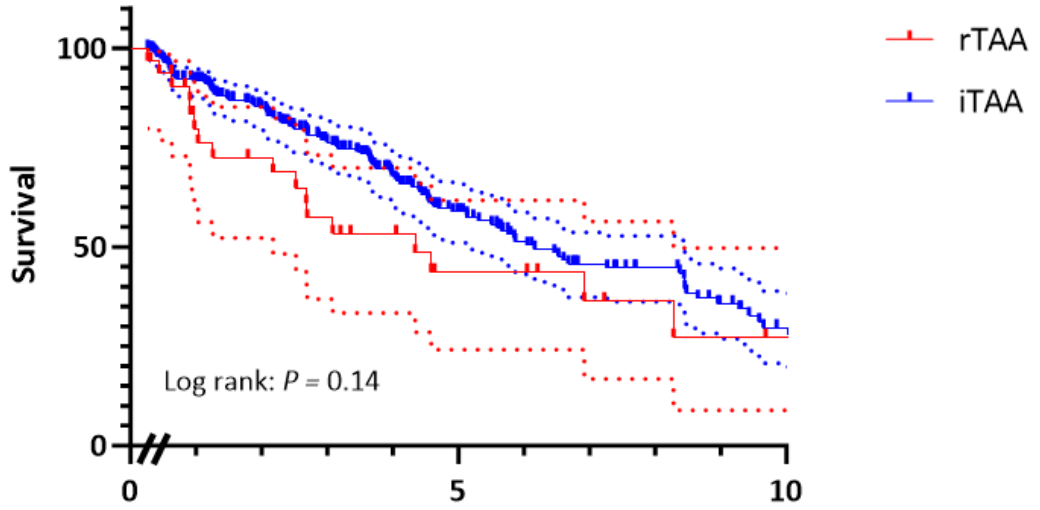
Survival of ruptured thoracic aortic aneursym (rTAA) vs intact thoracic aortic aneursysm (iTAA)



No. at Risk						
rTAA	65	19	12	8	4	2
iTAA	256	165	104	56	36	17

Median Survival: rTAA: 0.9 years, iTAA: 5.9 years

Survival of ruptured thoracic aortic aneursym (rTAA) vs intact thoracic aortic aneursysm (iTAA) for patients alive at 90 days

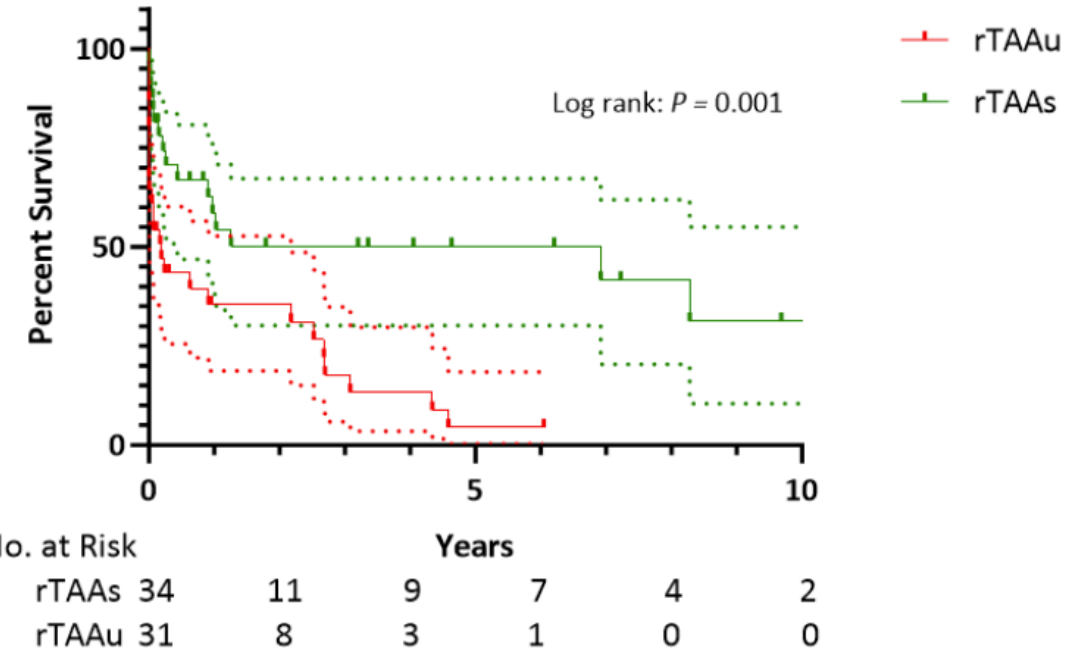


No. at Risk						
rTAA	32	19	12	8	4	2
iTAA	226	165	104	56	36	17

Median Survival: rTAA: 4.3 years, iTAA: 6.2 years

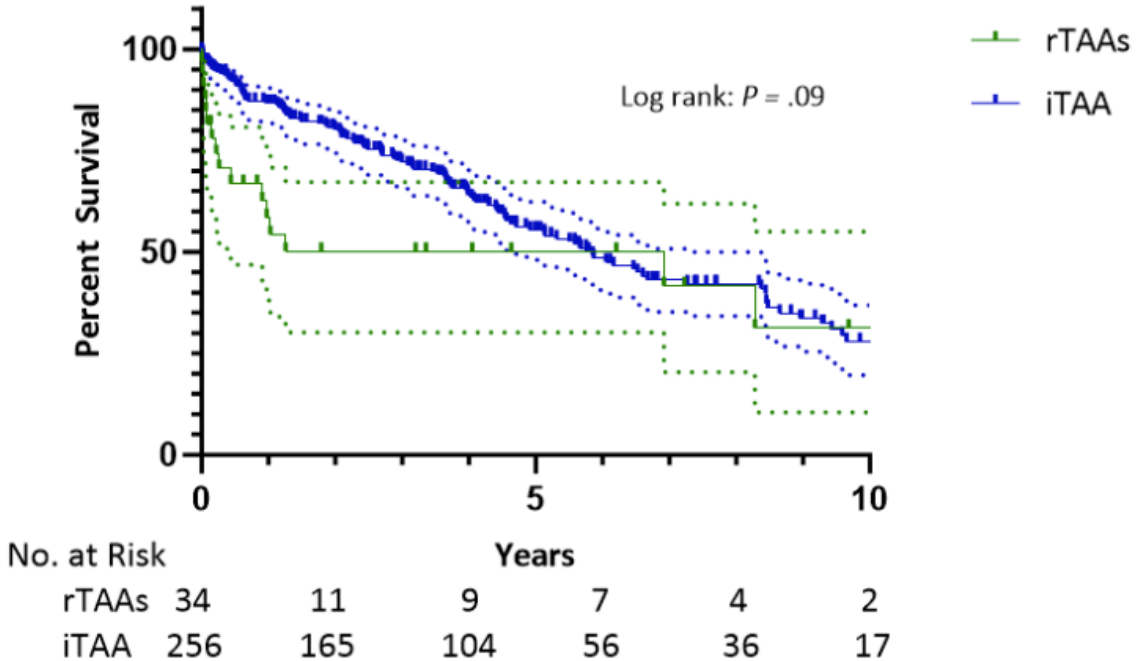
LONG-TERM SURVIVAL BY HEMODYNAMIC STABILITY

Survival of hemoydynamically unstable rupture (rTAAu) vs hemoydynamically stable rupture (rTAAs)



Median Survival: rTAAu: 0.2 years, rTAAs: 6.9 years

Survival of hemoydynamically stable ruptured aneurysm (rTAAu) vs intact aneurysm (iTAA)



Median Survival: rTAAs: 6.9 years, iTAA: 5.9 years

30-DAY OUTCOME BY HEMODYNAMIC STABILITY

Table 6. 30 -Day Outcomes Hemodynamically Unstable vs. Stable

	rTAAu (n=31)	rTAAs (n = 34)	*P*
30-Day Mortality	14 (45.2)	6 (17.6)	**0.03**
Hours in ICU (n = 16,25)*	230.6 (277.0)	155.2 (211.0)	0.07
Length of Stay (n=19,29)**	20.3 (16.03)	13.1 (10.7)	0.33
Stroke	6 (19.4)	3 (8.8)	0.29
Spinal Cord Ischemia	4 (12.9)	6 (17.6)	0.73
Post-Operative Lumbar Drain	3 (9.7)	2 (5.9)	>0.99
Pneumonia	4 (12.9)	3 (8.8)	0.70
Prolonged Ventilation	8 (27.6)	3 (9.1)	0.09
30-Day Aortic Re-intervention	3 (9.7)	3 (8.8)	>0.99
Discharge Location (n = 19,29)	7 (36.8)	12 (41.4)	0.24
30-Day Readmission (n = 19,29)	2 (10.5)	4 (13.8)	0.26

Values are *n* (%), unless otherwise noted

* Hours in ICU: mean (SD), some data missing

** Days in hospital: mean (SD)

30-DAY OUTCOMES ITAA VS RTAAS

Table 7. 30 -Day Outcomes Hemodynamically Stable Rupture vs Intact Aneursym

	iTAA (n=256)	rTAAs (n = 34)	*P*
30-Day Mortality	8 (3.1)	6 (17.6)	**.003**
Hours in ICU (n = 219,25)*	65.1 (60.2)	155.2 (211.0)	**<0.001**
Length of Stay (n= 244,29)**	13.1 (10.7)	7.6 (5.3)	**<0.001**
Stroke	11 (4.3)	3 (8.8)	0.22
Spinal Cord Ischemia	24 (9.4)	6 (17.6)	0.14
Transient	17 (6.5)	3 (8.8)	0.71
Permanent	7 (2.7)	3 (8.8)	0.10
Post-Operative Lumbar Drain	5 (2.0)	2 (5.9)	0.19
Pneumonia	7 (2.7)	3 (8.8)	0.10
Prolonged Ventilation	12 (4.7)	3 (8.8)	0.39
30-Day Aortic Re-intervention	6 (2.3)	3 (8.8)	0.08
Discharge Home (n = 246,29)	193 (78.5)	17 (58.6)	**0.02**
30-Day Readmission (n = 246,29)	32 (13.8)	4 (13.8)	>.99

Values are *n* (%).

* Hours in ICU: mean (SD), some data missing

** Days in hospital: mean (SD), some data missing

CONCLUSIONS

rTAA vs iTAA

- Survival:
  - 1 year: 48% vs. 88%
  - 5 year: 26% vs 56%
  - 10 year: 16% vs 28%
  - For patients alive at 90 days after surgery, no significant difference in long term survival
- 30-day Outcomes:
  - **Higher rates of stroke** (13.8% vs 4.3%)
  - **Higher rates of spinal cord ischemia** (15.4% vs 9.4%)
  - **Higher rates of pneumonia** (10.8% vs 2.7%)
  - **Prolonged ventilation** (17.7 vs 4.7%).
- Re-intervention:
  - Primary cause: Endoleak
  - Primary Intervention: TEVAR
  - **30-Day Intervention required more often**

Hemodynamic Stability

- Median Survival:
  - rTAAu: 0.19 years
  - rTAAs: 6.9 years
  - iTAA: 5.9 years
- 30-day survival:
  - rTAAu: 55%
  - rTAAs:82%
  - iTAA: 97%
- Care time line:
  - rTAAs and rTAAu significantly longer time in ICU, length of stay, and non-home discharge.

REFERENCES

1. Patel PB, Schermerhorn ML. Emergent thoracic endovascular aortic aneurysm repair for ruptured aneurysm: in-hospital and long-term results. J Cardiovasc Surg (Torino). 2020 Dec;61(6):675-680. doi: 10.23736/S0021-9509.20.11595-7. Epub 2020 Nov 13. PMID: 33185076.

2. Ogawa Y, Watkins AC, Lingala B, Nathan I, Chiu P, Iwakoshi S, He H, Lee JT, Fischbein M, Woo YJ, Dake MD. Improved midterm outcomes after endovascular repair of nontraumatic descending thoracic aortic rupture compared with open surgery. J Thorac Cardiovasc Surg. 2021 Jun;161(6):2004-2012. doi: 10.1016/j.jtcvs.2019.10.156. Epub 2019 Nov 16. PMID: 31926735.

3. Jonker FH, Verhagen HJ, Lin PH, Heijmen RH, Trimarchi S, Lee WA, Moll FL, Atamneh H, Rampoldi V, Muhs BE. Open surgery versus endovascular repair of ruptured thoracic aortic aneurysms. J Vasc Surg. 2011 May;53(5):1210-6. doi: 10.1016/j.jvs.2010.10.135. Epub 2011 Feb 5. PMID: 21296537.

4. Hammo S, Larzon T, Hultgren R, Wanhainen A, Mani K, Resch T, Falkenberg M, Forssell C, Sonesson B, Pirouzram A, Roos H, Hellgren T, Khan S, Höijer J, Wahlgren CM. Outcome After Endovascular Repair of Ruptured Descending Thoracic Aortic Aneurysm: A National Multicentre Study. Eur J Vasc Endovasc Surg. 2019 Jun;57(6):788-794. doi: 10.1016/j.ejvs.2018.10.029. Epub 2019 Mar 22. PMID: 30910493.

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