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REVIEW ARTICLE

Total endovascular aortic arch repair: a comprehensive review comparing parallel graft techniques and custom-made devices

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ABSTRACT

INTRODUCTION: Endovascular approaches have emerged as promising alternatives for treating aortic arch pathology, particularly in high-risk patients. This review provides a comprehensive analysis of total endovascular aortic arch reconstruction, focusing on Parallel Graft Techniques (PGTs) and Custom-Made Devices (CMDs).

METHODS: PubMed and Scopus were searched to conduct a comprehensive review comparing the technical aspects, clinical outcomes, strengths, and limitations of PGTs and CMDs. Only studies reporting on total endovascular aortic aneurysm repair were considered. Studies with fewer than five patients, published in a language other than Portuguese, English, or Spanish, and reporting hybrid/open procedures or partial aortic arch reconstructions were excluded. Findings were summarised descriptively.

RESULTS: A total of 38 studies comprising 871 patients were included (214 in PGT and 657 in the CMD group). Technical success rates were high in both groups, mostly ranging from 80% to 100%. No clear superiority was observed between the two approaches for thirty-day, aorta-related, or overall mortality. However, stroke and spinal cord ischaemia (SCI) rates appeared higher in the CMD group, ranging from 0 to 42.9% and 0 to 9.1%, respectively. The occurrence of type I and III endoleaks was higher in the PGT group (0-45.5% versus 0-32.4%), though this did not translate into a clear difference in reintervention rates. During follow-up, high target vessel patency rates were observed in both groups, typically exceeding 95%.

CONCLUSION: PGTs appear to have non-inferior outcomes in terms of stroke rate and in-hospital and overall mortality. Although the occurrence of type I/III endoleaks remains higher in PGTs, this does not seem to affect reintervention rates. Thus, PGTs should be considered a viable option for treating complex aortic arch pathology, particularly in fragile patients, those with adverse anatomy, or in emergent situations. Large-volume prospective studies directly comparing these two techniques are currently warranted.

Keywords: Endovascular Aneurysm Repair (MeSH); Aorta, Thoracic (MeSH); Aortic Arch Syndromes (MeSH); Stroke (MeSH); Endoleak (MeSH)

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INTRODUCTION

The management of aortic arch pathology is often demanding and poses significant challenges because of its anatomical complexity, high-flow dynamics, and potential involvement of the supra-aortic trunks. The history of aortic arch repair has evolved from open surgery to hybrid debranching procedures and, ultimately, to total endovascular strategies. Open surgical repair, though traditionally considered the gold standard, carries substantial morbidity and mortality, particularly in elderly patients with multiple comorbidities.

In this context, Thoracic Endovascular Aortic Repair (TEVAR) has emerged as a minimally invasive alternative, particularly in surgically unfit patients.[1,2] Nevertheless, its application in the aortic arch requires not only an adequate proximal landing zone but also preservation of supra-aortic branch perfusion, which has driven the development of several endovascular techniques, such as Parallel Graft Techniques (PGTs) and branched or fenestrated Custom-Made Devices (CMDs).[3,4] In fact, such endovascular strategies offer several advantages, including shorter procedural times, reduced perioperative complications, and faster recovery.

Despite the increasing interest in this field, current evidence remains limited to small observational studies with a paucity of robust comparative data regarding these endovascular approaches, particularly when applied to TEVAR with proximal landing in Ishimaru's zone 0.

This narrative review aims to provide a comprehensive comparative analysis of total endovascular aortic arch reconstruction, focusing on PGTs and CMDs, their technical aspects, clinical outcomes, strengths and limitations.

METHODS

A comprehensive search was conducted in the PubMed and Scopus databases using the following query: (endovascular aortic repair OR (chimney OR branched OR fenestrated)) AND (aortic arch pathology OR aortic arch aneurysm OR aortic arch pseudoaneurysm OR aortic arch dissection OR aortic arch penetrating ulcer OR Ishimaru zone 0). Study selection followed predefined inclusion criteria: articles published in the past ten years on total endovascular aortic arch repair with proximal landing in Ishimaru's zone 0, using PGTs or CMDs to preserve both the Brachiocephalic Trunk (BCT) and the Left Common Carotid Artery (LCCA). Studies with fewer than five patients, published in a language other than Portuguese, English or Spanish, or reporting hybrid/open procedures or partial aortic arch reconstructions were excluded. Given the narrative nature of this review, findings were summarised descriptively rather than by statistical pooling.

RESULTS

Technical considerations of parallel graft techniques

The PGTs represent off-the-shelf solutions for endovascular aortic arch repair, allowing preservation of blood flow to the BCT, LCCA, and/or left subclavian artery (LSA), while simultaneously excluding the diseased aortic segment by deploying additional stent grafts parallel to the main aortic component. These methods include chimney, snorkel and periscope techniques, which differ in the orientation of the branch grafts, depending on the target vessel and corresponding access.[5] Before the procedure, careful planning is required using high-resolution computed tomography angiography to determine the most appropriate approach and the appropriate device sizes. Usually, a 20-30% oversizing is considered with respect to the main aortic component. Typically, the femoral artery is the chosen access for deployment of the primary thoracic stent graft, while carotid and/or axillary accesses are necessary for the deployment of parallel stents. During the procedure, the main aortic component is usually deployed first. At the same time, the parallel grafts are already correctly positioned through the sheaths (1 to 2 cm beyond the proximal margin of the primary graft). Grafts' overlapping length should be at least 5 cm.[6]

One of the key advantages of PGTs is their immediate availability, which makes them particularly valuable in emergent situations, such as ruptured aneurysms or complicated dissections, where timely intervention can be lifesaving. Additionally, PGTs are less expensive and offer greater flexibility and versatility in addressing complex cases with challenging anatomy. A potential drawback associated with this technique is the increased risk of gutter-related endoleaks, which raises concern about long-term durability.[5]

Technical considerations of custom-made graft techniques

CMDs, specifically branched and fenestrated endografts, provide anatomically precise solutions for endovascular aortic arch repair. These devices are tailored using detailed preoperative imaging to match each patient's unique anatomy. On the one hand, branched endografts are deployed via femoral access for the main component, with additional carotid and/or axillary access to cannulate the arch branches. Subsequently, bridging stents are used to connect the supra-aortic trunks to the internal branches of the main graft. Regarding these components, a variety of stents (balloon- or self-expandable) have been used, depending on the indications for use (IFUs) and the individual surgeon's preference. On the other hand, fenestrated endografts incorporate pre-designed fenestrations that should be aligned with the origins of the supra-aortic arteries, as planned in advance.

The manufacturing process for both branched and fenestrated devices is meticulous, and these devices are theoretically associated with better sealing and longer durability compared with off-the-shelf solutions, thereby minimising the risk of endoleaks and stent migration. However, these procedures are usually more complex, with steeper learning curves and are time-consuming, making them less suitable for emergent cases.[7]

Descriptive analysis according to the outcomes of interest

A total of 38 articles comprising 871 patients were included in this analysis (14 studies with 214 patients treated with PGTs and 24 studies with 657 patients treated with CMDs). The mean age was 72.1±10.4 years in the CMD group and 65.7±12.3 years in the PGT group. The majority of patients were male in both groups. The most frequently reported aetiologies were degenerative aneurysms, followed by aortic dissections and post-dissection aneurysms. Within the PGT group, the proportions of degenerative aneurysms and aortic dissections were relatively balanced, whereas CMDs were predominantly used for degenerative aneurysms. The remaining indications for treatment included pseudoaneurysms, penetrating aortic ulcers and type 1a endoleaks after previous TEVAR, Tables 1 and 2.[8-45]

In the clinical setting, the proportion of urgent cases within PGT series varied widely, ranging from exclusively urgent to predominantly elective. By contrast, CMD procedures were primarily elective because of manufacturing time constraints. However, some series describe the use of CMDs in urgent cases where stent grafts were either already available for the patient or sourced from another patient with similar anatomy.[26] Tables 3 to 6 present the incidence of events for each study's outcomes of interest.

Table 1. Details of studies reporting outcomes of parallel graft techniques for total endovascular aortic arch repair, included in this review

Authors	Year	Study type	N	Age (years) ± SD	Male n (%)	Etiology n (%)	LSA preservation n (%)
Voskresensky et al.[8]	2017	R	5	74.8 ± 10.4	4 (80)	3 (60) Degenerative Aneurysm 1(20) EL Ia after TEVAR 1 (20) PAU	4 (80)
Wang et al.[9]	2017	R	22	61.5 ± 7.7	20 (90.9)	19 (86.4) Aortic Dissection 2 (9.1) Degenerative Aneurysm 1 (4.5) EL Ia after TEVAR	1 (4.5)
Shahverdyan et al.[10]	2017	R	19	71.5 ± 8.5	17 (89.4)	6 (31.6) Degenerative Aneurysm 4 (21.1) Aortic Dissection 5 (26.3) EL Ia after TEVAR 3 (15.8) PAU 1 (5.3) Pseudoaneurysm	NR
Wang et al. [11]	2018	R	7	56.1 ± 10.8	5 (71.4)	4 (57.1) Degenerative Aneurysm 2 (28.6) Aortic Dissection 1 (14.3) EL Ia after TEVAR	7 (100)
Kanaoka et al. [12]	2020	R	22	77.0 ± 10.0	15 (68.2)	22 (100) Degenerative Aneurysm	3 (13.6)
Teymouri et al.[13]	2023	R	5	63.8 ± 6.0	3 (60)	4 (80) Aneurysm + Dissection 1 (20) Degenerative Aneurysm	5 (100)
Gao et al.[14]	2017	R	10	55.6 ± 9.2	8 (80)	10 (100) Aortic Dissection	5 (50)
Olivas-Flores et al.[15]	2019	R	6	52.5 ± 12.4	5 (83.3)	6 (100) Aortic Dissection	0 (0)
Guo et al.[16]	2020	R	11	60.5 ± 11.9	9 (81.8)	4 (36.4) Pseudoaneurysm 3 (27.3) Aortic Dissection 3 (27.3) Degenerative Aneurysm 1 (9.1) EL Ia after TEVAR	11 (100)
Bosiers et al.[17]	2016	R	13	NR	NR	NR	NR
Pecoraro et al.[18]	2017	R	20	NR	NR	NR	NR
Bao et al.[19]	2021	R	6	NR	NR	NR	6 (100)
Zhao et al.[20]	2019	R	30	NR	NR	NR	NR
Ahmad et al.[21]	2021	R	38	NR	NR	NR	NR

SD: Standard deviation; **LSA:** Left subclavian artery; **R:** Retrospective; **P:** Prospective; **TEVAR:** Thoracic endovascular aortic repair; **EL:** Endoleak; **PAU:** Penetrating aortic ulcer; **NR:** Not reported

Table 2. Details of studies reporting outcomes of custom-made stent grafts for total endovascular aortic arch repair, included in this review

Authors	Year	Study type	N	Age (years) ± SD	Male n (%)	Etiology n (%)	LSA preservation n (%)
Kurimoto et al.[22]	2015	R	37	78.2 ± 6.6	29 (78.4)	31 (83.8) Degenerative Aneurysms 3 (8.1) Aortic dissections 2 (5.6) Aneurysm + Dissection 1 (2.7) Pseudoaneurysm	26 (70.3)
Spear et al.[23]	2015	R	27	74 (range 69-77)	22 (81.5)	19 (70.4) Degenerative Aneurysm 8 (29.6) Post-dissection Aneurysm	27(100)
Tazaki et al.[24]	2017	R	7	NR	NR	7 (100) Degenerative Aneurysm	7 (100)
Spear et al.[25]	2017	R	18	64.0 (range 60-73)	15 (83.3)	18 (100) Post-dissection Aneurysm	11 (57.9)
Law et al.[26]	2019	R	11	67.0 ± 14.0	5 (45)	6 (54.5) Degenerative Aneurysm 3 (27.3) Aortic Dissection 1 (9.1) Pseudoaneurysm	11 (100)
Tsilimparis et al.[27]	2019	R	54	68.0 ± 10.0	38 (70.4)	26 (48.1) Post-dissection Aneurysm 24 (44.4) Degenerative Aneurysm 4 (7.4) PAU	54 (100)
Ferrer et al.[28]	2019	R	24	75.2 ± 6.5	24 (100)	13 (4.2) Degenerative Aneurysm 9 (37.5) PAU 2 (8.3) Aortic Dissection	23 (95.8)
Verscheure et al.[29]	2019	R	70	69.1 (range 62.4-74.1)		70 (100) Aortic Dissection	70 (100)
Weijde et al.[30]	2020	R	11	73.8 ± 4.8	9 (81.8)	9 (81.8) Degenerative Aneurysm 2 (18.2) Pseudoaneurysm	8 (72.7)
Tsilimparis et al.[31]	2019	R	12	NR	NR	10 (83.3) Degenerative Aneurysm 2 (16.7) Post-dissection Aneurysm	10 (83.3)
Tenorio et al.[32]	2021	R	39	70.0 ± 7.0	31 (79.5)	25 (64.1) Post-dissection Aneurysm 14 (35.9) Degenerative Aneurysm	39 (100)
Czerny et al.[33]	2021	R	43	73.0 ± 9.0	33 (76.7)	26 (61) Degenerative Aneurysm 8 (19) PAU 7 (16) Post-dissection Aneurysm 2 (5) Unknown	34 (79.1)
Li et al.[34]	2021	R	16	54.5 ± 11.3	16 (100)	16 (100) Aortic Dissection	16 (100)
Hauck et al.[35]	2022	R	54	77.4 ± 8.1	44 (81.5)	40 (74.1) Degenerative Aneurysm 7 (13) Aortic Dissection 7 (13) PAU	33 (61.1)
Lee et al.[36]	2024	R	5	78.0 ± 13.0	4 (80)	NR	5 (100)
Zhang et al.[37]	2023	R	15	68 (range 64-73)	14 (93.3)	10 (66.7) Degenerative Aneurysms 3 (13.3) Post-dissection Aneurysm 3 (13.3) PAU 1 (6.7) Pseudoaneurysm	NR
Abisi et al.[38]	2023	P	18	67.8 ± 11.0	15 (83.3)	10 (55.6) Degenerative Aneurysm 6 (33.3) Post-dissection Aneurysms 2 (11.1) PAU	
Nana et al.[39]	2023	R	8	72.3 ± 27.0	7 (87.5)	4 (50) Aortic Dissection 3 (37.5) Degenerative Aneurysm 1 (12.5) Pseudoaneurysm	8 (100)
Becker et al.[40]	2023	R	10	75.0 ± 11.7	6 (60)	10 (100) Pseudoaneurysm	8 (80)
Iglesias et al.[41]	2023	R	12	74.0 ± 7.0	12 (100)	9 (75) Degenerative Aneurysm 1 (8.3) Pseudoaneurysm 1 (8.3) PAU 1 (8.3) EL Ia after TEVAR	12 (100)
Knapsis et al.[42]	2024	R	6	74.2 ± 4.1	5 (83.3)	4 (66.7) Post-dissection Aneurysms 2 (33.3) PAU	6 (100)
Becker et al.[43]	2024	R	22	72 (range 63-79)	16 (72.7)	13 (59.1) Post-dissection Aneurysm 9 (40.9) Degenerative Aneurysm	22 (100)
Fukushima et al.[44]	2024	R	30	75.9 ± 6.3	NR	30 (100) Degenerative Aneurysm	6 (20)
Jubouri et al.[45]	2023	R	108	70.7 ± 9.9	72 (66.6)	81 (75) Degenerative Aneurysm 27 (25) Aortic Dissection	NR

SD: Standard deviation; **LSA:** Left subclavian artery; **R:** Retrospective; **P:** Prospective; **TEVAR:** Thoracic endovascular aortic repair; **EL:** Endoleak; **PAU:** Penetrating aortic ulcer; **NR:** Not reported

Table 3. 30-day mortality, stroke/TIA, reintervention, aortic-related mortality and overall mortality of studies reporting parallel graft techniques for total endovascular aortic arch repair, included in this review

Authors	30 day mortality n (%)	Stroke/TIA n (%)	Reintervention n (%)	Aorta-related deaths n (%)	Overall mortality n (%)
Voskresensky et al.[8]	0 (0)	1 (20)	0 (0)	1 (11)	0 (0)
Wang et al.[9]	0 (0)	2 (9.1)	2 (9.1)	0 (0)	0 (0)
Shahverdyan et al.[10]	NR	NR	NR	NR	NR
Wang et al.[11]	0 (0)	0 (0)	0 (0)	0 (0)	1 (14.3)
Kanaoka et al.[12]	1 (4.5)	1 (4.5)	NR	1 (4.5)	4 (18.2)
Teymouri et al.[13]	0 (0)	0 (0)	2 (40)	0 (0)	1 (20)
Gao et al.[14]	2 (20)	0 (0)	1 (10)	0 (0)	0 (0)
Olivas-Flores et al.[15]	0 (0)	0 (0)	2 (33.3)	0	1 (16.7)
Guo et al.[16]	0 (0)	5 (45.5)	2 (18.2)	1 (9.1)	3 (27.3)
Bosiers et al.[17]	1 (7.7)	NR	NR	0 (0)	NR
Pecoraro et al.[18]	2 (10)	NR	NR	NR	NR
Bao et al.[19]	NR	0 (0)	NR	NR	NR
Zhao et al.[20]	NR	NR	NR	NR	NR
Ahmad et al.[21]	NR	5 (13.2)	NR	NR	NR

TIA: Transient ischemic attack; **NR:** Not reported

Table 4. 30-day mortality, stroke/TIA, reintervention, aortic-related mortality and overall mortality of studies reporting custom-made stent grafts for total endovascular aortic arch repair, included in this review

Authors	30 day mortality n (%)	Stroke/TIA n (%)	Reintervention n (%)	Aorta-related deaths n (%)	Overall mortality n (%)
Kurimoto et al.[22]	0 (0)	2 (5.4)	4 (10.8)	0 (0)	6 (16.2)
Spear et al.[23]	0 (0)	3 (11.1)	6 (22.2)	1 (3.7)	1 (3.7)
Tazaki et al.[24]	2 (28.6)	3 (42.9)	NR	NR	NR
Spear et al.[25]	1 (5.3)	2 (10.5)	6 (33.3)	1 (5.3)	4 (21.1)
Law et al.[26]	1 (9)	1 (9)	5 (45.5)	0 (0)	3 (27.3)
Tsilimparis et al.[27]	3 (5.6)	6 (11.1)	12 (22.2)	1 (1.9)	7 (13.0)
Ferrer et al.[28]	4 (16.7)	7 (29.2)	4 (16.7)	2 (8.3)	5 (20.8)
Verscheure et al.[29]	2 (2.9)	7 (10)	32 (45.7)	1 (1.4)	10 (14.3)
Weijde et al.[30]	2 (18.2)	4 (36.4)	2 (18.2)	1 (9.1)	2 (18.2)
Tsilimparis et al.[31]	1 (8.3)	1 (8.3)	NR	NR	NR

Authors	30 day mortality n (%)	Stroke/TIA n (%)	Reintervention n (%)	Aorta-related deaths n (%)	Overall mortality n (%)
Tenorio et al.[32]	2 (5.1)	2 (5.1)	14 (35.9)	0 (0)	4 (10.3)
Czerny et al.[33]	4 (9.3)	11 (25.6)	4 (9.3)	1 (2.3)	15 (34.9)
Li et al.[34]	1 (6.3)	1 (6.3)	2 (12.5)	1 (6.3)	5 (31.3)
Hauck et al.[35]	2 (3.7)	5 (9.3)	8 (14.8)	2 (3.7)	21 (38.9)
Lee et al.[36]	0 (0)	0 (0)	NR	0 (0)	0 (0)
Zhang et al.[37]	1 (6.7)	2 (13.3)	NR	NR	NR
Abisi et al.[38]	0 (0)	0 (0)	3 (16.7)	0 (0)	0 (0)
Nana et al.[39]	0 (0)	0 (0)	3 (37.5)	0 (0)	0 (0)
Becker et al.[40]	2 (20)	2 (20)	3 (30)	0 (0)	3 (30)
Iglesias et al.[41]	1 (8.3)	5 (41.7)	1 (8.3)	0 (0)	2 (16.7)
Knapsis et al.[42]	0 (0)	0 (0)	0 (0)	NR	NR
Becker et al.[43]	1 (4.5)	3 (13.6)	1 (4.5)	0 (0)	1 (4.5)
Fukushima et al.[44]	0 (0)	1 (3.3)	1 (3.3)	0 (0)	0 (0)
Jubouri et al.[45]	4 (3.7)	32 (29.6)	50 (46.3)	0 (0)	4 (3.7)

TIA: Transient ischemic attack; **NR:** Not reported

Table 5. Technical success, type I/III endoleaks, spinal chord ischaemia, branch patency, and duration of follow-up of studies reporting parallel graft techniques for total endovascular aortic arch repair, included in this review

Authors	Technical success n (%)	Type I/III Endoleak n (%)	Spinal cord ischemia n (%)	Branch patency (%)	Follow-up (months)
Voskresensky et al.[8]	4 (80)	1 (20)	0 (0)	100%	NR
Wang et al.[9]	19 (86.3)	3 (13.6)	NR	100%	28.0 ± 19.8
Shahverdyan et al.[10]	NR	NR	NR	100%	NR
Wang et al.[11]	NR	3 (42.9)	0 (0)	100%	15.7 (range 9-20)
Kanaoka et al.[12]	18 (81.8)	6 (27.3)	NR	95.5%	NR
Teymouri et al.[13]	5 (100)	2 (40)	NR	100%	54.0 ± 37.2
Gao et al.[14]	10 (100)	0 (0)	NR	100%	17.0 ± 14.5
Olivas-Flores et al.[15]	6 (100)	1 (16.7)	0 (0)	100%	12.0
Guo et al.[16]	5 (45.5)	5 (45.5)	0 (0)	90.9%	27.4 ± 16.5
Bosiers et al.[17]	NR	NR	NR	NR	NR
Pecoraro et al.[18]	NR	NR	NR	100%	NR
Bao et al.[19]	6 (100)	NR	NR	100%	NR
Zhao et al.[20]	NR	3 (10)	NR	100%	NR
Ahmad et al.[21]	NR	8 (21.1)	NR	NR	NR

ICU: Intensive care unit; **IQR:** Interquartile range; **NR:** Not reported

Table 6. Technical success, type I/III endoleaks, spinal chord ischaemia, branch patency, and duration of follow-up of studies reporting custom-made stent grafts for total endovascular aortic arch repair, included in this review

Authors	Technical success n (%)	Type I/III Endoleak n (%)	Spinal cord ischemia n (%)	Patency (%)	Follow-up (months)
Kurimoto et al.[22]	37 (100)	12 (32.4)	3 (8.1)	100%	16.9 ± 12.8
Spear et al.[23]	27 (100)	0 (0)	2 (7.4)	100%	12 (IQR 6-12)
Tazaki et al.[24]	7 (100)	NR	0 (0)	100%	NR
Spear et al.[25]	16 (84.2)	1 (5.3)	0 (0)	100%	NR
Law et al.[26]	11 (100)	0 (0)	0 (0)	100%	6 (range 1-28)
Tsilimparis et al.[27]	53 (98.1)	2 (3.7)	3 (5.6)	98.1%	12.0 ± 9.0
Ferrer et al.[28]	23 (95.8)	0 (0)	0 (0)	100%	18 (range 1-60)
Verscheure et al.[29]	66 (94.3)	4 (5.7)	0 (0)	100%	10 (IQR 4.6-21.4)
Weijde et al.[30]	11 (100)	1 (9.1)	1 (9.1)	90.9%	17 (range 3-42)
Tsilimparis et al.[31]	NR	NR	1 (8.3)	NR	NR
Tenorio et al.[32]	39 (100)	5 (12.8)	0 (0)	100%	3.2 (IQR 1-14)
Czerny et al.[33]	NR	4 (9.3)	1 (2.3)	NR	16.0 ± 18.0
Li et al.[34]	16 (100)	1 (6.3)	NR	87.5%	98 (range 0-119)
Hauck et al.[35]	53 (98.1)	2 (3.7)	1 (1.9)	98.1%	35.8 ± 38.2
Lee et al.[36]	5 (100)	NR	0 (0)	100%	13.1
Zhang et al.[37]	15 (100)	NR	1 (6.7)	NR	12.3 (IQR 6.3-30.6)
Abisi et al.[38]	18 (100)	4 (22.2)	0 (0)	100%	9 (range 4-18)
Nana et al.[39]	8 (100)	1 (12.5)	0 (0)	100%	2 (range 1-4)
Becker et al.[40]	9 (90)	3 (30)	0 (0)	100%	20 (IQR 55)
Iglesias et al.[41]	12 (100)	1 (8.3)	0 (0)	100%	15.5 (range 0-44)
Knapsis et al.[42]	6 (100)	0 (0)	0 (0)	100%	NR
Becker et al.[43]	12 (100)	4 (18.2)	0 (0)	100%	NR
Fukushima et al.[44]	30 (100)	0 (0)	1 (3.3)	100%	34.9 (range 1-73)
Jubouri et al.[45]	NR	NR	NR	74%	NR

ICU: Intensive care unit; **IQR:** Interquartile range; **NR:** Not reported

Technical success

Technical success rates were high in both groups, mostly ranging from 80% to 100%. There was only one outlier study reporting a lower technical success rate of 45.5% in PGT group.[16] CMDs exhibited the most consistent success rates, typically exceeding 95%, owing to their patient-specific design and precise deployment.

Thirty-day, aorta-related and overall mortality

No clear superiority was observed between the two approaches, though the overall mortality rate appeared slightly higher in the CMD group, ranging from 0 to 38.9%[22-45] (versus 0-27.3% in the PGT group).[8-21] The thirty-day mortality rate ranged from 0 to 20% in PGTs[8-21] and from 0 to 28.6% in CMDs.[22-45] Aorta-related mortality rates were also low, ranging from 0 to 11% in PGTs[8-21] and from 0 to 9.1% in CMDs.[22-45]

Stroke rate and neurological complications

Stroke rate appeared higher in the CMD group, ranging from 0 to 42.9%.[22-45] By contrast, only one study on PGTs reported a stroke rate of 45.5%,[16] whereas the remaining PGT studies reported stroke rates <20%. Moreover, although LSA preservation was substantially more common with CMDs, no spinal cord ischaemia (SCI) cases were reported in the PGT group, whereas CMD had an SCI rate ranging from 0 to 9.1%.[22-45]

Occurrence of endoleaks and reintervention rates

As expected, the occurrence of type I and III endoleaks was higher in the PGT group, ranging from 0 to 45.5%[8-21] (versus 0-32.4% in the CMD group).[22-45] Nevertheless, this discrepancy did not translate into a clear difference in reintervention rates. In fact, the overall reintervention rate appeared higher in CMD patients, whereas aorta-related reinterventions remained similar between the two groups. Non-aorta-related reinterventions in the CMD group were mostly access complications.

Target vessel patency

The mean follow-up was 28.3±22.1 months for PGTs and 20.7±25.2 months for CMDs. During this period, high target vessel patency rates were observed in both groups, typically exceeding 95%.[8-45]

DISCUSSION

This comprehensive review compared the outcomes of PGTs and CMDs in total endovascular aortic arch repair, focusing on technical aspects, clinical outcomes, and strengths and limitations. Our findings suggest that although both strategies achieved acceptable mid-term results, they have distinct advantages and drawbacks that must be carefully weighed in clinical decision-making. Both techniques demonstrated comparable 30-day mortality and reasonably low aortic mortality, reinforcing the safety of these endovascular strategies for treating complex aortic arch pathologies. Long-term durability was further supported by high target vessel patency, generally exceeding 95% in both groups.

Conversely, the overall mortality and stroke rates seemed to be slightly higher in CMDs, possibly due to the older age of this group or the aortic arch manipulation during the deployment of branched/fenestrated endografts in zone 0 TEVAR. As expected, PGTs were associated with lower technical success rates and a higher incidence of type I and III endoleaks, probably through the gutters of the stent grafts. However, aorta-related reintervention rates appeared comparable between the two groups, which may reflect different failure patterns – PGTs may be associated with more endoleaks that remain asymptomatic and are treated conservatively, whereas CMDs may require secondary interventions for device-related issues or disease progression. Although LSA preservation was substantially more common with CMDs, SCI was reported in nine CMD studies but in none of the PGT studies, which is probably associated with differences in the extent of aortic coverage.

Study limitations

The absence of direct comparative data between PGTs and CMDs, together with the retrospective design of the included studies, is a major limitation of this review. Additionally, the lack of outcome stratification by the proximal landing zone, combined with the use of single-chimney techniques with extra-anatomical bypasses (rather than endovascular revascularisation of both BCT and LCCA), led to the exclusion of several potentially relevant studies from our analysis. Furthermore, time-stratified data were not available in the included studies, preventing assessment of learning-curve effects.

CONCLUSION

PGTs appear to have non-inferior outcomes compared with CMDs in terms of stroke rate and in-hospital and overall mortality. Although the occurrence of type I and III endoleaks remains higher in PGTs, this does not seem to affect aorta-related reintervention rates. Thus, PGTs should be considered a viable option for treating complex aortic arch pathology, particularly in fragile patients, those with adverse anatomy, or in emergent situations. The lack of high-quality data underscores the need for prospective, comparative studies to better define the optimal approach for total aortic arch reconstruction.

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