Limited vs Extended Repair for Type A Aortic Dissection involving Aortic Arch

Matthew Henn[1] and Marc Moon[2]

[1]The Ohio State University Wexner Medical Center
[2]Washington University

August 3, 2020

Abstract

Significant controversy exists in the management of type A aortic dissections with aortic arch involvement. There is a substantial variability in approaches to this complex problem ranging from simply replacing the ascending aorta to total arch replacement with frozen elephant trunk – all of which balance the competing interests of reducing operative risk and reducing risk of reintervention. The diversity of clinical details, variability of surgical experience, and lack of significant randomized data make a consensus approach to these patients unlikely. However, it is important to understand the risks and benefits of each technique, and herein we evaluate the outcomes of each. Our approach to these patients has been to reserve arch replacement for those who have arch aneurysmal disease, imminent risk of rupture, or cerebral malperfusion, and perform a hemiarch replacement in all other scenarios with arch involvement. Such approach is easily taught, safe, and reproducible while focusing more on survival rather than long-term freedom from reintervention.

Abstract

Significant controversy exists in the management of type A aortic dissections with aortic arch involvement. There is a substantial variability in approaches to this complex problem ranging from simply replacing the ascending aorta to total arch replacement with frozen elephant trunk – all of which balance the competing interests of reducing operative risk and reducing risk of reintervention. The diversity of clinical details, variability of surgical experience, and lack of significant randomized data make a consensus approach to these patients unlikely. However, it is important to understand the risks and benefits of each technique, and herein we evaluate the outcomes of each. Our approach to these patients has been to reserve arch replacement for those who have arch aneurysmal disease, imminent risk of rupture, or cerebral malperfusion, and perform a hemiarch replacement in all other scenarios with arch involvement. Such approach is easily taught, safe, and reproducible while focusing more on survival rather than long-term freedom from reintervention.

The extent of surgical repair for type A aortic dissections involving the aortic arch remains a controversial topic – particularly with regards to the distal extent of repair. The competing interests of mitigating operative risk and avoiding late re-intervention are at the forefront of this controversary. The conservative approach of simply replacing the ascending aorta while avoiding intervention on the dissected arch is the fastest and safest approach. However, leaving a residual false lumen in the arch and descending aorta leads to aortic dilation, which is associated with high re-intervention rates with significant morbidity and mortality.[1-3]

Conversely, total arch replacement at the time of acute dissection has the advantage of decreasing the patency of the false lumen of the residual aorta, which can induce reverse remodeling of the aorta leading to decreased risk of aneurysmal dilation.[4, 5] The obvious benefit is a reduction in late re-interventions on the arch and proximal descending aorta – at the cost of increased operative risk.[4-6]

Unfortunately, decision-making in the extent of repair is not so clear-cut. In addition to limited ascending replacement and total arch replacement there are a multitude of variations in surgical approach including composite root replacement, hemiarch replacement, classic elephant trunk, open frozen elephant trunk, descending replacement, and multiple novel endovascular techniques. This diversity in approach combined with the broad spectrum of clinical variables, significant diversity in clinical experience, and lack of any randomized data in the literature has made a consensus on extent of surgical repair unlikely.

In the evaluation of each approach, it is important to first understand the operative risk and risk of re-intervention after the different strategies of type A dissection repair. At Washington University in St. Louis, we evaluated the natural history of the residual aorta after repair of acute type A aortic dissections over 10 years. In our series of 168 patients, freedom from reoperation was 74%, and over half of the re-operations did not involve the aortic arch.[3] After multivariable regression, independent predictors of reoperation included non-resected primary tear, absence of postoperative B-blocker therapy, and elevated systolic blood pressure at late follow-up. Interestingly, the extent of distal repair (ascending aortic replacement vs hemiarch) did not affect aortic growth or need for late reoperation.[3]

In a follow-up series, we further explored these findings in 252 patients who underwent type A repair over the course of 25 years.[7] Initial operative mortality was 16% with a 5-year and 10-year survival of 78%, and 59%, respectively. Late reoperation rate was 13% and elevated systolic blood pressure at late follow-up was found to be a powerful predictor of reoperation. Specifically, freedom from reoperation for those with SBP <120 mm Hg was significantly higher at 92 ±5% compared to with those with SBP 120 mm Hg to 140 mm Hg (74%±7%) or >140 mm Hg (49%±14%, P<.001).[7] Further, reoperation was markedly increased in patients not on B-blocker therapy. These findings suggest that long-term, aggressive blood pressure control with B-blockers is more important in avoiding late reoperation than the extent of distal aortic resection.[3, 6, 7]

In another robust series from Mt. Sinai[2] including 179 patients who underwent type A aortic dissection repair, there was an operative mortality of 13% with a 5-year and 10-year survival of 78% and 66%, respectively. The cumulative risk of reoperation on the distal aorta at 10 years was 16% – one quarter of which were on the abdominal aorta. The majority of patients in the series underwent hemiarch replacement (54%) or ascending replacement (36%), and the most important risk factors for reoperation were an aortic diameter exceeding 4 cm and a patent false lumen.[2] Nonetheless, 84% of patients were free from aortic reintervention a decade after their repair.

These data are similar to older data from France[8] in which 160 consecutive patients underwent Type A repair and 77% were free from reoperation on the arch or distal aorta at 10 years. In this series, 15% underwent arch replacement and distal extent of aortic resection at initial operation did not significantly influence the risk of distal reoperation. However, operative mortality was nearly double more contemporary series at 32% with 5-year and 10-year survival of 57% and 52%, respectively.[8]

Lastly, data from Cleveland[9] in which 208 patients underwent type A repair with an operative mortality of 14%, 85% were free from aortic re-intervention at 10 years. Over half of the re-interventions were on the proximal aorta and extent of initial distal resection did not influence reoperation or survival. However, 15% of patients underwent total arch replacement at the initial operation and had significantly worse survival than those that underwent isolated ascending replacement or hemiarch replacement.[9]

Perhaps more important than the raw numbers of aortic reoperation is the mortality of reoperation. In our group and others, the perioperative mortality of reoperation on the distal aorta after type A repair appears to be relatively low – between 7-13%.[2, 3, 8] The largest series evaluating the outcomes of distal aortic re-intervention following type A dissection repair is from Roselli and colleagues.[1] They evaluated 305 type A aortic dissection repair survivors who underwent 429 subsequent interventions on the distal aorta over the course of 2 decades. Initial repairs included ascending aorta replacement (74%) and arch repair (25%), and the most common indication for re-intervention was distal aneurysmal disease (95%). Re-interventions included combinations of ascending repair (69%), Elephant trunk (48%), total arch replacement (74%), and descending/thoracoabdominal replacement (37%) with an overall in-hospital mortality of 6.1% and 10-year

survival of 65%. Not surprisingly, infection, concomitant CABG, and combined arch and descending repairs were associated with reduced in-hospital and late survival.[1]

Strategies to mitigate aneurysmal disease of the arch and descending aorta following acute type A repair have led to various frozen elephant trunk techniques. Pochettino and colleagues[10] compared 42 hemiarch replacements to 36 hemiarch replacements with additional open antegrade thoracic stent-grafting. Circulatory arrest times were higher in the stented group, but operative mortality was equivalent (14%). At 15.9 months, open thoracoabdominal aneurysm repair was required in 11% of standard hemiarch patients compared with 0% in those with a frozen elephant trunk (p=0.08). However, one major concerning trend was that transient paresis occurred in 9% of the stented group compared to 2% of the non-stented group.[10] Further, 25% of patients in the stented group underwent endovascular reintervention to achieve false-lumen obliteration.

Roselli and colleagues[11] have developed a modified technique of open frozen elephant trunk during acute type A repair that includes a branched graft deployed in an antegrade fashion into the descending aorta and left subclavian. Overall outcomes of this technique have been impressive with an operative mortality of 4.2% after 72 cases and complete obliteration of the false lumen in 72% of patients. However, 4.2% of patients suffered spinal cord injury and the reintervention rate was 28% at 5 years – albeit all of reinterventions were endovascular and there were no reintervention mortalities or late paralysis.

Avoiding spinal cord ischemia is of critical importance when employing the frozen elephant trunk technique and a recent meta-analysis by Preventza and colleagues[12] explored this relationship. In their pooled analysis of 35 studies with 3154 patients who underwent frozen elephant trunk, spinal cord ischemia was significantly higher with stent length 15cm or greater or coverage beyond T8 than with stent length of 10cm (11.6% vs 2.5%, $P < .001$). However, it is important to mention that there is no distinction between permanent vs transient spinal cord injury, and adjuncts such as cerebrospinal fluid drainage and permissive hypertension can rescue patients who develop spinal cord injury after distal aortic coverage.[13, 14]

The most radical approach to acute type A dissections with arch involvement is the total arch replacement with classic or frozen elephant trunk. Most centers reserve total arch replacements for patients with arch tears or an aneurysmal disease. However, if an arch replacement is required, excellent results can be achieved in experienced centers. Sun and colleagues[4] from Beijing performed a total arch replacement with frozen elephant trunk in 104 patients with type A dissection, reporting a low mortality rate of 8.6%. Despite a low rate of radiographic follow-up with computed tomography scans done in 65 patients at a mean of 4.6 years, no patient underwent an intervention on the distal aorta, and the false lumen was completely obliterated in 63. However, it is notable that there was a 2.9% new postoperative paraplegia rate. In another impressive series of total arch replacements from Japan, Omura and colleagues[15] performed 88 total arch replacements with classic elephant trunk achieving a hospital mortality of 10.2% and a 95% freedom from intervention from reoperation at 5 years.

While results such as these achieve the goal of comparable mortality with a lower reintervention rate compared to ascending and hemiarch replacements, we must keep in mind that all data presented herein are from aortic centers of excellence. It is difficult to imagine we can expect such results in less experienced centers, particularly when the most common hospital to perform type A dissection repair in the United States does an average of 1 per year.[16] As such, our approach at Washington University in St. Louis has been to reserve total arch replacement for cases in which the arch is aneurysmal, at imminent risk of rupture, or there is cerebral malperfusion. For all other scenarios, we tend to extend resection to a hemiarch when the tear extends into the arch. Such technique is reproducible to our trainees and can achieve the ultimate goal of maximizing survival rather than long-term freedom from reintervention, which we mitigate with strict long-term blood pressure control and beta blocker use.

References

1. Roselli EE, Loor G, He J, Rafael AE, Rajeswaran J, Houghtaling PL, Svensson LG, Blackstone EH and Lytle BW. Distal aortic interventions after repair of ascending dissection: the argument for a more aggressive approach. *J Thorac Cardiovasc Surg* . 2015;149:S117-24 e3.

2. Halstead JC, Meier M, Etz C, Spielvogel D, Bodian C, Wurm M, Shahani R and Griepp RB. The fate of the distal aorta after repair of acute type A aortic dissection. *J Thorac Cardiovasc Surg* . 2007;133:127-35.

3. Zierer A, Voeller RK, Hill KE, Kouchoukos NT, Damiano RJ, Jr. and Moon MR. Aortic enlargement and late reoperation after repair of acute type A aortic dissection. *Ann Thorac Surg* . 2007;84:479-86; discussion 486-7.

4. Ma WG, Zhang W, Wang LF, Zheng J, Ziganshin BA, Charilaou P, Pan XD, Liu YM, Zhu JM, Chang Q, Rizzo JA, Elefteriades JA and Sun LZ. Type A aortic dissection with arch entry tear: Surgical experience in 104 patients over a 12-year period. *J Thorac Cardiovasc Surg* . 2016;151:1581-92.

5. Watanuki H, Ogino H, Minatoya K, Matsuda H, Sasaki H, Ando M and Kitamura S. Is emergency total arch replacement with a modified elephant trunk technique justified for acute type A aortic dissection? *Ann Thorac Surg* . 2007;84:1585-91.

6. Waterford SD, Gardner RL and Moon MR. Extent of Aortic Replacement in Type A Dissection: Current Answers for an Endless Debate. *Ann Thorac Surg* . 2018;106:1246-1250.

7. Melby SJ, Zierer A, Damiano RJ, Jr. and Moon MR. Importance of blood pressure control after repair of acute type a aortic dissection: 25-year follow-up in 252 patients. *J Clin Hypertens (Greenwich)* . 2013;15:63-8.

8. Kirsch M, Soustelle C, Houel R, Hillion ML and Loisance D. Risk factor analysis for proximal and distal reoperations after surgery for acute type A aortic dissection. *J Thorac Cardiovasc Surg* . 2002;123:318-25.

9. Sabik JF, Lytle BW, Blackstone EH, McCarthy PM, Loop FD and Cosgrove DM. Long-term effectiveness of operations for ascending aortic dissections. *J Thorac Cardiovasc Surg* . 2000;119:946-62.

10. Pochettino A, Brinkman WT, Moeller P, Szeto WY, Moser W, Cornelius K, Bowen FW, Woo YJ and Bavaria JE. Antegrade thoracic stent grafting during repair of acute DeBakey I dissection prevents development of thoracoabdominal aortic aneurysms. *Ann Thorac Surg* . 2009;88:482-9; discussion 489-90.

11. Roselli EE, Idrees JJ, Bakaeen FG, Tong MZ, Soltesz EG, Mick S, Johnston DR, Eagleton MJ, Menon V and Svensson LG. Evolution of Simplified Frozen Elephant Trunk Repair for Acute DeBakey Type I Dissection: Midterm Outcomes. *Ann Thorac Surg* . 2018;105:749-755.

12. Preventza O, Liao JL, Olive JK, Simpson K, Critsinelis AC, Price MD, Galati M, Cornwell LD, Orozco-Sevilla V, Omer S, Jimenez E, LeMaire SA and Coselli JS. Neurologic complications after the frozen elephant trunk procedure: A meta-analysis of more than 3000 patients. *J Thorac Cardiovasc Surg* . 2020;160:20-33 e4.

13. Lou X and Chen EP. Commentary: The elephant in the room: Walking the walk and talking the talk after a frozen elephant trunk procedure.*J Thorac Cardiovasc Surg* . 2020;160:34-35.

14. Lou X, Duwayri YM, Jordan WD, Jr., Chen EP, Veeraswamy RK and Leshnower BG. The Safety and Efficacy of Extended TEVAR in Acute Type B Aortic Dissection. *Ann Thorac Surg* . 2020.

15. Omura A, Miyahara S, Yamanaka K, Sakamoto T, Matsumori M, Okada K and Okita Y. Early and late outcomes of repaired acute DeBakey type I aortic dissection after graft replacement. *J Thorac Cardiovasc Surg* . 2016;151:341-8.

16. Chikwe J, Cavallaro P, Itagaki S, Seigerman M, Diluozzo G and Adams DH. National outcomes in acute aortic dissection: influence of surgeon and institutional volume on operative mortality. *Ann Thorac Surg* . 2013;95:1563-9.