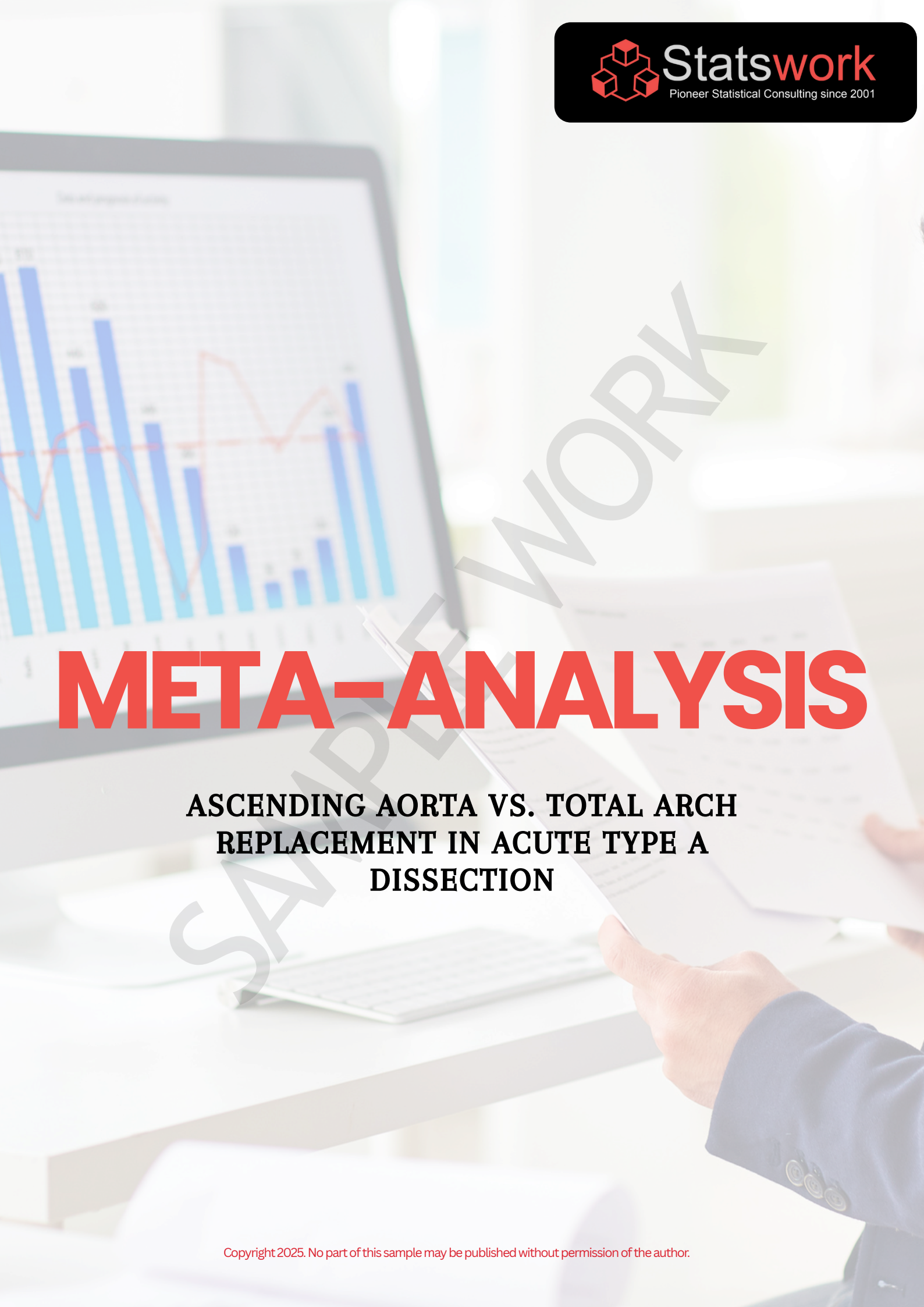


META-ANALYSIS

ASCENDING AORTA VS. TOTAL ARCH REPLACEMENT IN ACUTE TYPE A DISSECTION

Statswork

Ascending Aorta vs. Total Arch Replacement in Acute Type A Dissection: A Meta-Analysis

Abstract

Acute type A aortic dissection (ATAAD) is a time-sensitive surgical emergency. This systematic review and meta-analysis examine the early and long-term clinical outcomes associated with Ascending Aorta Replacement (AR) and Total Aortic Arch Replacement (TR) in patients with ATAAD. Fifteen cohort studies with 2822 patients were included. The data demonstrated that AR has significantly less in-hospital mortality and less cardiopulmonary bypass time and time spent in circulatory arrest when compared to TR, however long-term mortality and rates of aortic re-intervention is similar. This data is useful to guide surgical decision-making in ATAAD.

1. Introduction

Acute type A aortic dissection (ATAAD) is a life-threatening cardiovascular emergency marked by a disruption of the intimal layer within the ascending aorta, which can potentially lead to rapid mortality. The treatment of choice is surgical repair. The optimal extent of surgical repair (Ascending Aorta Replacement [AR] or Total Aortic Arch Replacement [TR]) remains controversial with conflicting reports in the literature. The aim of this meta-analysis is to compare early mortality, long-term survival, postoperative complications, and re-operation among patients undergoing either surgical strategy.

2. Methodology

We performed a thorough review of the literature in PubMed, Embase, Web of Science, BIOSIS, and CNKI, capturing articles published prior to 2025. The inclusion criteria were defined as cohort studies comparing AR/HA/Partial Arch versus TR in patients with ATAAD. In total, 15 cohort studies covering 2,822 patients were included in the analysis.

Statistical Methods

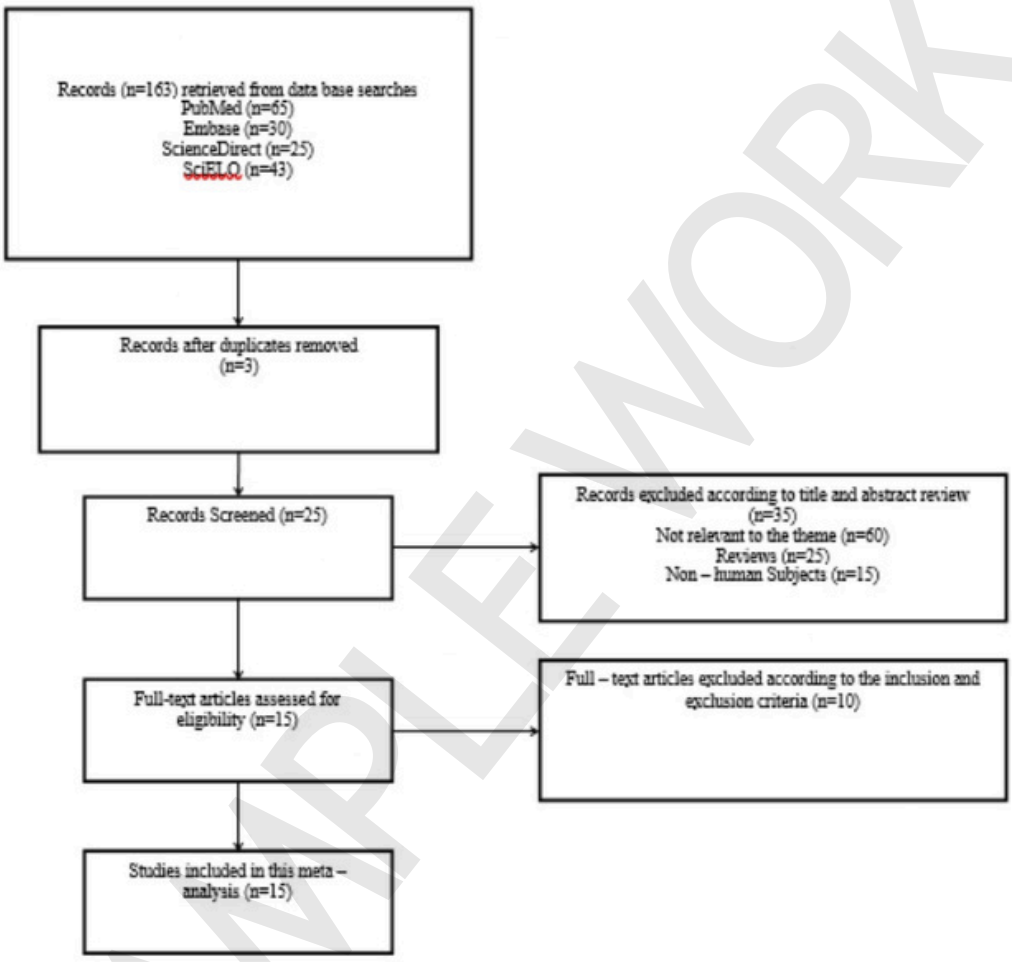
- Pooled Risk Ratios (RR) and Mean Differences were estimated using the random-effects DerSimonian and Laird model.
- Heterogeneity was evaluated with both Cochrane Q, and I^2 statistics.
- Publication bias was evaluated looking at funnel plot symmetry, using Kendall's Tau, and through Egger's regression test.

3. Results

3.1 Literature Search Summary

- Initially identified articles: 2,104
- After screening and full-text review, 15 eligible cohort studies were selected.

Figure 1 Study selection flow chart



3.2 Patient Characteristics

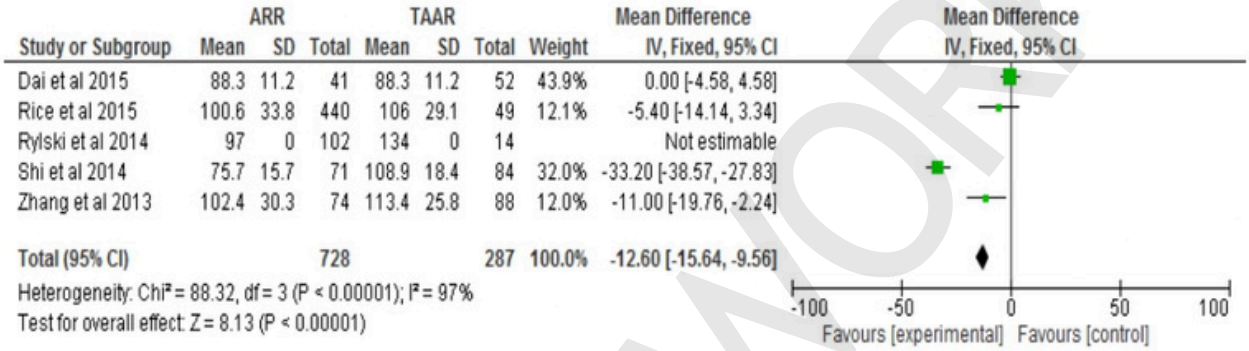
- Total patients: 2,822
  - AR/HA/Partial Arch: 1,911 patients
  - TR: 911 patients
- Studies originated from China, Germany, Italy, Japan, Netherlands, South Korea, UK, and USA.
- Mean follow-up duration ranged from **12 months to 10 years**.

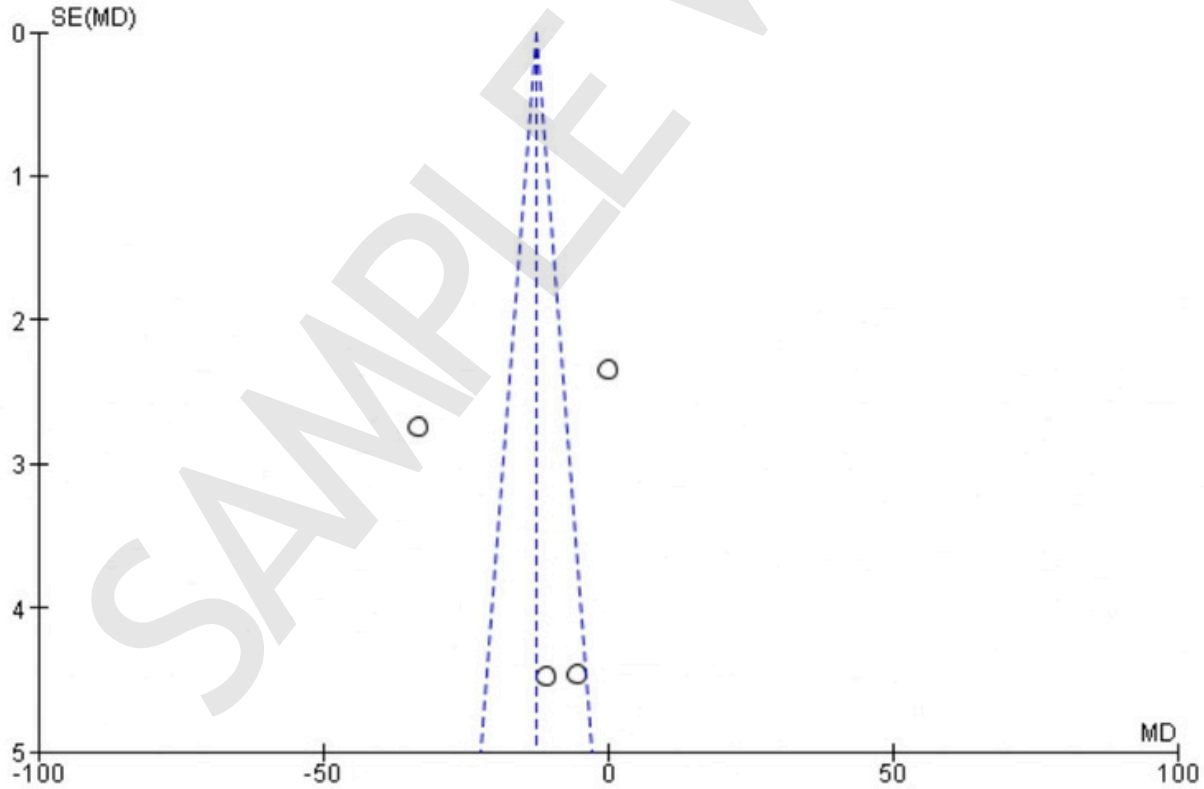
3.3 Primary Outcomes

In-Hospital Mortality

- AR was associated with significantly lower in-hospital mortality compared to TR (RR=0.77; 95% CI: 0.61–0.96; p=0.02) (Figure 2 – Forest Plot).

Figure 2: Comparison of aortic cross-clamp (ACC) time between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)

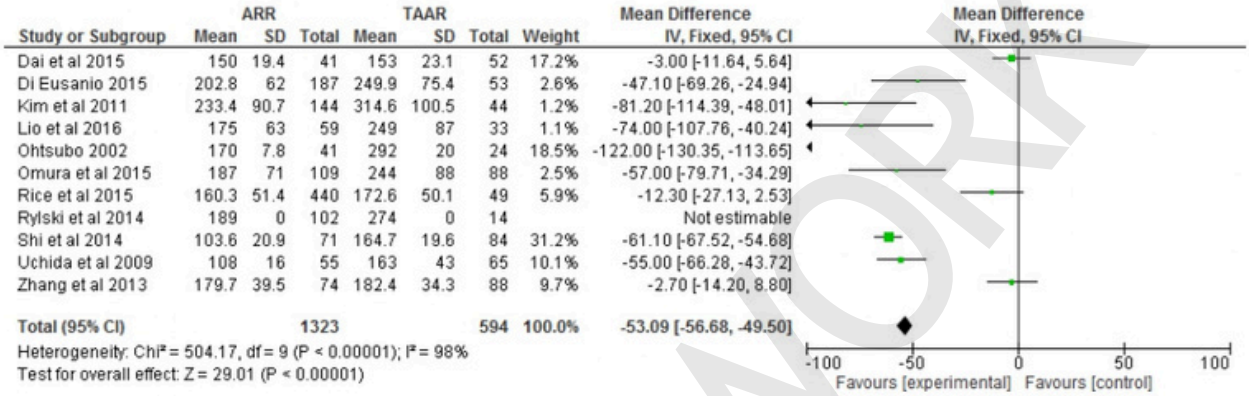




Long-Term Mortality

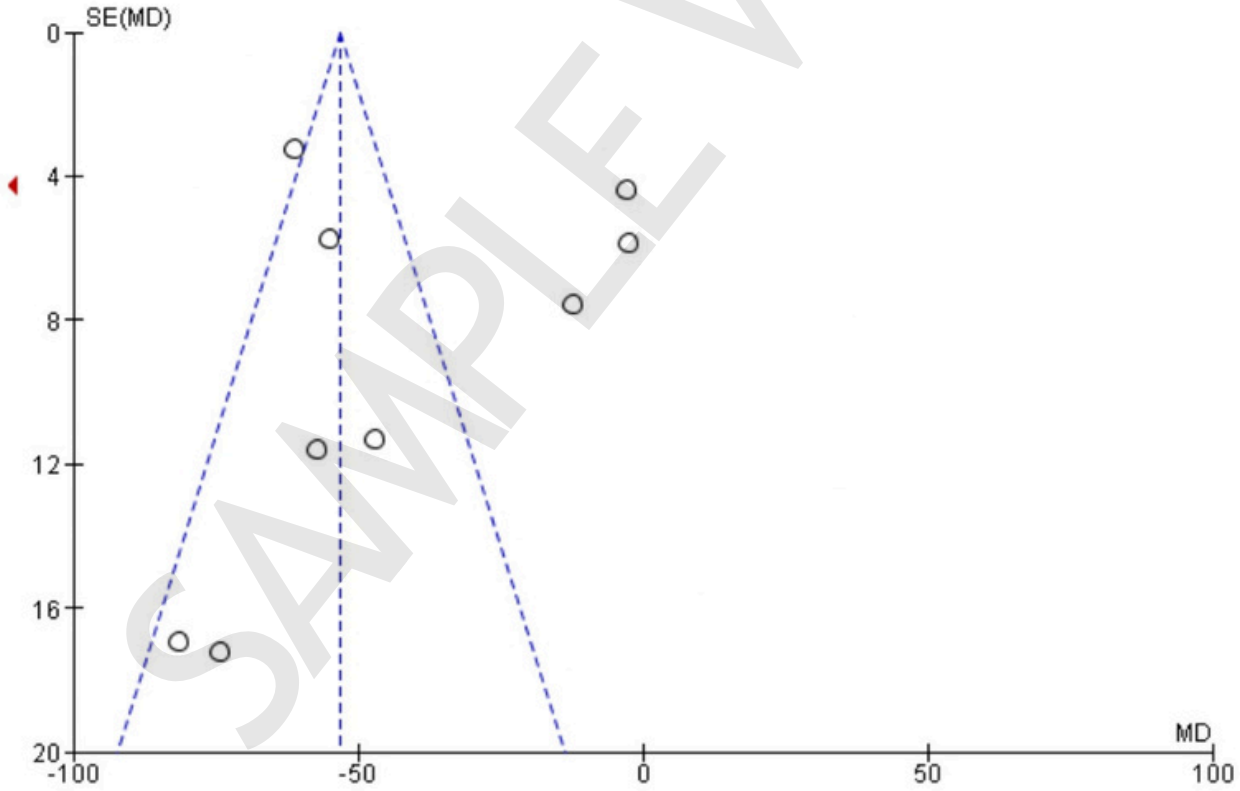
- No significant difference was observed in long-term survival (OR=0.73; 95% CI: 0.53–1.01; p=0.06) (Figure 3).

Figure 3: Comparison of Cardiopulmonary bypass (CPB) time between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)



Study or Subgroup	ARR Mean	ARR SD	ARR Total	TAAR Mean	TAAR SD	TAAR Total	Weight	Mean Difference IV, Fixed, 95% CI
Dai et al 2015	150	19.4	41	153	23.1	52	17.2%	-3.00 [-11.64, 5.64]
Di Eusanio 2015	202.8	62	187	249.9	75.4	53	2.6%	-47.10 [-69.26, -24.94]
Kim et al 2011	233.4	90.7	144	314.6	100.5	44	1.2%	-81.20 [-114.39, -48.01]
Lio et al 2016	175	63	59	249	87	33	1.1%	-74.00 [-107.76, -40.24]
Ohtsubo 2002	170	7.8	41	292	20	24	18.5%	-122.00 [-130.35, -113.65]
Omura et al 2015	187	71	109	244	88	88	2.5%	-57.00 [-79.71, -34.29]
Rice et al 2015	160.3	51.4	440	172.6	50.1	49	5.9%	-12.30 [-27.13, 2.53]
Rylski et al 2014	189	0	102	274	0	14		Not estimable
Shi et al 2014	103.6	20.9	71	164.7	19.6	84	31.2%	-61.10 [-67.52, -54.68]
Uchida et al 2009	108	16	55	163	43	65	10.1%	-55.00 [-66.28, -43.72]
Zhang et al 2013	179.7	39.5	74	182.4	34.3	88	9.7%	-2.70 [-14.20, 8.80]
Total (95% CI)			1323			594	100.0%	-53.09 [-56.68, -49.50]

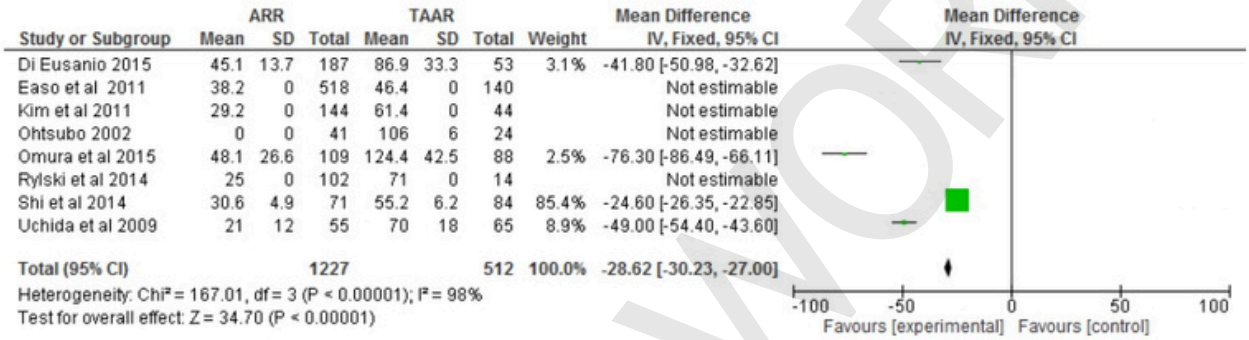
Heterogeneity: Chi² = 504.17, df = 9 (P < 0.00001); I² = 98%
Test for overall effect: Z = 29.01 (P < 0.00001)



Neurological Dysfunction

- Permanent neurological dysfunction: RR=1.15; 95% CI: 0.78–1.69; p=0.50.
- Temporary neurological dysfunction: RR=0.89; 95% CI: 0.53–1.48; p=0.65 (Figures 4 and 5).

Figure 4: Comparison of antegrade cerebral perfusion (ACP) between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)



Study or Subgroup	ARR Mean	ARR SD	ARR Total	TAAR Mean	TAAR SD	TAAR Total	Weight	Mean Difference IV, Fixed, 95% CI
Di Eusanio 2015	45.1	13.7	187	86.9	33.3	53	3.1%	-41.80 [-50.98, -32.62]
Easo et al 2011	38.2	0	518	46.4	0	140		Not estimable
Kim et al 2011	29.2	0	144	61.4	0	44		Not estimable
Ohtsubo 2002	0	0	41	106	6	24		Not estimable
Omura et al 2015	48.1	26.6	109	124.4	42.5	88	2.5%	-76.30 [-86.49, -66.11]
Rylski et al 2014	25	0	102	71	0	14		Not estimable
Shi et al 2014	30.6	4.9	71	55.2	6.2	84	85.4%	-24.60 [-26.35, -22.85]
Uchida et al 2009	21	12	55	70	18	65	8.9%	-49.00 [-54.40, -43.60]
Total (95% CI)			**1227**			**512**	**100.0%**	**-28.62 [-30.23, -27.00]**

Heterogeneity: Chi² = 167.01, df = 3 (P < 0.00001); I² = 98%
Test for overall effect: Z = 34.70 (P < 0.00001)

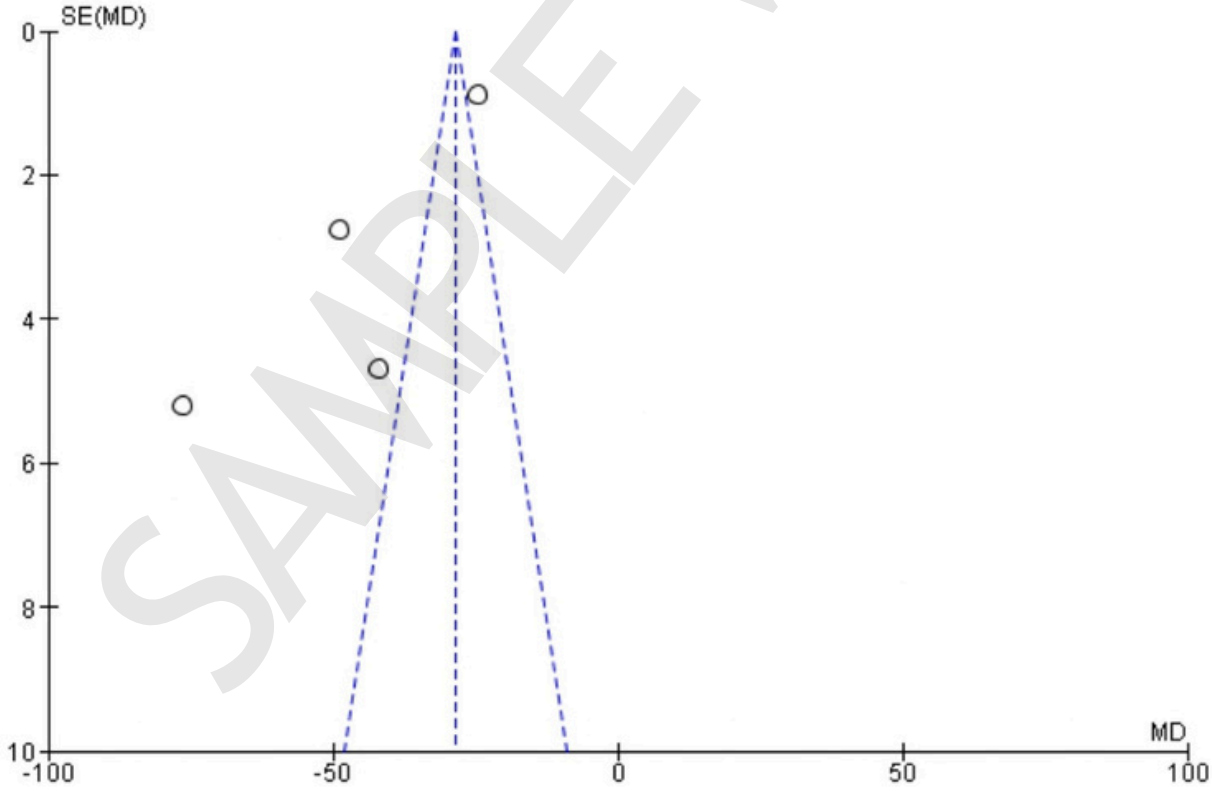
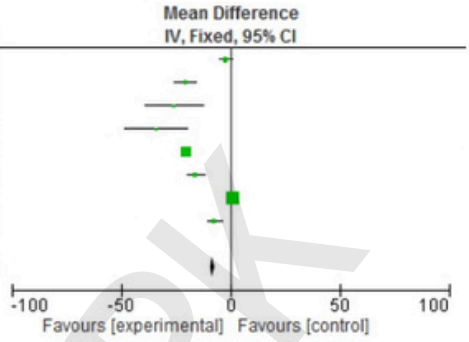
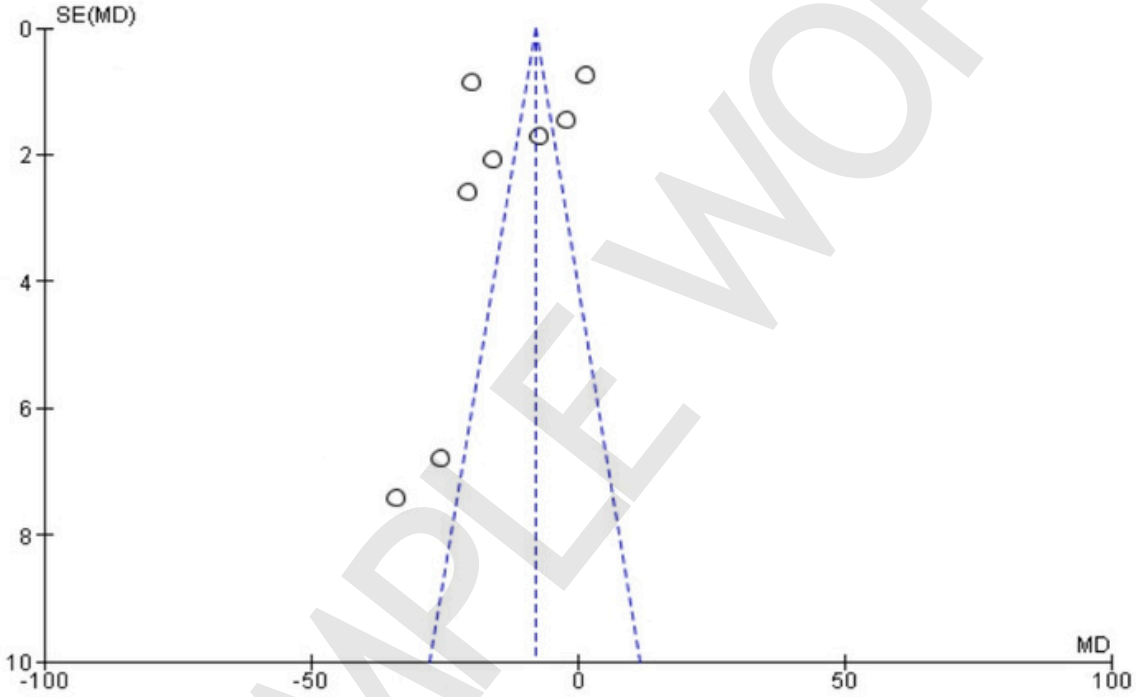


Figure 5: Comparison of circulatory arrest time (CA) between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)

Study or Subgroup	ARR Mean	ARR SD	ARR Total	TAAR Mean	TAAR SD	TAAR Total	Weight	Mean Difference IV, Fixed, 95% CI
Dai et al 2015	23.8	7.2	41	25.9	6.6	52	11.0%	-2.10 [-4.94, 0.74]
Easo et al 2011	24.3	14.4	518	44.8	29.7	140	3.4%	-20.50 [-25.57, -15.43]
Kim et al 2011	24.6	13.9	144	50.2	44.3	44	0.5%	-25.60 [-38.88, -12.32]
Lio et al 2016	32	23	59	66	39	33	0.4%	-34.00 [-48.54, -19.46]
Ohtsubo 2002	28	1.2	41	48	4.2	24	30.0%	-20.00 [-21.72, -18.28]
Rice et al 2015	27.2	9.3	440	43.1	14.3	49	5.3%	-15.90 [-20.00, -11.80]
Shi et al 2014	30.6	4.9	71	29.3	4.3	84	41.4%	1.30 [-0.16, 2.76]
Zhang et al 2013	28.1	10.1	74	35.4	11.6	88	7.9%	-7.30 [-10.64, -3.96]
Total (95% CI)			**1388**			**514**	**100.0%**	**-8.09 [-9.04, -7.15]**

Heterogeneity: Chi² = 415.21, df = 7 (P < 0.00001); I² = 98%
Test for overall effect: Z = 16.84 (P < 0.00001)

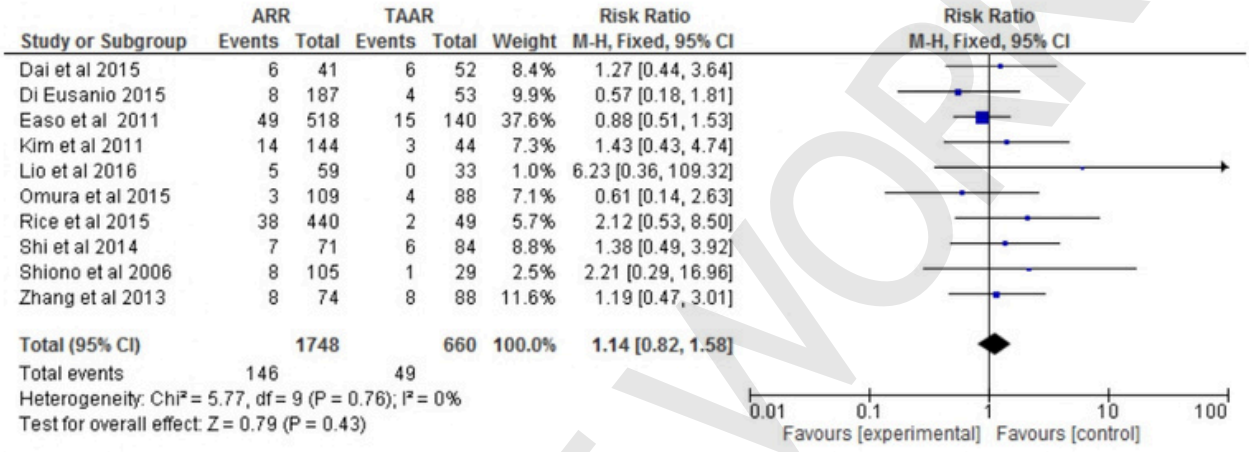


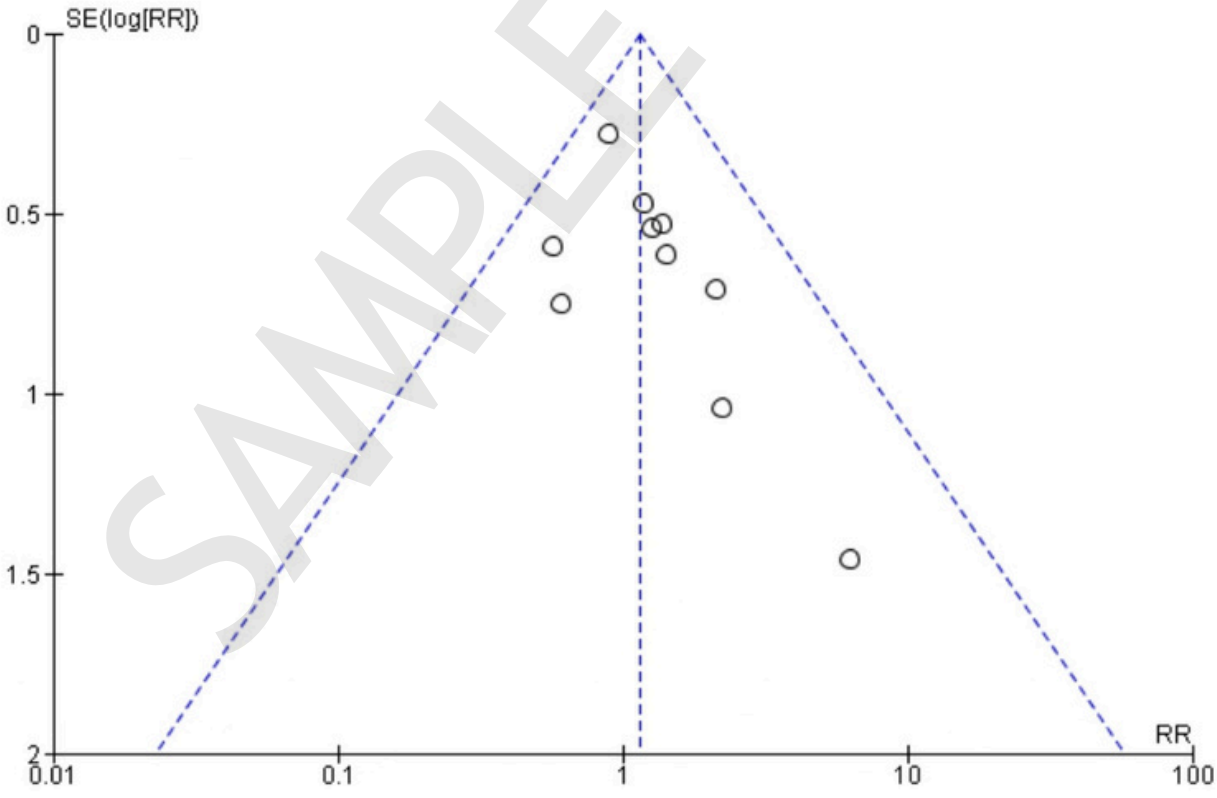


Renal Dialysis

- AR had a higher risk of requiring renal dialysis postoperatively (RR=0.74; 95% CI: 0.56–0.96; p=0.03) (Figure 6).

Figure 6: Comparison of coronary artery by-pass grafting (CABG) between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)





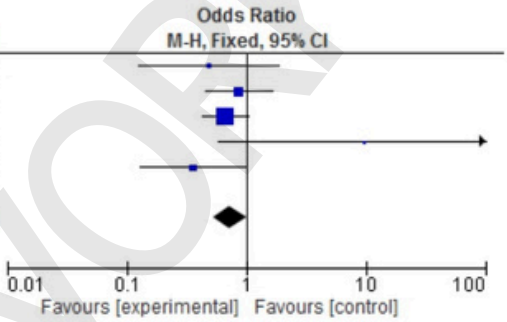
Aortic Re-Operation

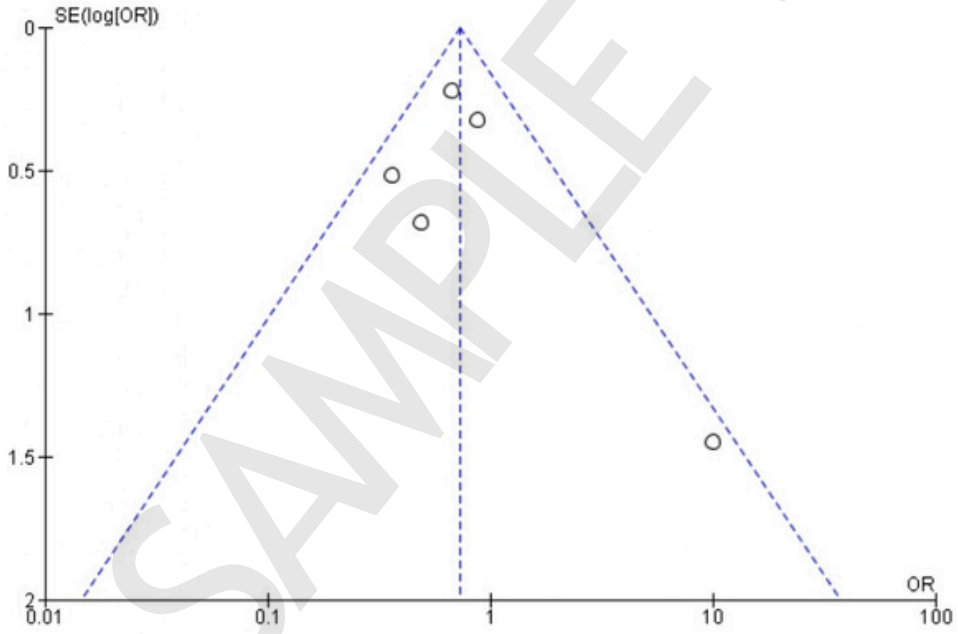
- No statistically significant difference in re-operation rates between AR and TR (AR 7.6% vs. TR 5.3%; RR=1.39; 95% CI: 0.94–2.07; p=0.10) (Figure 7).

Figure 7: Results of AR versus TR on long-term mortality

Study or Subgroup	ARR Events	ARR Total	TAAR Events	TAAR Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Dai et al 2015	35	41	48	52	7.2%	0.49 [0.13, 1.85]
Di Eusanio 2015	114	187	34	53	24.2%	0.87 [0.46, 1.64]
Easo et al 2011	97	518	36	140	53.8%	0.67 [0.43, 1.03]
Kim et al 2011	14	144	0	44	0.8%	9.89 [0.58, 169.20]
Lio et al 2016	9	59	11	33	14.0%	0.36 [0.13, 0.99]
Total (95% CI)		**949**		**322**	**100.0%**	**0.73 [0.53, 1.01]**
Total events	269		129			

Heterogeneity: Chi² = 5.96, df = 4 (P = 0.20); I² = 33%
Test for overall effect: Z = 1.90 (P = 0.06)





3.4 Secondary Outcomes

- **Operative Times:**
  - CPB Time: Significantly shorter in AR group (Mean Difference = -53.09 minutes; p<0.0001).
  - Circulatory Arrest Time: Mean Difference = -8.09 minutes; p<0.001.
  - ACP Time: Mean Difference = -28.62 minutes; p<0.0001.
- No significant differences in aortic cross-clamp time or CABG rates.

Table 1. Characteristics of the 15 Acute Type A AD (Disease) studies included in the meta-analysis.

Author, year	Country	Study Period	Study design	Total sample size	Follow-up (months)	AR, *n*	TR, *n*	Dissection	Quality¥
Dai et al. [16]	Fujian, China	2008-2010	Observational Cohort	93	64 ± 5.3 months	41	52	TAR: triple branched stent graft reconstruction of the aortic arch; AR with hemiarch and AAR replacement	7
Di Eusanio et al. [17]	Bologna, Italy	1997-2012	Observational Cohort	240	4.8±3.9 years (0.1-15.5 years)	187	53	TAR: Elephant trunk technique (Classic/frozen); AR: partial arch replacement + ascending aorta + hemiarch	8
Easo et al.[18]	Oldenburg, Germany	2006-2010	Observational Cohort	658	-	518	140	TAR: Elephant trunk technique (Classic/frozen); AR: ascending aorta + hemiarch/open anastomosis	7
Kim et al.[26]	Seoul, South Korea	1999-2009	Observational Cohort	188	47.5 months (0-130.4	144	44	TAR: AR: ascending aorta + hemiarch	9

					months) (4.0 years)				
Lio et al.[27]	Rome, Italy	2006-2013	Observational Cohort	92	19.5 months (interquartile range [IQR], 1–59 mo.) and 30.5 ± 29.8 months (IQR range, 0–100 mo.).	59	33	TAR: AR: ascending aorta + hemiarch	8
Ohtsubo et al. [28]	Saga, Japan	1989-2001	Observational Cohort	47	42.0±36 months (0-147 months) 3.5 years	23	24	TAR: AR: ascending aorta + hemiarch	7
Omura et al.[19]	Kobe, Japan	1999-2014	Observational Cohort	197	60±48 months	88	197	TAR: Elephant trunk technique (Classic/frozen); AR: partial arch replacement + ascending aorta + hemiarch	9
Rice et al.[20]	Texas,USA	NS	Observational Cohort	489	49 months	440	49	TAR: AR: ascending aorta + hemiarch	9
Rylski et al.[21]	Freiburg, Germany	2001-2013	Observational Cohort	51	4.9 years 45% > 5 years	37	14	TAR: AR: ascending aorta + hemiarch	9
Shi et al.[29]	Shenyang, China	2006–2011	Observational Cohort	155	42.7±17.8 months 8 (3.6 years)	71	84	TAR: Elephant trunk technique; AR: Aorta+stented elephant trunk+ ascending aorta + hemiarch	8
Shiono et al.[7]	Tokyo, Japan	1995-2005	Observational Cohort	134	FU Upto 10 years	105	29	TAR: AR: ascending aorta + hemiarch	8
Shen et al.[31]	China	Jan to Nov 2010		38	12± 3 months	16	22	TAR: With Elephant Trunk Techniques VS	8

Omura et al.[19]	61±13	70±11	62 (70.5)	50 (45.9)	-	-	-	-	-	-	-	-
Rice et al.[20]	62.4±13.4	57.9±14.8	38 (77.5)	313 (71.1)	44 (89.8)	370 (84.1)	1 (2.0)	9 (2.1)	6 (12.2))	30 (6.8)	9 (18.4)	69 (15.7)
Rylski et al.[21]	55	66	8 (57)	21 (57)	13 (93)	31 (84)	0	2 (5)	1 (7)	2 (5)	1 (7)	3 (8)
Shi et al.[29]	53.9±12.2	55.9±10.1	57 (67.9)	53 (74.6)	67 (79.8)	55 (77.5)	22 (26.2)	10 (14.1)	1 (1.2)	0	12 (14.3)	13 (18.3)
Shiono et al.[7]	61.9±12.6	82.0±2.4	52 (47.3)	10 (41.7)	96 (87.2)	23 (95.8)	8 (7.3)	0	10 (9.1)	2 (8.3)	46 (41.8)	11 (45.8)
Shen et al.[31]	45.4±10.4	42.4±11.5	16 (72.7)	12 (75.0)	13 (59.1)	8(50.0)	3 (13.6)	2 (12.5)	-	-	2 (9.1)	1 (6.25)
Tan et al.[22]	-	-	-	-	-	-	-	-	-	-	-	-
Uchida et al.[23]	64.4	72.3	28 (43.1)	25 (45.4)	-	-	-	-	6 (9)	12 (22)	-	-
Zhang et al.[24]	45.5±13.5	49.1±12.6	74 (84.1)	55 (74.3)	64 (72.7)	47 (63.5)	21 (23.9)	13 (17.6)	1 (1.1)	2 (2.7)	17 (23.0)	25 (28.4)

*Number of patients

Table 3. Mortality and Morbidity

Author, year	Operative outcome and Follow-Up							
	30-day mortality		In hospital death		Late death (≥ 1year)		Subsequent operation	
	TR	AR	TR	AR	TR	AR	TR	AR
Dai et al. [16]	2 (3.85)	1 (2.44)	2 (3.85)	2 (4.88)	-	-	-	-
Di Eusanio et al. [17]	-	-	12 (22.6)	45 (24.1)	-	-	-	-
Easo et al.[18]	-	-	36 (25.7)	97 (18.7)	-	-	-	-

					(range, 8-18 months)			AR: ascending aorta	
Tan et al.[22]	Nieuwegein, The Netherland	1986-2001	Observational Cohort	70	2.6 years (0-14.5 years)	53	17	TAR: AR: ascending aorta + hemiarch	8
Uchida et al.[23]	Hiroshima, Japan	1997-2008	Observational Cohort	120	67 months (3-124 months) (5.6 years)	55	65	TAR: AR: ascending aorta + hemiarch	7
Zhang et al.[24]	Shanghai, China	2002-2010	Observational Cohort	162	55.7±33.1 months (4.6 years)	74	88	PR(AS+HA) VS ER (TA+descending)	7

*Number of patients *Study Sample size; ¥ - Study quality was evaluated using the Newcastle–Ottawa scale

Table 2. Characteristics of the patients 15 Acute Type A AD (Disease) studies included in the meta-analysis -.

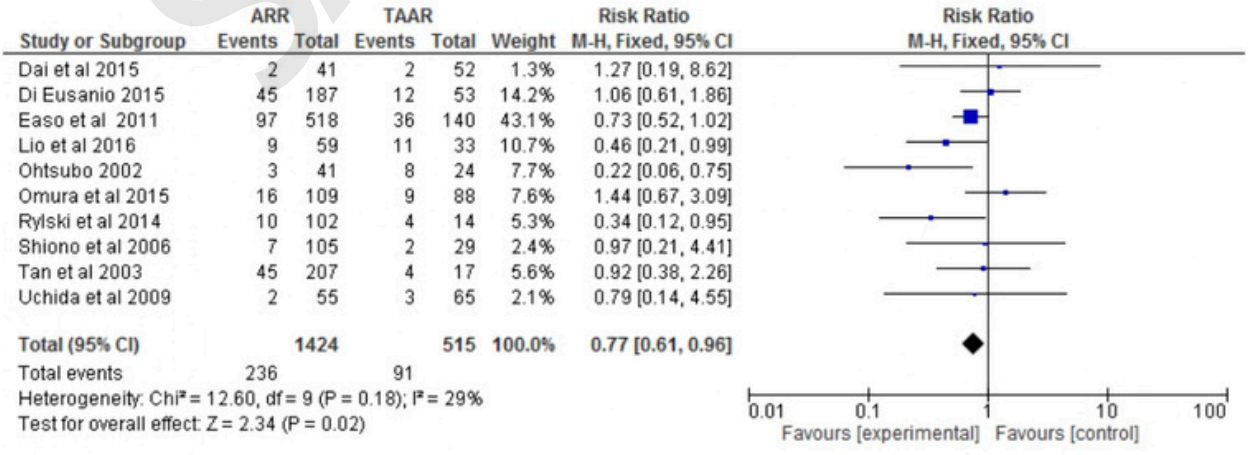
Author, year	Mean age (years)		Male gender n (%)		Hypertension n (%)		Marfan syndrome n (%)		Stroke n (%)		Cardiogenic shock-tamponade n (%)	
	TR	AR	TR	AR	TR	AR	TR	AR	TR	AR	TR	AR
Dai et al. [16]	49.8±9.6	49.1±10.4	29 (65.0)	25 (61.3)	49 (94.2)	40 (97.6)	3 (5.8)	2 (4.9)				
Di Eusanio et al. [17]	59.2±12.3	64.4±11.2	41 (77.4)	125 (66.8)	40 (75.5)	138 (80.2)	3 (5.7)	5 (2.7)	3 (5.7)	7 (3.7)	2 (3.8)	25 (13.4)
Easo et al.[18]	-	-	-	-	-	-	-	-	-	-	-	-
Kim et al.[26]	55.0±12.1	57.6±11.5	26 (59.1)	69 (47.9)	24 (54.5)	92 (63.9)	1 (2.3)	7 (4.9)	-	-	4 (9.1)	13 (9.0)
Lio et al.[27]	61±12	66±10	28 (85)	43 (73)	30 (91)	51 (86)	-	-	-	-	-	-
Ohtsubo et al. [28]	68	68	13 (54.2)	7 (30.4)	-	-	-	-	-	-	-	-

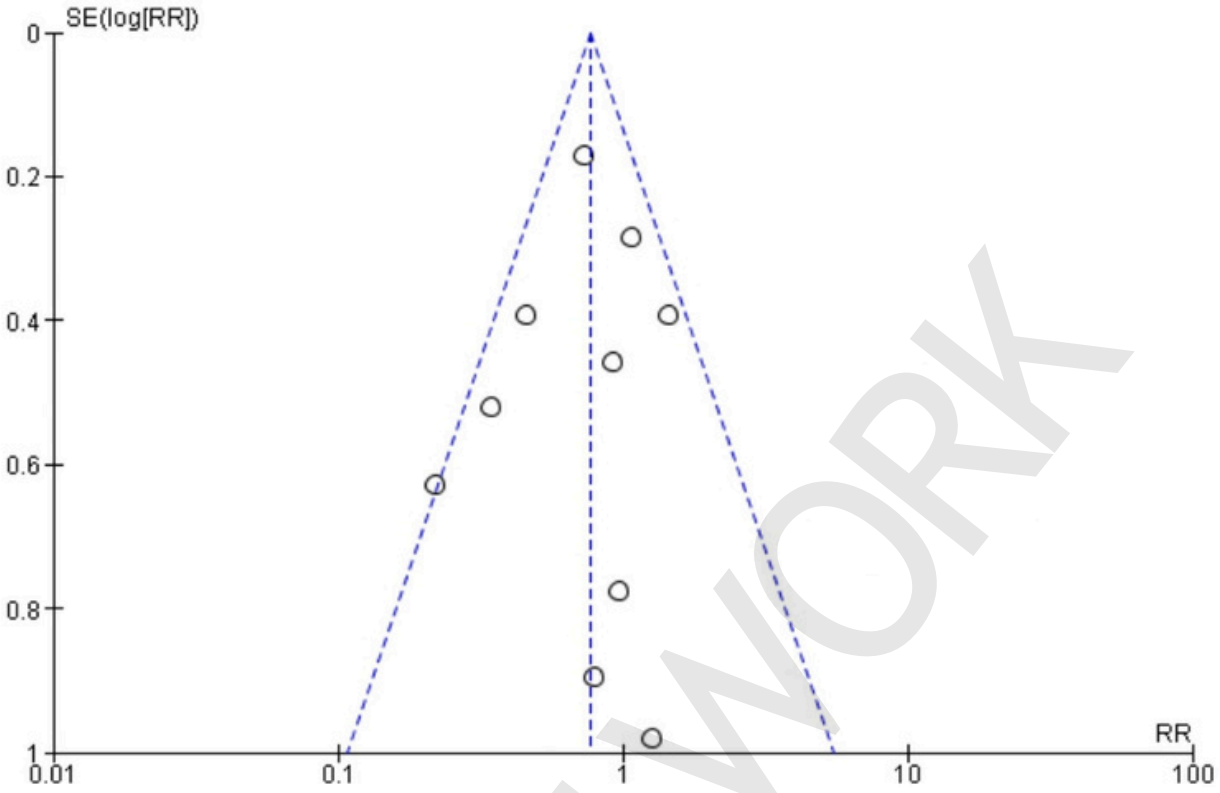
Kim et al.[26]	6 (13.6)	14 (9.7)	-	-	10 (22.7)	14 (9.7)	-	-
Lio et al.[27]	-	-	11 (33.3)	9 (15.2)	-	-	-	-
Ohtsubo et al. [28]	6 (25)	2 (4.8)	8 (33.3)	3 (7.3)	-	-	-	-
Omura et al.[19]	6 (6.8)	12 (11.0)	9 (10.2)	16 (14.7)	15 (13.8)	9 (10.2)	-	-
Rice et al.[20]	10 (20.4)	57 (12.9)	-	-	-	-	-	-
Rylski et al.[21]	-	-	4 (28.6)	10 (9.8)	-	-	-	-
Shi et al. [29]	5 (5.9)	3 (4.2)	-	-	-	-	-	-
Shiono et al.[7]	6 (5.5)	3 (12.5)	2 (6.9)	7 (6.7)	10 (9.1)	9 (37.5)	-	-
Tan et al.[22]	-	-	4 (23.5)	45 (21.7)	-	-	-	-
Uchida et al.[23]	-	-	3 (4.6)	2 (3.6)	3 (4.6)	9 (16.4)	-	-
Zhang et al.[24]	5 (5.7)	4 (5.4)	-	-	-	-	-	-

4. Publication Bias

No significant publication bias was detected. Funnel plot showed symmetry, with Kendall's Tau = 0.07 (p=0.18) and Egger's regression test intercept = 1.18 (p=0.06) (Figure 8 – Funnel Plot).

Figure 8: Comparison of in-hospital mortality between patients undergoing either ascending aortic replacement (AR) or total arch replacement (TR)





5. Discussion

According to this meta-analysis, AR provides a substantial advantage over TR in terms of in-hospital mortality and operative time for treating ATAAD. Both surgical approaches showed similar long-term survival and postoperative complications. TR may provide some theoretical advantages with respect to management of the false lumen in the future, and re-operation, but this did not reach statistical significance in the pooled analysis. Ultimately, the procedure selected should be individualized based on the patient's risk profile and the surgeon's experience.

6. Conclusion

This systematic review and meta-analysis indicate that **Ascending Aorta Replacement (AR)** is related with reduced in-hospital mortality, lower operative time when compared to **Total Aortic Arch Replacement (TR)** in patients with ATAAD and does not adversely affect long-term survival and rates of re-intervention. Even if TR is likely still appropriate in rare cases of patients with extensive disease and a known distribution, AR continues to remain a safe and valid approach for many patients.Future studies should be **prospective multicenter studies** at a minimum of 30 days follow-up, and further studies should also include patient centred outcomes as well as preferences about re-intervention and survivor guidelines that provide recommendations for patient-centred clinical decision making of surgical strategies for ATAAD.