

Late Outcomes of Reimplantation vs Remodeling for Root Repair in Acute Type A Dissection: Experience from International Registry of Acute Aortic Dissection over 27 Years

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Background and Objective

- Valve sparing root replacement (VSRR) has emerged as the preferred treatment option for patients undergoing aortic root surgery
- Reimplantation (David procedure) and remodeling (Yacoub procedure) are the two main VSARR techniques dominating surgical practice
- Currently available data on the efficacy and durability of VSRR mainly come from patients with root aneurysm
- Due to technical differences, there are only a limited number of studies comparing the long-term outcomes of two techniques
- Even fewer studies are available that have compared the early and long-term outcomes of the David and Yacoub procedure for VSRR during acute type A aortic dissection (ATAAD) repair

Background and Objective

- Literature search in PubMed revealed 12 studies of approximately 515 patients with ATAAD over 3 decades, only 2 with late outcomes
- We seek to compare the early and late outcomes of the David and Yacoub techniques in patients with ATAAD using data from IRAD over a 27-year period

Author, year	N of patients	D vs Y (N)	Early death (n/d)	Late death (n/d)	Overall 5-year survival
Schäfers, 1998	15	3 vs 12	0/3 vs 2/12, P=1.000	NR	NR
Graeter, 2000	22	5 vs 17	0/5 vs 2/17, P=1.000	NR	NR
Leyh, 2000	20	9 vs 11	2, group unknown	NR	NR
Leyh, 2002	30	22 vs 8	*3/22 vs 2/8, P=0.563	1/25, group unknown	NR
Graeter, 2002	29	5 vs 24	NR	NR	NR
Erasmi, 2003	36	15 vs 21	3/15 vs 4/21, P=1.000	1/12 vs 5/17, P=0.498	NR
Erasmi, 2007	49	28 vs 21	4/28 vs 3/21, P=1.000	NR	NR
Svensson, 2007	32	11 vs 21	0/11 vs 1/21, P=1.000	NR	NR
David, 2010	25	18 vs 7	4/228 vs 1/61, P=1.000	NR	NR
Subramanian, 2012	78	27 vs 51	4/27 vs 8/51, P=1.000	NR	80% vs 60%, P=0.2
Kallenbach, 2014	96	83 vs 13	0/83 vs 1/13, P= 0.135	2/83 vs 4/12, P=0.006	NR
Sievers, 2018	83	44 vs 39	7/44 vs 6/39, P=1.000	17/37 vs 16/33, P=0.006	74.9% vs 61.9%, P=0.706

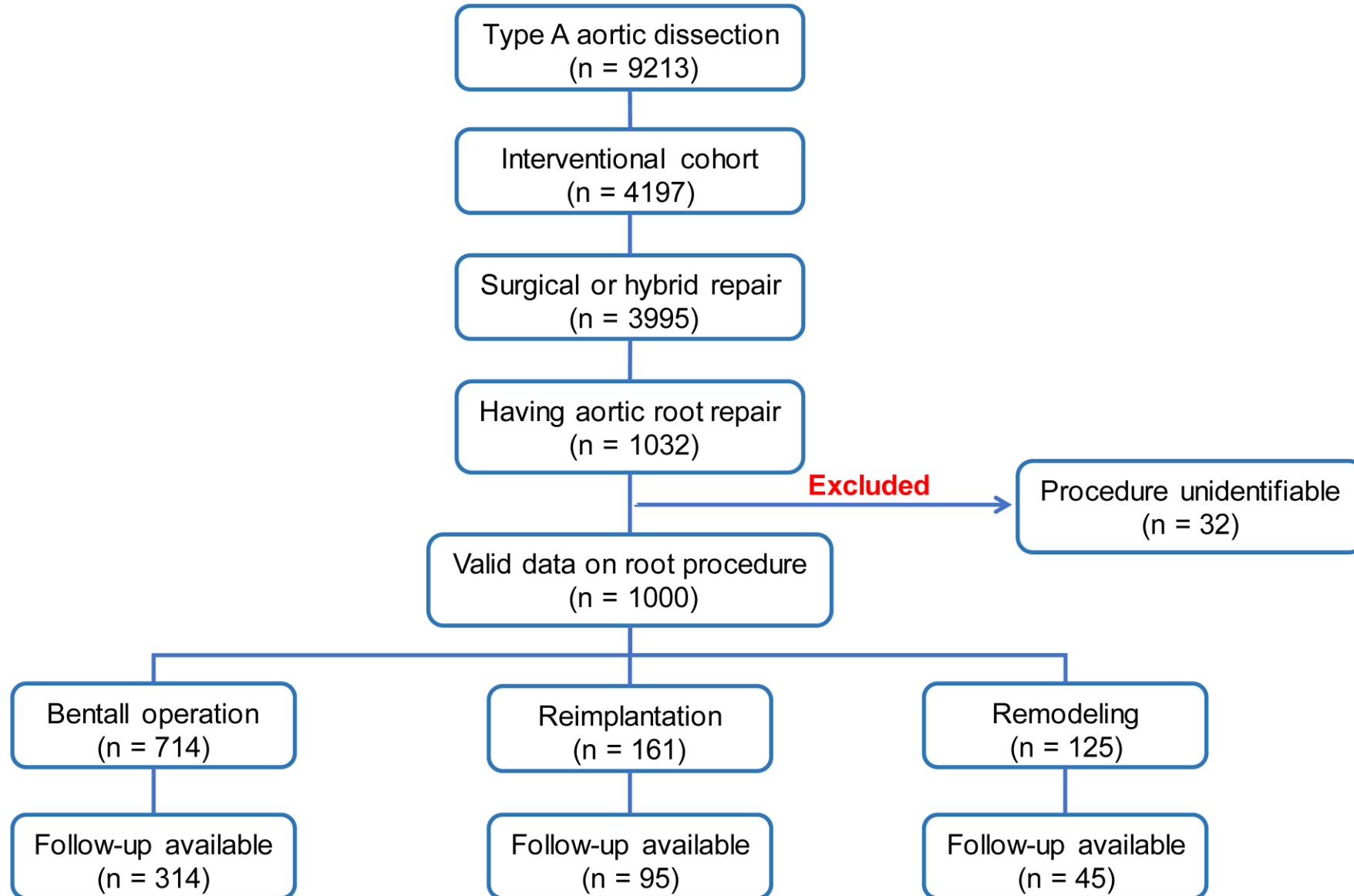
N, number (of patients); D, reimplantation (David procedure); Y, remodeling (Yacoub procedure); NR, not reported

* Calculation based on inference from the early death and late survival

Patients and Methods

- The International Registry of Acute Aortic Dissection (IRAD) database was queried to identify patients with ATAAD who had an aortic root procedure from 03/1996 to 06/2023
- Out of 4197 patients in the Interventional Cohort, 1032 underwent a root repair, and 1000 of them had valid data on the root procedure
- Bentall procedure was performed in 714, David procedure in 161 (Group D), and Yacoub procedure in 125 (Group Y)
- Follow-up was available in 55.8% at median 4.0 years (interquartile range 1–5)
- The baseline characteristics, operative data, early outcomes and follow-up outcomes were compared between Groups D and Y
- Aortic regurgitation and dilation during follow-up were expressed as cumulative incidence
- Variables included in the regression model for early death were procedure (David vs Yacoub), age, sex, time period, preoperative stroke and hypotension, and circulatory arrest time

Flow Chart of Patient Inclusion



Baseline Characteristics

Variable	Whole series (n = 286)	Reimplantation (n = 161)	Remodeling (n = 125)	P value
Age, year	58.7 ± 15.1	57.2 ± 15.5	60.5 ± 14.3	.090
Male gender	66.4 (190/286)	69.6 (112/161)	62.4 (78/125)	.210
Hypertension	80.7 (213/264)	78.5 (117/149)	83.5 (96/115)	.348
Genetic disorder	5.8 (14/243)	6.8 (9/133)	4.5 (5/110)	.584
Atherosclerosis	14.6 (35/239)	15.2 (20/132)	14.0 (15/107)	.856
Known aortic aneurysm	14.1 (34/241)	16.9 (23/136)	10.5 (11/105)	.192
Prior aortic dissection	8.6 (21/244)	8.8 (12/136)	8.3 (9/108)	1.000
History of AR or aortic stenosis	7.2 (17/236)	7.6 (10/131)	6.7 (7/105)	.806
Ever smoker	51.8 (101/195)	48.8 (59/121)	56.8 (42/74)	.304
Chronic kidney injury	7.8 (17/218)	10.7 (14/131)	3.4 (3/87)	.070
Maximal root diameter, cm	4.5 ± 1.3	4.7 ± 1.3	4.2 ± 1.2	.063
Maximal ascending aortic size, cm	5.1 ± 1.3	5.2 ± 1.5	4.9 ± 1.1	.554
Aortic regurgitation (yes/no)	48.1 (89/185)	40.5 (45/111)	59.5 (44/74)	.016

Values are expressed as mean ± standard deviation, or % (numerator/denominator)

AR, aortic regurgitation

Dissection Extent and Malperfusion

Variable	Whole series (n = 286)	Reimplantation (n = 161)	Remodeling (n = 125)	P value
Distal extent - arch	17.9 (40/223)	15.6 (21/135)	21.6 (19/88)	.286
Distal extent - descending aorta	18.4 (41/223)	18.5 (25/135)	18.2 (16/88)	1.000
Distal extent - infrarenal aorta	8.5 (19/223)	4.4 (6/135)	14.8 (13/88)	.012
Distal extent - iliofemoral artery	16.1 (36/223)	17.0 (23/135)	14.8 (13/88)	.713
Coronary artery involvement	9.1 (26/286)	9.9 (16/161)	8.0 (10/125)	.673
Arch vessel involvement	52.6 (100/190)	47.5 (57/120)	61.4 (43/70)	.072
Abdominal vessel involvement	35.0 (63/180)	32.7 (36/110)	38.6 (27/70)	.428
Pericardial effusion	43.2 (89/206)	35.5 (43/121)	54.1 (46/85)	.010
Malperfusion syndrome/ischemia	33.5 (90/269)	29.6 (45/152)	38.5 (45/117)	.152
Cerebral ischemia (stroke)	2.6 (7/265)	0.7 (1/151)	5.3 (6/114)	.045
Spinal cord ischemia	0.4 (1/265)	0.7 (1/151)	0 (0/114)	1.000
Myocardial ischemia	4.2 (9/216)	3.8 (5/130)	4.7 (4/86)	.744
Mesenteric ischemia/infarct	2.3 (6/257)	1.4 (2/148)	3.7 (4/109)	.406
Acute kidney injury	5.1 (13/256)	6.1 (9/147)	3.7 (4/109)	.566
Limb ischemia	9.7 (25/258)	12.8 (19/149)	5.5 (6/109)	.057
Cardiac tamponade	12.6 (33/261)	11.3 (17/150)	14.4 (16/111)	.459
Hypotension	16.5 (42/254)	11.8 (17/144)	22.7 (25/110)	.026

Values are expressed as % (numerator/denominator)

Operative Details

Variable	Whole series (n = 286)	Reimplantation (n = 161)	Remodeling (n = 125)	P value
Cerebral perfusion	88.8 (238/268)	89.8 (141/157)	87.4 (97/111)	.560
Antegrade cerebral perfusion	65.3 (147/225)	75.9 (101/133)	50.0 (46/92)	<.001
Hemiarch or partial arch repair	67.5 (185/274)	63.9 (101/158)	72.4 (84/116)	.152
Total arch repair	17.4 (38/218)	15.7 (21/134)	20.2 (17/84)	.464
Coronary ostial repair or CABG	27.9 (65/233)	29.6 (42/142)	25.3 (23/91)	.550
Cardiopulmonary bypass time, min	202.8 ± 67.3	210.7 ± 69.6	191.8 ± 62.7	.079
Cross-clamp time, min	136.8 ± 59.2	146.0 ± 66.3	123.7 ± 44.4	.064
Cerebral perfusion time, min	35.0 (25.0–49.0)	30.0 (20.0–49.0)	37.0 (31.0–50.0)	.030
Circulatory arrest time, min	39.0 (23.0–75.0)	30.0 (19.0–60.0)	62.0 (37.0–96.0)	<.001

Values are expressed as mean ± standard deviation, or median (interquartile range), or (numerator/denominator)
 CABG, coronary artery bypass grafting

Early Outcomes

Variable	Whole series (n = 286)	Reimplantation (n = 161)	Remodeling (n = 125)	P value
In-hospital mortality	12.6 (36/285)	8.7 (14/161)	17.7 (22/124)	.030
Death of neurologic cause	16.7 (6/36)	0 (0/14)	27.3 (6/22)	.063
Stroke	8.2 (21/257)	6.8 (10/146)	9.9 (11/111)	.491
Coma	3.9 (10/257)	1.4 (2/146)	7.2 (8/111)	.022
Spinal cord injury	0.4 (1/257)	0 (0/146)	0.9 (1/111)	.432
Acute renal failure	17.9 (45/252)	21.2 (31/146)	13.2 (14/106)	.133
Reexploration for bleeding	8.2 (14/171)	6.5 (7/108)	11.1 (7/63)	.386
Extension of dissection	1.6 (4/244)	1.4 (2/141)	1.9 (2/103)	1.000
Mesenteric ischemia/infarct	3.3 (8/246)	1.4 (2/141)	5.7 (6/105)	.076
Length of stay, day	11.0 (7.0–18.5)	10.0 (8.0–16.5)	11.0 (7.0–19.0)	.568

Values are expressed as median (interquartile range), or (numerator/denominator)

Late Outcomes

Variable	Whole series (n = 139)	Reimplantation (n = 95)	Remodeling (n = 44)	P value
Duration of follow-up, year	4.0 (1.0–5.0)	4.9 (1.9–5.0)	2.8 (1.0–5.0)	.163
Late death, n	16	8	8	NA
Time to late death, year	2.1 (1.0–3.7)	1.9 (0.7–3.7)	2.7 (1.0–4.2)	NA
New or worsened AR, n	32	25	7	NA
Time to aortic regurgitation, year	1.0 (0.5–2.0)	1.0 (0.5–2.0)	1.0 (0.5–2.0)	NA
Aortic regurgitation > mild, n	10	9	1	NA
Distal aortic dilatation, n	29	18	11	NA
Time to aortic dilation, year	1.0 (0.5–2.0)	2.0 (1.0–2.0)	1.0 (0.5–2.0)	NA
Kaplan-Meier survival at 5 years, %	88.0 (80.0–92.9)	91.0 (81.8–95.6)	80.6 (61.0–91.0)	.187
Aortic regurgitation at 4 years, %	41.5 (29.1–53.5)	47.2 (31.1–61.7)	29.8 (12.0–50.1)	.217
> mild AR at 4 years, %	13.6 (6.5–23.3)	17.6 (7.9–30.4)	3.7 (0.3–15.9)	.174
Distal aortic dilatation at 4 years, %	36.6 (25.6–47.6)	33.0 (20.5–45.9)	44.8 (23.1–64.5)	.259

Values are expressed as median (interquartile range), or number of cases, or % (95% confidence interval) for Kaplan-Meier estimates
 NA, not applicable, AR, aortic regurgitation

Multivariable Analysis of Early Death

Endpoint / Risk factor	Odds ratio	95% confidence interval	<i>P</i> value
procedure (David vs Yacoub)	1.71	0.79 – 3.61	0.174
preoperative hypotension	3.18	1.33 – 7.62	0.009
preoperative stroke	1.74	0.39 – 7.75	0.468
circulatory arrest time (min)	1.02	1.01 – 1.03	0.002
distal extent to infrarenal aorta	1.87	0.81 – 4.31	0.140

Conclusions

- In patients with acute type A dissection from IRAD database, the remodeling technique was associated with higher early mortality compared to the reimplantation procedure
- However, procedure (remodeling vs reimplantation) was not identified as a risk factor for early mortality
- The higher early mortality with remodeling may be ascribable, in part, to preoperative hypotension
- Despite the limitations of this study, these results show that both the reimplantation and remodeling techniques could achieve comparable rates of survival, aortic dilation, and new or worsened aortic regurgitation in the mid-term