Extended Arch Procedures for Acute Type A Aortic Dissection: A Downstream Problem?

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Current discussion regarding the management of acute type A aortic dissection is focused on whether to perform a standard hemiarch resection or perform an extended repair, in hopes of improving long-term outcomes by avoiding late, distal aortic sequelae. Critical to this discussion is an estimation of the short-term risks of an extended procedure and the magnitude of the late "downstream problem." Extension of the hemiarch to a total arch plus frozen elephant trunk does not improve survival; carries some increased perioperative risk, not the least of which is paraplegia; but decreases late aortic events, the most common of which is reoperation on the distal aorta. However, these reoperations are low frequency, primarily elective, low-risk events and it should be noted that extended index repairs do not eliminate or necessarily decrease the incidence of late reoperations. Routine extension of the index procedure puts 100% of patients at risk in order to protect a minority that may benefit. Therefore, it is important to select patients at high risk for reoperation if an extended repair is to be performed. Predictors that may identify this high-risk group include the size and location of the entry tear, aortic and luminal dimensions, degree of luminal flow and thrombosis, and the presence of a connective tissue disorder. Timing may also be important and, in patients at high risk for late events, early complications may be minimized by strategies that delay an extension of the proximal repair until the subacute period.

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Central Message

Distal aortic reoperation after a hemiarch repair for type A dissection is a low frequency, primarily elective, low-risk event. Only patients at high risk for late events need extended index repairs.

Perspective Statement

Current discussion regarding the management of acute type A aortic dissection is focused on whether to perform a standard hemiarch resection or an extended repair, in hopes of improving long- term outcomes by avoiding late, distal aortic sequelae. Critical to this discussion is an estimation of the short-term risks of an extended procedure and the magnitude of the late "downstream problem."

INTRODUCTION

Current discussion regarding the management of acute type A aortic dissection (ATAAD) is focused on whether to perform a proximal repair, such as a hemiarch resection, or an extended repair, such as a total arch replacement, possibly including an elephant trunk or fixed elephant trunk, in hopes of improving long-term outcomes. Suggested indications for performing an extended repair include: young age,[1] connective tissue disorder,[1] enlarged arch,[1] and malperfusion,[2,3] with strategies ranging from extended repair for all ATAAD[4] to more selective approaches. Many recommend a "tear directed" strategy, advocating extended repair for intimal tears on the greater curve of the arch,[1,5] large tears in the proximal descending aorta,[6] or for all arch tears.[7]

Abbreviations: ATAAD, acute type A aortic dissection

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Varying study designs make it difficult to compare ATAAD follow-up reports. Different endpoints have been used; including survival; aneurysm formation; growth rate; false lumen patency; late events, including rupture and need for re-intervention; and composites, such as event-free survival. Moreover, different proximal repair operations were used, with most studies comprised of a mixture of ascending replacement, ascending plus hemiarch, and even a small percent of ascending plus total arch cases; yet these proximal repair studies are often cited as if they represent hemiarch results. The only large, long-term, exclusively hemiarch study is that of Rylski and colleagues.[5] Another issue confounding comparisons of proximal repair and extended repair report concerns proximal repair reoperation rates. Most studies group DeBakey type I and II cases, an important issue, since hemiarch should be curative for the latter. On the other hand, many studies include reoperations that would not be solved by extended repair procedures, including anastomotic pseudoaneurysms, graft infections, planned second stage elephant trunk procedures, and proximal problems, such as aortic insufficiency.

Arch Tears: How Frequent and Where Are They?

Arch tears in ATAAD, including cases with multiple tears, occur in 30−35% of cases.[8,9] The great majority are located on the lesser curvature and can be excised by hemiarch.[9] Thus, arch tears represent a significant portion of ATAAD, justifying the focus on how best to manage them.

THE DOWNSTREAM PROBLEM

The downstream problem premise is that hemiarch significantly lowers survival based on a high incidence of false lumen patency and late, distal aortic problems that require high risk, secondary operations. The corollary is that an index extended repair can avoid these problems.

False Lumen Patency Post Hemiarch

It is well established that the false lumen remains patent in a majority of cases following hemiarch for ATAAD.[3,10−13] The number of communications between true and false lumina in the residual aorta following proximal repair for ATAAD has been shown to positively correlate with the rate of aortic growth,[14] and false lumen patency has been correlated with increased late events and decreased survival.[12,13] However, a recent study of acute type B dissection, perhaps a surrogate for the distal segment following hemiarch repair, reported no effect of false lumen patency on late survival.[15]

Many studies have shown that a frozen elephant trunk does promote false lumen thrombosis at the level of the stent, but not at the diaphragmatic and visceral segment levels. For example, Zhang and colleagues reported 100% proximal thrombosis at 6−12 months but only 45.1% distally.[16]

Early Mortality and Late Events: Hemiarch vs Extended Procedures

While many experienced centers reported no difference in early mortality between proximal repair and extended repair,[1,2,16−18] the German Registry for Acute Aortic Dissection Type A (GERAADA) and International Registry of Acute Aortic Dissections (IRAD) registries showed a trend[19,20] and a meta-analysis of 1872 patients from 9 studies showed significantly less early mortality with proximal repair.[21] Regarding long-term survival, although some studies have shown improved survival with extended repair,[17] most,[1,16,18] including the IRAD[20] and meta-analysis[21] reports show no difference in late survival between proximal repair and extended repair approaches. In terms of late events, Omura and colleagues[1] and the meta-analysis by Yan[21] and colleagues report a significant increase in late events with proximal repair. This is the downstream problem.

How Big Is the Downstream Problem: How Many Come Back, How Urgently, and at What Risk?

Re-intervention probably comprises the most common late aortic event following ATAAD, but is a weak endpoint, since some patients may be unwilling or unfit to undergo required reoperations. Also, there is an unknown competing risk of aortic-related mortality. However, most large centers maintain their reoperation rates and reported rates of re-intervention following a proximal, index ATAAD repair range from 7% to 26% (weighted average 13.1%).[1,5,6,9,11,13,16,18,22,23] A study of 534 proximal repair cases reported only 8% late re-interventions,[13] and the homogeneous study of 534 hemiarch cases from the University of Pennsylvania[5] reported a re-intervention rate of 15% for DeBakey type I and 10% for DeBakey type II. Thus, late re-interventions are relatively uncommon. However, for patients that have undergone one re-intervention, the rate of re-re-interventions is as high as 40% at 5 years, and is especially so for patients with connective tissue disorders.[24]

Among a recent group of large studies, 81−92% of re-intervention cases were elective,[5,13,24,25] perhaps contributing to a very low re-operative risk, which ranged from 0% to 12% (weighted average 4.7%)[1,3,5,7,11,13,22−24,26] Thus, in terms of the magnitude of the downstream problem: re-interventions are mostly elective, infrequent, low-risk events.

Balance: Short-term Risk vs Long-term Benefit

Like any prophylactic operation, the short-term risks of extending a hemiarch must be small compared with the long-term benefit of avoiding late reoperations; but late reoperations are low frequency, predominantly elective, low-risk procedures, with options for open and endovascular approaches, and thus the short-term risks must be minimal. The short-term risks of extending the hemiarch include increased hypothermic circulatory arrest time; increased operative mortality;[19−21] increased myocardial ischemic time, stroke, recurrent laryngeal nerve injury, the potential for endoleaks and significantly, an incidence of paraplegia. De novo, postoperative spinal cord injury post hemiarch is extremely rare, but spinal injury remains a devastating complication of frozen elephant trunk procedures, with an incidence of 2.6% for type A in a recent meta-analysis of frozen elephant trunk procedures.[27] In addition to these short-term risks, frozen elephant trunk procedures also have long-term complications, including infection,

erosion into the bronchus or esophagus, pseudoaneurysm formation, graft fracture, endoleaks and, subverting the purported benefit of extended repair, reoperations! Whereas reoperations were required in about 10−15% of proximal repairs, they were required in 14−19% of frozen elephant trunk procedures performed for ATAAD.[28,29]

SELECTIVE USE OF EXTENDED PROCEDURES FOR ATAAD

Routine extended repair for ATAAD puts 100% at short- and long-term risk to avoid reoperations in 10−15% after a hemiarch. A more judicious approach is to offer extended repair to patients that are at high risk for late complications following hemiarch, and, using acute type B studies as surrogates for the residual dissected aorta following type A repair, several predictive parameters may help identify patients that might benefit from extended repair and, conversely, patients that will probably do well long term with a hemiarch.

Large (> 1cm), proximal intimal tears ATAAD,[6,30] and tears on the concave surface of the proximal descending aorta in acute type B dissection[31] have been associated with poorer outcomes. However, small tears, whether proximal or not, had excellent survival at 10 years.[6]

Frequently, outcomes have been correlated with the descending aortic diameter.[9,15,30,32−34] Ray and colleagues[34] demonstrated excellent intervention-free survival in acute type B dissection for diameters <35 mm and progressively worse outcomes for diameters increasing to ≥43 mm. A frequent cutoff differentiating excellent from inferior outcomes is 40 mm.[9,15,30,32,33]

False lumen patency is another parameter often correlated with outcomes, and studies have variously focused on false lumen size,[11,30,35] shape, degree of thrombosis,[36] and capacity of outflow branches.[37] An important observation regarding false lumen measurements in the acute phase is that the dissection membrane is dynamic and moves throughout the cardiac cycle, making false lumen size measurement by one fixed CT image misleading. Accordingly, Sailer and colleagues[38] recommend using circumferential extent as a more constant and reliable indication of true and false lumen dimensions.

Composites have also been used to predict long-term outcomes. In acute type B dissection for example, a diameter ≤40 mm combined with a closed false lumen rarely required late re-intervention.[32] In postoperative ATAAD, a thrombosed false lumen or a patent false lumen with no new entry points at the distal anastomosis had excellent freedom from aortic enlargement.[7] Similarly, indices combining multiple predictors have been shown to predict groups that have excellent late outcomes.[33,38] Patients with connective tissue disorders are at high risk for late reoperations and may be considered for extended repair.[38]

Another consideration of selective treatment of ATAAD is the timing of extending hemiarch. In acute type B dissection, the University of Pennsylvania group showed that delaying intervention until the subacute phase decreased major complications, including spinal cord injury.[39] Adapting this strategy for ATAAD patients at high risk for late events, this group has suggested performing a Zone II Arch resection, anticipating a distal endovascular extension in the subacute phase.[40]

CONCLUSION

Extension of the hemiarch to total arch plus frozen elephant trunk for ATAAD decreases late aortic events but does not improve survival and may carry some increased perioperative risk, not the least of which is paraplegia. The most common late event is reoperation on the distal aorta; however, these reoperations are low frequency, primarily elective, low-risk events. Moreover, extended repair procedures do not eliminate late reoperations and it is unclear whether, or to what extent, they reduce the incidence of reoperations. Routine extension of the index procedure puts 100% of patients at risk in order to protect the minority that may benefit. Therefore, it is important to select patients at high risk for reoperation if an extended repair is to be performed. Predictors that may identify this high risk group include the size and location of the entry tear, aortic and luminal dimensions, degree of luminal flow and thrombosis, and the presence of a connective tissue disorder. Timing may also be important and, in patients at high risk for late events, early complications may be minimized by strategies that delay an extension of the proximal repair until the subacute period.

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