

Can Less Be More?: Zone 2 versus Zone 3 Arch Replacement

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Background and Objective

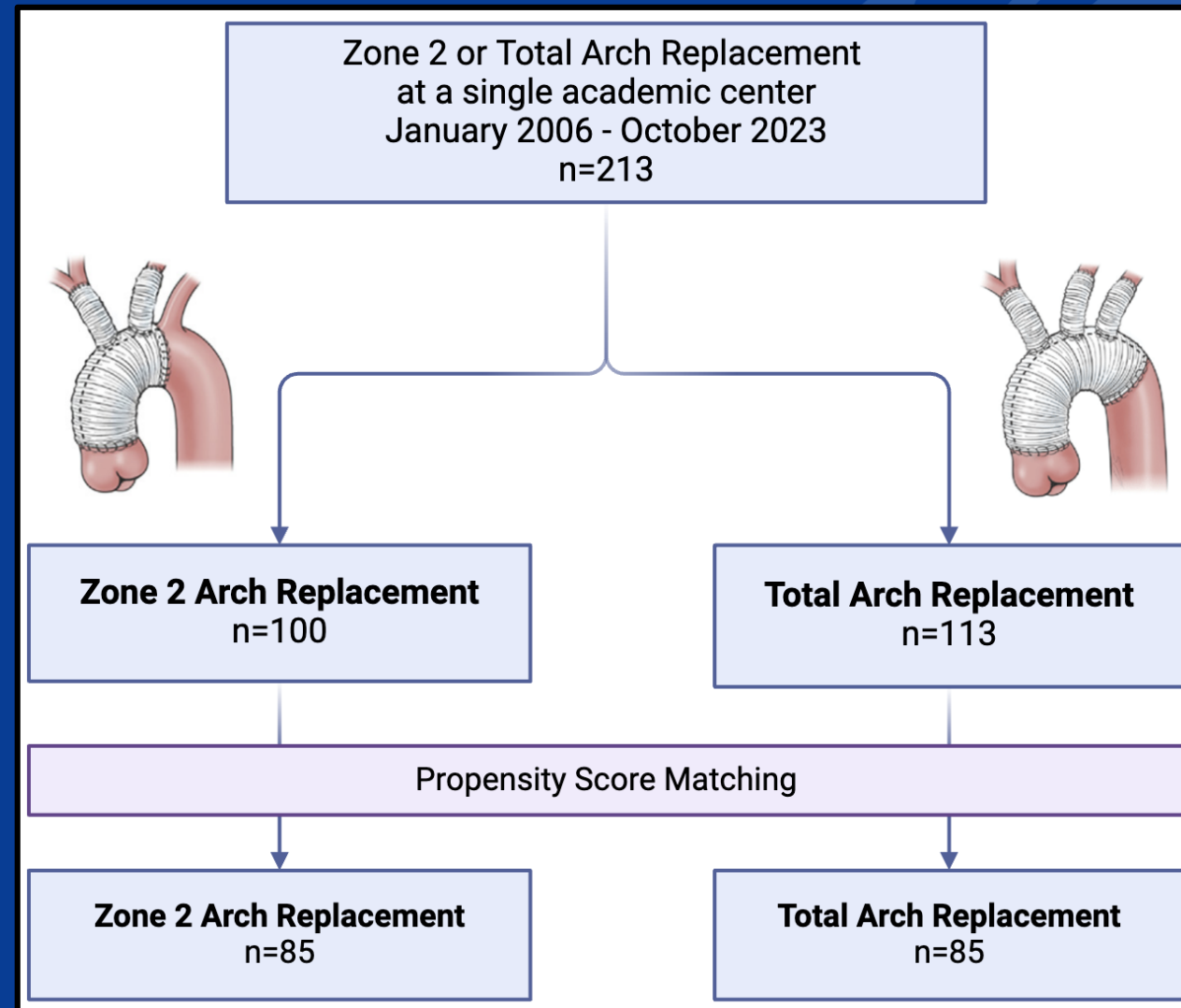
- **Total Arch Replacement (TAR or Zone 3 Arch Replacement) is a common approach for aortic arch pathologies but remains a challenging procedure with high morbidity and mortality¹⁻³**
- **Zone 2 Arch Replacement (Z2R) may be increasingly utilized to treat arch pathologies with the development of endovascular therapies⁴⁻⁸**
- **Aim: Compare long term outcomes between patients undergoing Z2R and TAR at one institution**

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Patients

Z2R at our institution: Zone 2 anastomosis without LSA reconstruction or elephant trunk



Methods

- **Primary endpoints: long-term mortality and unplanned distal aortic reintervention due to progressing aortic disease**
- **Secondary endpoints: in-hospital mortality, stroke**
- **Propensity score matching formed well-balanced groups**
- **Kaplan-Meier method used to analyze 10-year survival**
- **Nelson's non-parametric estimates to analyze cumulative incidence of reintervention with death as a competing factor**

Patient Characteristics and Operative Details

Baseline Characteristics	All n=213	All Patients		p-value
		Zone 2 n=100	TAR n=113	
Age at surgery	63 [53, 70]	63 [52, 69]	63 [54, 71]	0.46
Female	70 (32.9)	30 (30.0)	40 (35.4)	0.49
Hypertension	177 (83.1)	84 (84.0)	93 (82.3)	0.88
Diabetes	33 (15.5)	14 (14.0)	19 (16.8)	0.71
CKD	41 (19.2)	22 (22.0)	19 (16.8)	0.43
Connective Tissue Disease	11 (5.2)	5 (5.0)	6 (5.3)	>0.99
Surgical Indication				0.16
Acute Dissection	55 (25.8)	31 (31.0)	24 (21.2)	
Chronic Dissection	92 (43.2)	37 (37.0)	55 (48.7)	
Aneurysm	66 (31.0)	32 (32.0)	34 (30.1)	

Operative Details	All n=213	All Patients		p-value
		Zone 2 n=100	TAR n=113	
CPB time (min)	205 [169, 246]	204 [170, 240]	206 [166, 251]	0.40
CCT (min)	103 [78, 137]	102 [75, 142]	103 [84, 132]	0.81
Concomitant Procedures				
Root replacement	68 (31.9)	34 (34.0)	34 (30.1)	0.64
Elephant trunk				<0.001
Conventional	27 (12.7)	7 (7.0)	20 (17.7)	
Frozen	43 (20.2)	5 (5.0)	38 (33.6)	

Improved in-hospital outcomes and comparable 10-year survival

Variable	All n=213	All Patients			Matched Cohort		
		Zone 2 n=100	TAR n=113	p-value	Zone 2 n=85	TAR n=85	p-value
Operative Mortality	15 (7.0)	3 (3.0)	12 (10.6)	0.06	3 (3.5)	11 (12.9)	0.05
Stroke	22 (10.3)	10 (10.0)	12 (10.6)	>0.99	9 (10.6)	9 (10.6)	>0.99
SCI	4 (1.9)	1 (1.0)	3 (2.7)	0.70	1 (1.2)	2 (2.4)	>0.99
Re-exploration for Bleeding	18 (8.5)	6 (6.0)	12 (10.6)	0.34	5 (5.9)	8 (9.4)	0.56
Prolonged Ventilation	65 (30.5)	29 (29.0)	36 (31.9)	0.76	26 (30.6)	25 (29.4)	>0.99
AKI Requiring CVVH/HD	18 (8.5)	6 (6.0)	12 (10.6)	0.34	4 (4.7)	8 (9.4)	0.37
Deep Sternal Wound Infection	3 (1.4)	1 (1.0)	2 (1.8)	>0.99	1 (1.2)	1 (1.2)	>0.99
RLN Injury	7 (3.3)	2 (2.0)	5 (4.4)	0.55	2 (2.4)	2 (2.4)	>0.99

TAR – total arch replacement; SCI – spinal cord ischemia; AKI – acute kidney injury; CVVH/HD – continuous veno-venous hemofiltration/hemodialysis; RLN – recurrent laryngeal nerve

- Lower operative mortality after Z2R in matched cohort
- No difference in stroke rate or other complications

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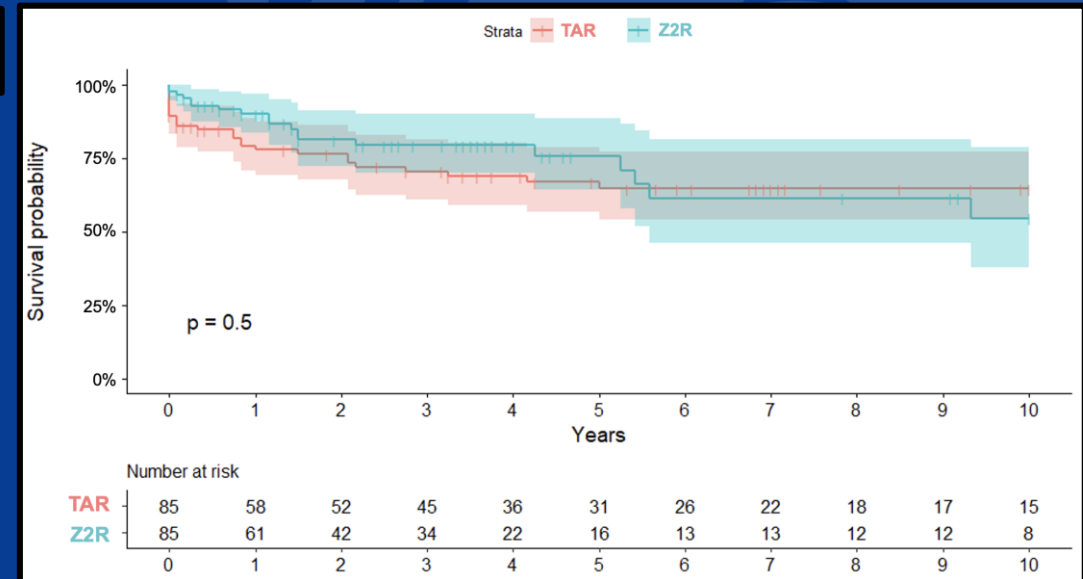


Figure 1. Survival at 10 years was 54.5% (95% CI 37.8%–78.6%) after Z2R and 64.7% (54.3%–77.1%) after TAR (log-rank p=0.50).

Increased rate of all distal reinterventions in Z2R, including planned and endovascular

2

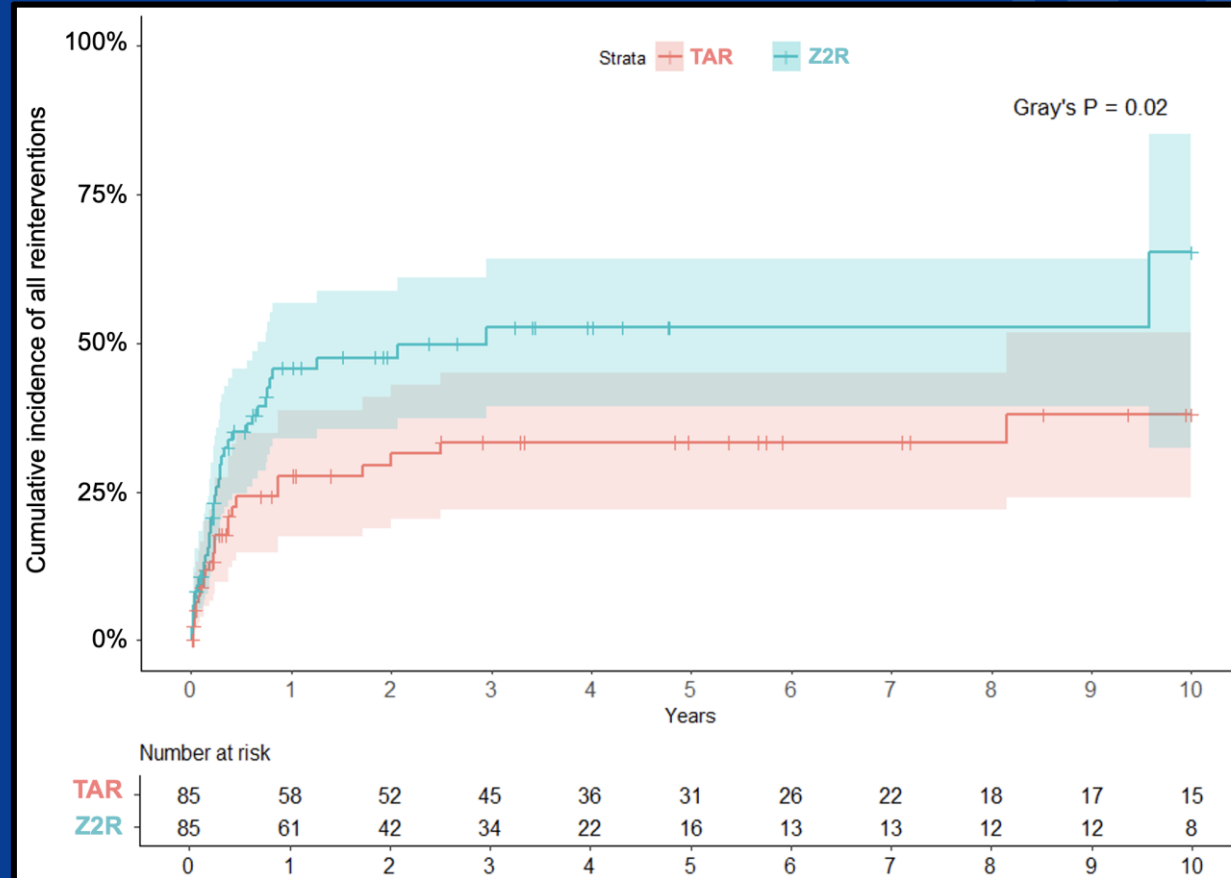


Figure 2. At 10 years, the cumulative incidence of first distal aortic reinterventions, including planned and unplanned procedures, was 65.2% (32.3%–85.1%) after Z2R and 37.9% (24.0%–51.7%) after TAR (p=0.02).

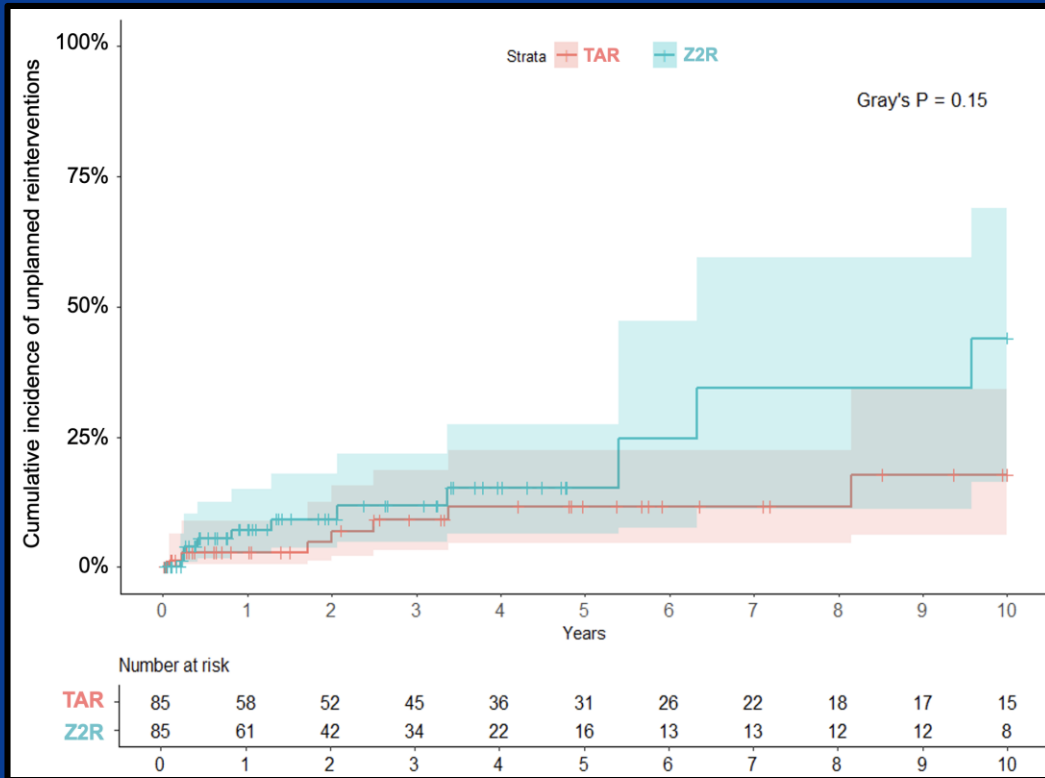
Outcomes after distal aortic reinterventions

	Endovascular Distal Aortic Surgery	Open Distal Aortic Surgery
<i>All Reinterventions</i>	n=74	n=29
Operative mortality	3 (4.1)	3 (10.3)
Stroke	3 (4.1)	1 (3.4)
Spinal cord ischemia	1 (1.4)	2 (6.9)
Re-exploration for bleeding	0 (0.0)	3 (10.3)
Prolonged ventilation	5 (6.8)	8 (27.6)
AKI requiring CVVH/HD	2 (2.7)	2 (6.9)
Deep sternal infection	0 (0.0)	1 (3.4)
RLN injury	0 (0.0)	0 (0.0)
<i>Planned Reinterventions</i>	n=52	n=12
Operative mortality	1 (1.9)	3 (25.0)
Stroke	0 (0.0)	0 (0.0)
Spinal cord ischemia	0 (0.0)	1 (8.3)
Re-exploration for bleeding	0 (0.0)	1 (8.3)
Prolonged ventilation	1 (1.9)	3 (25.0)
AKI requiring CVVH/HD	1 (1.9)	0 (0.0)
Deep sternal infection	0 (0.0)	0 (0.0)
RLN injury	0 (0.0)	0 (0.0)

In-hospital outcomes after distal aortic reinterventions in all patients were satisfactory, particularly in planned endovascular reinterventions

No difference in unplanned aortic reinterventions

3



Variable	HR	95% CI	p-value
Age at surgery	0.98	0.96, 1.01	0.12
Male sex	0.84	0.42, 1.71	0.63
eGFR	1.00	0.99, 1.02	0.56
Acute dissection (ref: aneurysm)	2.97	1.08, 8.19	0.04
Chronic dissection (ref: aneurysm)	2.72	1.03, 7.22	0.04
TAR (ref: Z2R)	1.07	0.57, 1.99	0.84

On multivariable regression, surgical indication but not arch replacement strategy was associated with unplanned aortic reinterventions

Figure 3. The cumulative incidence of first unplanned aortic reinterventions was 43.9% (16.2%–68.9%) after Z2R and 17.6% (6.1%–34.1%) after TAR (p=0.15).

Limitations

- **Although propensity score matching was well-balanced, there may be unmeasured confounders in selecting which patients receive Z2R vs. TAR**
- **Era effect may affect outcomes**
- **Retrospective, single-center study limits generalizability**

Conclusions

- Improved in-hospital mortality after Z2R and comparable 10-year survival
- As expected, Z2R had higher rates of all distal reinterventions including planned reinterventions, which were well-tolerated
- Unplanned aortic reintervention rate for distal disease progression was comparable at 10 years and associated with dissection, not arch replacement
- Zone 2 arch replacement with or without a staged endovascular reintervention is a viable option with short- and long-term outcomes comparable to those after total arch replacement