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Is extended arch replacement justified for acute type A aortic dissection?

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Abstract

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed is whether patients with acute type A aortic dissection have a better outcome after total arch replacement. Altogether, 138 papers were found using the reported search, of which 8 represented the best evidence to answer the clinical question. The authors, journal, date and country they are from, patient group studied, study type, relevant outcomes and results of these papers are tabulated. All studies are retrospective. Five representative studies reported that total arch replacement could be performed safely without increasing operative mortality and morbidity compared with hemiarch replacement, but with an overall longer time of cardiopulmonary bypass and circulatory arrest. The other three reports documented an apparently higher early mortality rate in the total arch group than in the hemiarch group. In terms of long-term results, freedom from reoperation on the distal aorta is similar for patients treated with total arch replacement and with hemiarch replacement at 5 and 10 years in four papers. As for the false lumen, three reports documented that the rate of complete thrombosis of the false lumen in the proximal descending aorta was significantly higher in the total arch group than in the hemiarch group (P <0.05). Only one study reported similar rates of complete thrombosis formation of the distal aorta in the two groups at different follow-up points (P >0.05). The remaining four reports did not provide information about the false lumen. Evidence for long-term outcomes, albeit limited, has proved that better results of thrombosis of the false lumen can be achieved with a more extensive total arch repair. Although the literature shows no advantage of the total arch over a more limited approach, the more extensive approach may be required to achieve this goal when the entry tear extends to, or is localized in, this segment of the aorta. This suggests that a more extensive surgical strategy can be justified when it is based on circumstances, on the individual patient's clinical condition, and on the anatomical and pathological features of the dissection.

Keywords: The aorta • Thoracic • Aortic diseases • Aneurysm • Dissecting • Cardiac surgical procedures • Vascular surgical procedures • Blood vessel prosthesis implantation

INTRODUCTION

A best evidence topic was constructed according to a structured protocol, as described by Dunning *et al.* [1] in the *ICVTS*.

THREE-PART QUESTION

In [patients undergoing surgery, for acute type A aortic dissection] does [aggressive initial treatment with total arch repair] result in [reduced mortality and improved closure of the distal false lumen]?

CLINICAL SCENARIO

You are planning emergency surgery for a patient with acute type A aortic dissection. The patient has a dissection in the ascending aorta extending over the aortic arch and involving the descending aorta. The location of the intimal entry tear is limited to the ascending aorta. You wonder whether you should adopt a traditionally limited hemiarch repair, or resort to an extended aortic replacement.

SEARCH STRATEGY

Medline 1950 to December 2013 using PubMed interface [exp Aneurysm, Dissecting/or aortic dissection.mp. aortic dissection.mp] AND [type A.mp OR type 1.mp] AND [total arch replacement.mp OR extended arch replacement.mp OR hemiarch replacement.mp OR hemiarch repair.mp].

SEARCH OUTCOME

One hundred and thirty-eight papers were found using the reported search. Of these, eight papers were identified that have provided the best evidence to answer our question. These are presented in Table 1.

RESULTS

Ohtsubo *et al.* [2] documented 88 patients who underwent graft replacement for acute type A dissection. Compared with extended

Table 1: Best evidence clinical papers

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Ohtsubo *et al*. (2002), Ann Thorac Surg, Japan [2] Retrospective cohort study (level 2b)	*88 patients:* ascending aortic replacement (Ascending group, *n* = 41), hemiarch replacement (Hemiarch group, *n* = 23) and total arch replacement (Total arch group, *n* = 24)	*Operative outcome*	*Cardiopulmonary bypass (CPB) time (min)* Ascending group: 170 ± 7.8 Hemiarch group: 190 ± 9.7 Total arch group: 292 ± 20.0 (*P* <0.001, among three groups, and hemiarch versus total arch)	Procedure chosen based on the location of intimal tear CPB between the femoral artery and the right atrium. Axillary perfusion was added when malperfusion was present preoperatively
			Selective cerebral perfusion time (min) Ascending group: 0 Hemiarch group: 29 ± 12.7 Total arch group: 106 ± 6.0	Antegrade cerebral perfusion not routinely used for hemiarch replacement
			Operation time (min) Ascending group: 365 ± 19.2 Hemiarch group: 352 ± 15.2 Total arch group: 565 ± 35 (*P* <0.001, among three groups, and hemiarch versus total arch)	Less intraoperative transfusion of red blood cells (*P* = 0.0006) and fresh-frozen plasma (*P* = 0.0003) in the Ascending and hemiarch groups than in the Total arch group
		Early outcome	*Early mortality* Ascending group: 2/41, 4.8% Hemiarch group: 2/23, 8.7% Total arch group: 6/24, 25% (*P* <0.001, among three groups, and hemiarch versus total arch)	Chest tube drainage over the first 24 h was significantly less in the Ascending and Hemiarch groups than in the Total arch group (*P* = 0.0028) No difference in the incidence of postoperative coma, focal neurological deficit or patent false lumen in the descending thoracic or abdominal aorta
			Focal neurological deficits Ascending group: 2/41, 4.8% Hemiarch group: 4/23, 17.3% Total arch group: 2/24, 8.3% (*P* >0.05, among three groups)	
		Late outcomes	*Mean follow-up:* 42.0 ± 36.3 months *Patency of the distal false lumen (thoracic aorta)* Ascending group: 10/41, 28.5% Hemiarch group: 5/23, 26.3% Total arch group: 2/24, 14.2% (*P* >0.05, among three groups)	
			5-year survival Ascending group: 86 0.8 ± 6.8% Hemiarch group: 91.3 ± 5.9% Total arch group: 44.4 ± 14.3% (*P* = 0.0018, hemiarch or ascending versus total arch)	
			Freedom from reoperation on the distal aorta at 5 years Ascending group: 96.4 ± 3.5% Hemiarch group: 93.8 ± 6.3% Total arch group: 100 ± 0% (*P* >0.05, hemiarch or ascending versus total arch)	
Tan *et al*. (2003), Ann Thorac Surg, Netherlands [3] Retrospective cohort study (level 2b)	*70 patients*: Hemiarch repair (*n* = 53) Total arch replacement (*n* = 17)	*Early outcome*	*Early mortality* Hemiarch group: 4/17, 23.5% Total arch group: 9/53, 17.0% (*P* = 0.72)	Extent of aortic replacement determined by the location of intimal tear
		Late outcome	*Mean follow-up:* 2.6 years *Survival at 5 and 10 years* Hemiarch group: 68.7 and 57.7% Total arch group: 66.6 and 40.0% (*P* = 0.96)	CPB via the femoral artery and the right atrium Selective cerebral perfusion via the brachiocephalic artery and the left common carotid artery

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
			Freedom from reoperation on the aortic arch (5 and 10 years) Hemiarch group: 86.6 and 75.1% Total arch group: 96.3 and 77.0% (P = 0.21)	Arch replacement not predictive of a new postoperative neurological deficit (P = 0.43)
Shiono *et al.* (2006), Ann Thorac Surg, Japan [4] Retrospective cohort study (level 2b)	134 emergency cases. Repair of the ascending aorta and hemiarch in 105 patients (Ascending/hemiarch group) and total aortic arch in 29 (Total arch group)	*Early outcome*	*Early mortality* Ascending/hemiarch group: 7/105, 6.7% Total arch group: 2/29, 6.9% (P = 0.69) *Neurological deficit* Ascending/hemiarch group: 8/105, 7.6% Total arch group: 3/29, 10.3% (P = 0.77) *Pneumonia* Ascending/hemiarch group: 10/105, 9.5% Total arch group: 3/29, 10.3% (P = 0.77) *Haemodialysis* Ascending/hemiarch group: 13/105, 12.4% Total arch group: 5/29, 17.2% (P = 0.49)	Extent of aortic replacement decided by the location of intimal tear In younger patients, more total arch replacement was performed than ascending/hemiarch replacement (P = 0.005)
		Late outcome	*Mean follow-up:* 10 years *Late mortality* Ascending/hemiarch group: 15/105, 14.3% Total arch group: 4/29, 13.8% (P = 0.89) *Survival at 5 and 10 years* Ascending/hemiarch group: 77.4 and 63.5% Total arch group: 80.8 and 80.8% (P = 0.72) *Freedom from reoperation on the aortic arch (5 and 10 years)* Ascending/hemiarch group: 91.3 and 88% Total arch group: 60.9 and 76.6% (P = 0.48)	
Uchida *et al.* (2009), Ann Thorac Surg, Japan [5] Retrospective cohort study (level 2b)	120 consecutive patients, including 65 with total arch replacement and frozen elephant trunk, 55 with ascending aortic or hemiarch replacement	*Operative outcome*	*CPB time (min)* Ascending/hemiarch group: 108 ± 16 Total arch group: 163 ± 43 (P <0.05) *Selective cerebral perfusion time (min)* Ascending/hemiarch group: 21 ± 12 Total arch group: 70 ± 18 (P <0.05)	Procedures were chosen based largely on age and comorbidities 49 patients in the total arch group and 8 in the hemiarch group younger than 70 years of age Time of operation, CPB and selective cerebral perfusion remarkably longer in the total arch group than in the ascending/hemiarch group
		Early outcome	*Early mortality* Ascending/hemiarch group: 2/55, 3.6% Total arch group: 3/65, 4.6% (P >0.05) *Pneumonia* Ascending/hemiarch group: 2/55, 3.6% Total arch group: 2/65, 3.0% (P >0.05) *Sepsis* Ascending/hemiarch group: 1/55, 1.8% Total arch group: 2/65, 3.0% (P >0.05)	
		Late outcome	*Mean follow-up:* 67 months *Late mortality*	

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
			Ascending/hemiarch group: 9/55, 16.3% Total arch group: 3/65, 4.6% (P <0.05) *5-year survival rate* Ascending/hemiarch group: 69.0% Total arch group: 95.3% (P = 0.03) *Patent false lumen at the proximal descending aorta* Ascending/hemiarch group: 16/55, 29% Total arch group: 0/65, 0% (P <0.01)	
Kim *et al*. (2011), Eur J Cardiothorac Surg, South Korea [6] Retrospective cohort study (level 2b)	188 consecutive patients, hemiarch (Hemiarch group; n = 144) or total arch replacement (Total arch group; n = 44) with ascending aortic replacement	*Operative outcome*	*CPB time (min)* Hemiarch group: 233.4 ± 90.7 Total arch group: 314.6 ± 100.5 (P <0.001) *Cardiac ischaemic time (min)* Hemiarch group: 107.9 ± 64.0 Total arch group: 125.7 ± 111.4 (P <0.01) *Circulatory arrest time (min)* Hemiarch group: 24.6 ± 13.9 Total arch group: 50.2 ± 44.3 (P <0.01)	Patients in the total arch group more likely to have preoperative malperfusion syndrome and DeBakey type III-D dissection than those in the hemiarch group Choice of repair was dependent on individual patient's condition, intimal tear site and/or diameter of distal arch but finally on the surgeon's discretion Proximal descending aorta larger in the total arch group, and the intimal tear was more likely to be confined within the ascending aorta in the hemiarch group
		Early outcome	*Early mortality* Hemiarch group: 14/144, 9.7% Total arch group: 6/44, 13.6% (P = 0.58) *Permanent neurological injury* Hemiarch group: 9/144, 6.3% Total arch group: 10/44, 22.7% (P <0.05). *Temporary neurological injury* Hemiarch group: 29/144, 20.1% Total arch group: 11/44, 25% (P >0.05) *Pneumonia* Hemiarch group: 14/144, 9.7% Total arch group: 21/44, 47.7% (P <0.05)	
		Late outcome	*Mean follow-up:* 47.5 months *Late death* Hemiarch group: 23/144, 16% Total arch group: 10/44, 22.7% (P <0.01) *Reintervention* Hemiarch group: 20/144, 13.9% Total arch group: 3/44, 6.8% (P >0.05) *Patent false lumen* Hemiarch group: 30/144, 20.8% Total arch group: 12/44, 27.3% (P >0.05) *5-year survival* Hemiarch group: 83.2 ± 3.3% Total arch group: 65.8 ± 8.3% (P = 0.013)	

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
Sun *et al*. (2011), Circulation, China [7] Retrospective cohort study (level 2b)	65 patients with hemiarch repair and 149 patients with total arch replacement and frozen elephant trunk	*Operative outcome*	*CPB time (min)* Hemiarch group: 153 ± 44 Total arch group: 197 ± 47 (*P* <0.001) *Cardiac ischaemic time (min)* Hemiarch group: 75 ± 27 Total arch group: 107 ± 27 (*P* <0.001) *Circulatory arrest time (min)* Hemiarch group: 18 ± 7 Total arch group: 24 ± 9 (*P* <0.001)	Incidence of male gender, hypertension and acute cardiac tamponade was significantly higher in patients of the hemiarch group than the total arch group Although distal propagation and involvement of aortic dissection were less in the hemiarch group than in the total arch group, postoperative outcomes did not differ between the two groups
		Early outcome	*Early mortality* Hemiarch group: 4/65, 6.1% Total arch group: 7/149, 4.6% (*P* = 0.741) *Acute renal failure* Hemiarch group: 2/65, 3.0% Total arch group: 1/149, 0.7% (*P* = 0.226) *Bleeding* Hemiarch group: 2/65, 3.0% Total arch group: 5/149, 3.4% (*P* = 1.000) *Paraplegia/paraparesis* Hemiarch group: 1/65, 1.5% Total arch group: 3/149, 2.0% (*P* = 0.759)	
		Late outcome	*Mean follow-up:* 44 months *Late death* Hemiarch group: 2/62, 3.2% Total arch group: 4/141, 2.8% (*P* = 1.000) *Reintervention* Hemiarch group: 4/62, 6.5% Total arch group: 1/141, 0.7% (*P* = 0.031) *Thrombosis of the false lumen* Hemiarch group: 7/62, 14.5% Total arch group: 130/141, 92.2% (*P* <0.001)	
Easo *et al*. (2013), J Thorac Cardiovasc Surg, Germany [8] Retrospective cohort study (level 2b)	518 patients with ascending aortic and hemiarch replacement, 140 with total arch replacement and conventional or frozen elephant trunk	*Operative outcome*	*CPB time (min)* Hemiarch group: 308.1 ± 104.4 Total arch group: 390.4 ± 137.3 (*P* <0.01) *Circulatory arrest time (min)* Hemiarch group: 24.3 ± 14.4 Total arch group: 44.8 ± 29.7 (*P* <0.01)	Patients in the total arch group had a higher frequency of cardiopulmonary resuscitation (*P* = 0.04) Age (*P* = 0.0072), preoperative resuscitation (*P* = 0.041), length of cerebral perfusion (*P* = 0.0122) and length of circulatory arrest (*P* = 0.041) were risk factors for 30-day mortality
		Early outcome	*Early mortality* Hemiarch group: 18.7% Total arch group: 25.7% (*P* = 0.07) *New neurological deficit* Hemiarch group: 53/518, 13.6% Total arch group: 12/140, 12.5% (*P* = 0.07)	

Continued

Table 1: (*Continued*)

Author, date, journal and country Study type (level of evidence)	Patient group	Outcomes	Key results	Comments
			Re-exploration for bleeding Hemiarch group: 96/518, 18.5% Total arch group: 40/140, 28.6% (*P* = 0.013) *Length of ICU stay (days)* Hemiarch group: 8.1 ± 11.3 Total arch group: 10.3 ± 13.8 (*P* <0.01) *Length of hospital stay (days)* Hemiarch group: 16.3 ± 14.6 Total arch group: 17.1 ± 16.1 (*P* <0.01)	
Zhang *et al*. (2013), J Thorac Cardiovasc Surg, China [9] Retrospective cohort study (level 2b)	331 patients, 74 with proximal repair, including aortic root, ascending aortic or hemiarch repair, and 88 with extensive repair, including proximal repair, total arch replacement and frozen elephant trunk implantation	*Operative outcome*	*CPB time (min)* Hemiarch group: 179.7 ± 39.5 Total arch group: 182.4 ± 34.3 (*P* = 0.64) *Circulatory arrest time (min)* Hemiarch group: 28.1 ± 10.1 Total arch group: 35.4 ± 11.6 (*P* <0.01)	No significant difference in re-exploration for bleeding, prolonged ventilation, heart arrest, stroke or renal failure between the two groups. No spinal cord injury in any patient During follow-up, 3 and 0 aortic-related deaths in the hemiarch and total arch groups, respectively (*P* = 0.06)
		Early outcome	*Early mortality* Hemiarch group: 4/74, 5.4% Total arch group: 5/88, 5.7% (*P* = 0.94) *New onset of stroke* Hemiarch group: 1/74, 1.4% Total arch group: 2/88, 2.3% (*P* = 0.67) *Transient neurological dysfunction* Hemiarch group: 8/74, 10.8% Total arch group: 11/88, 12.5% (*P* = 0.74) *Re-exploration for bleeding* Hemiarch group: 2/74, 2.7% Total arch group: 4/88, 4.5% (*P* = 0.54) *Ventilation* >72 h Hemiarch group: 15/74, 20.3% Total arch group: 17/88, 19.3% (*P* = 0.88) *Renal failure* Hemiarch group: 1/74, 1.4% Total arch group: 2/88, 2.3% (*P* = 0.67)	
		Late outcomes	Mean follow-up: 55.7 ± 33.1 months *Survival rate (5 and 8 years)* Hemiarch group: 85.6, and 80.5% Total arch group: 95.0 and 87.7% (*P* = 0.11) *Reintervention* Hemiarch group: 11/65, 16.9% Total arch group: 4/74, 5.4% (*P* = 0.03) *Complete thrombosis at the diaphragmatic level* Hemiarch group: 20.3% Total arch group: 45.1% (*P* <0.01)	

arch replacement, hemiarch replacement was associated with a lower mortality; a shorter time of cardiopulmonary bypass (CPB), circulatory arrest and operation; less bleeding; a decreased requirement for blood transfusion and a comparable incidence of a patent distal false channel and of late vascular events.

Tan *et al*. [3] compared 53 patients treated with hemiarch replacement and 13 with total arch replacement. There was no significant difference in operative mortality, survival and freedom of reoperation on the aortic arch between two groups. Therefore, they conclude that aortic arch replacement, in order to exclude the intimal tear in the arch, is not an additional risk factor for mortality after surgery for acute type A dissection.

Shiono *et al*. [4] reviewed the results of 134 patients treated for acute type A aortic dissection. In patients with a limited ascending/hemiarch versus a total arch repair, the hospital mortality rate was 6.7 and 6.9%, respectively; and at 5 and 10 years, the actuarial survival rate was 77.4 vs 80.8% and 63.5 vs 80.8%, and the rate of freedom from reoperation was 91.3 vs 88.0% and 60.9 vs 76.6%, respectively. A limited ascending/hemiarch replacement did not increase the risk of reoperation and would not compromise late surgical results.

Uchida *et al*. [5] reported 120 consecutive patients with acute type A aortic dissection, including 65 with total arch replacement and frozen elephant trunk and 55 with ascending aortic or hemiarch replacement. Mortality and morbidity were similar in both groups, despite the longer duration of CPB and circulatory arrest in the total arch group. During late follow-up (mean, 67 months), the 5-year survival rate was 95.3% in the total arch group, which was significantly higher than the 69.0% in the hemiarch group ($P = 0.03$). The false lumen at the proximal descending aorta was patent in 16 patients (29%) of the hemiarch group, but was thrombosed in all patients of the total arch group.

Kim *et al*. [6] reported a cohort of 188 patients, of whom 44 underwent a total arch replacement and 144 a hemiarch and ascending aortic replacement. They concluded that total arch repair was associated with greater risks of mortality and permanent neurological injury than hemiarch repair for patients with acute DeBakey type I aortic dissection. The rate of aortic reoperation and thrombosis formation of the distal aorta did not differ significantly between the two surgical strategies.

Sun *et al*. [7] reported 65 patients undergoing a hemiarch repair and 149 patients a total arch replacement and stented elephant trunk. Early mortality and morbidity did not differ between two groups. At 44 ± 18 months, the rate of thrombosis of the false lumen was 92.2 vs 14.5% ($P < 0.001$), and the rate of surgical reintervention was 0.7 vs 6.5% ($P = 0.031$), in patients with total arch versus hemiarch repair, respectively.

In Easo and associates' report [8] based on the German Registry for Acute Aortic Dissection Type A (GERAADA), 518 patients were treated with hemiarch repair and 140 with total arch repair. The overall 30-day mortality rate was 20.2% ($n = 133$). Incidence of immediate postoperative complications, such as excessive bleeding and re-exploration, was higher in the total arch repair group; however, the 30-day mortality and onset of new neurological and malperfusion deficit did not differ remarkably between the two groups.

In the report of Zhang *et al*. [9], 74 patients underwent proximal repair, including the aortic root, ascending aortic or hemiarch repair, and 88 underwent extensive repair, including proximal repair and total arch replacement with stented elephant trunk implantation. The rates of early mortality and morbidity did not differ significantly between the two groups, despite the shorter circulatory arrest time in the proximal repair group. At a mean follow-up of 55.7 ± 33.1 months (maximum, 129), complete thrombosis of the false lumen in the proximal descending aorta was achieved in 100% of the extensive repair group versus 24.6% of the proximal repair group ($P < 0.001$). For patients with a patent false lumen in the proximal repair group, distal anastomotic leakage and unclosed small intimal tears were identified in 53.3 and 35.6% patients, respectively. The incidence of reintervention was also lower in the extensive repair group than in the proximal repair group (4.9 vs 15.9%, $P < 0.05$) during follow-up.

CLINICAL BOTTOM LINE

Currently available evidence has proved that total aortic arch replacement is not associated with higher early mortality rate. Evidence for long-term outcomes, albeit limited, has proved that better results of thrombosis of the false lumen can be achieved with a more extensive total arch repair.

We conclude that a more extensive surgical strategy can be justified when it is based on circumstances, on the individual patient's clinical condition, and on the anatomical and pathological features of the dissection.

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