

Change of Proximal Descending Aortic False Lumen after Conventional Repair of Acute Type I Dissection: Is It Always Unfavorable?

Sue Hyun Kim, M.D., Jun Sung Kim, M.D., Ph.D., Yoon Cheol Shin, M.D.,
Dong Jung Kim, M.D., Cheong Lim, M.D., Ph.D., Kay-Hyun Park, M.D., Ph.D.

Background: Some patients show favorable changes in the descending aortic false lumen after conventional repair of acute type A dissection, although the incidence of favorable changes has been reported to be low. We aimed to investigate the incidence of positive postoperative changes in the false lumen and the factors associated with positive outcomes. **Methods:** In 63 patients who underwent surgery for type A acute dissection as well as serial computed tomography (CT) scanning, morphological parameters were compared between the preoperative, early postoperative (mean interval, 5.4 days), and late CT scans (mean interval, 31.0 months) at three levels of the descending thoracic aorta. **Results:** In the early postoperative CT images, complete false lumen thrombosis and/or true lumen expansion at the proximal descending aorta was observed in 46% of the patients. In the late images, complete thrombosis or resolution of the proximal descending false lumen occurred in 42.9% of the patients. Multivariate analysis found that juxta-anastomotic false lumen thrombosis was predictive of favorable early changes, which were in turn predictive of continuing later improvement. **Conclusion:** Even after conventional repair without inserting a frozen elephant trunk, the proximal descending aortic false lumen showed positive remodeling in a substantial number of patients. We believe that the long-term prognosis of type A dissection can be improved by refining surgical technique, and particularly by avoiding large intimal tears at the anastomosis site during the initial repair.

Key words: 1. Aortic dissection
2. Remodeling

INTRODUCTION

It has been reported that 20%–40% of patients require a second operation for aneurysmal dilatation of the descending aorta during the first five years after emergency surgical repair of acute type A dissection [1-5]. A patent false lumen, a large false lumen area, and a large initial diameter of the descending aorta have been identified as risk factors for aneurysmal dilatation of the descending aorta and, subsequently, a poor long-term prognosis [4,5]. Based on these observations,

the so-called frozen elephant trunk (FET) was introduced, and was shown to promote false lumen thrombosis in the aortic segment covered by a stent graft [6,7]. However, it is still controversial whether the FET technique should be applied to all type A dissection patients. Some advocates of the routine insertion of a FET assume that positive remodeling of the descending false lumen is extremely unlikely to occur after conventional surgery.

Some patients show favorable changes in the remaining false lumen after conventional repair of acute type A dis-

Department of Thoracic and Cardiovascular Surgery, Seoul National University Bundang Hospital, Seoul National University College of Medicine
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Corresponding author: Kay-Hyun Park, Department of Thoracic and Cardiovascular Surgery, Seoul National University Bundang Hospital, 82 Gumi-ro 173beon-gil, Bundang-gu, Seongnam 463-707, Korea
(Tel) 82-31-787-7139 (Fax) 82-31-787-4050 (E-mail) drkhpark@gmail.com

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section, although the incidence of such favorable changes has been reported to be low. In our previous study, shrinkage or even complete resolution of the descending aortic false lumen was observed to have an incidence of 29.5%, which was higher than expected [8]. In this study, we aimed to investigate early and late changes in the descending thoracic aortic false lumen after conventional surgery in which up-to-date surgical techniques and strategies were applied, although a FET was not inserted. This study also evaluated factors that may influence postoperative changes in the descending aortic false lumen.

METHODS

This study was approved by the institutional review board, which waived the requirement of obtaining consent from individual patients (Seoul National University Bundang Hospital, B-1108/133-106).

1) Patients

Between January 2004 and December 2012, 146 patients underwent emergency surgical treatment for acute type A aortic dissection in Seoul National University Bundang Hospital. We excluded 12 cases of early mortality, 33 patients in which dissection was limited to the ascending aorta and proximal aortic arch (DeBakey type II), and 14 patients with preoperative thrombosis of the entire false lumen (intramural hematoma). Moreover, patients for whom serial computed tomography (CT) scans were not available for retrospective review from the preoperative stage through late follow-up were also excluded. A total of 63 patients were enrolled in this study.

Our study population included 40 men and 23 women. Their mean age was 50.5 ± 13.6 years (range, 27–78 years). Of these patients, 13 (20.6%) showed phenotypic manifestations of Marfan syndrome. All operations were performed under deep hypothermic circulatory arrest. Aortic arch replacement was performed in 28 patients (44%), of whom 13 underwent total arch replacement and 15 underwent partial arch replacement. In nine patients with retrograde type A dissection, an intimal tear was not found in the surgical field.

2) Review of computed tomography images and data analysis

Serial CT images of each patient in the preoperative, early postoperative, and late follow-up stages were reviewed retrospectively. Early postoperative CT was performed at a mean of 5.4 ± 3.0 days postoperatively (range, 1–14 days), before the patient was discharged from the hospital. Late follow-up CT was performed at a mean of 31.0 ± 20.7 months postoperatively (range, 6–97 months). The morphological features of the true and the false lumens were measured at three planes, representing the proximal, middle, and distal descending thoracic aorta (Fig. 1). At each level, the patency of the false lumen was assessed, and the width of the true and false lumens was recorded.

Early postoperative changes were categorized as following. A false lumen that was completely thrombosed and narrower than the true lumen was classified as improved. A false lumen that was completely thrombosed but wider than the true lumen was defined as favorable, as were patent false lumens that were significantly narrower than observed preoperatively. The presence of the following findings in comparison with the preoperative images led to a classification of the false lumen as unfavorable: further collapse of the true lumen, a newly patent false lumen that had been thrombosed preoperatively, and >5 mm of dilatation of the aortic diameter.

In the late postoperative findings, we defined improved change as complete false lumen thrombosis accompanied by a decrease of the aortic diameter, regression of the false lumen, or the new expansion of a previously narrow true lumen. Postoperative findings were classified as unfavorable if the overall aortic diameter had increased by more than 10 mm, if the aortic diameter had increased more than 5 mm within the first year, or if further collapse of the true lumen occurred.

Statistical analyses were performed using SPSS ver. 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Categorical variables were compared using the chi-square test or Fisher's exact test, and numerical variables were compared using the Student t-test. All p-values < 0.05 were considered to indicate statistical significance.

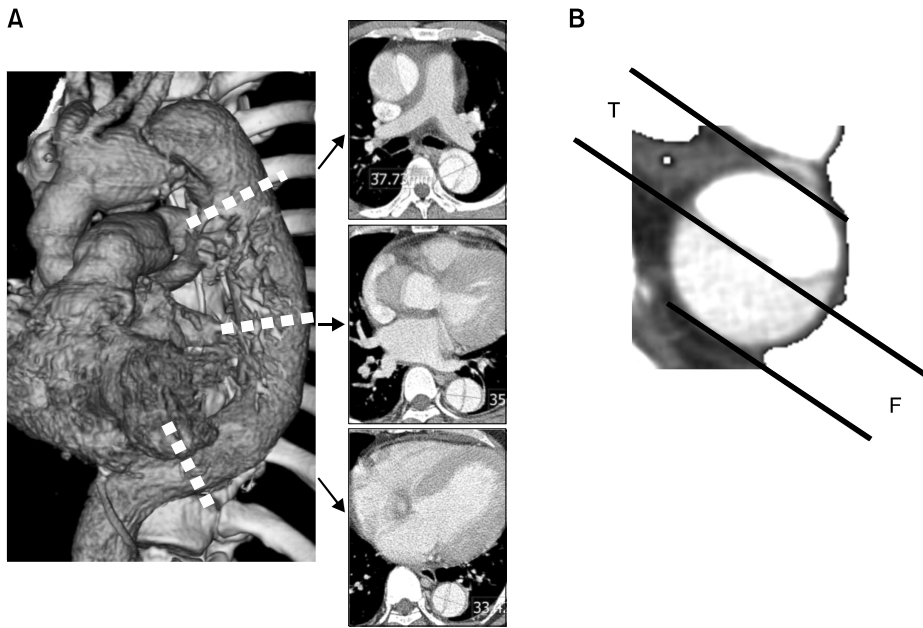


Fig. 1. (A) Three levels of the descending thoracic aorta where morphological features were recorded. (B) Measurement of the width of the true and false lumens and the total diameter. T, true lumen width; F, false lumen width; T+F, diameter of the aorta.

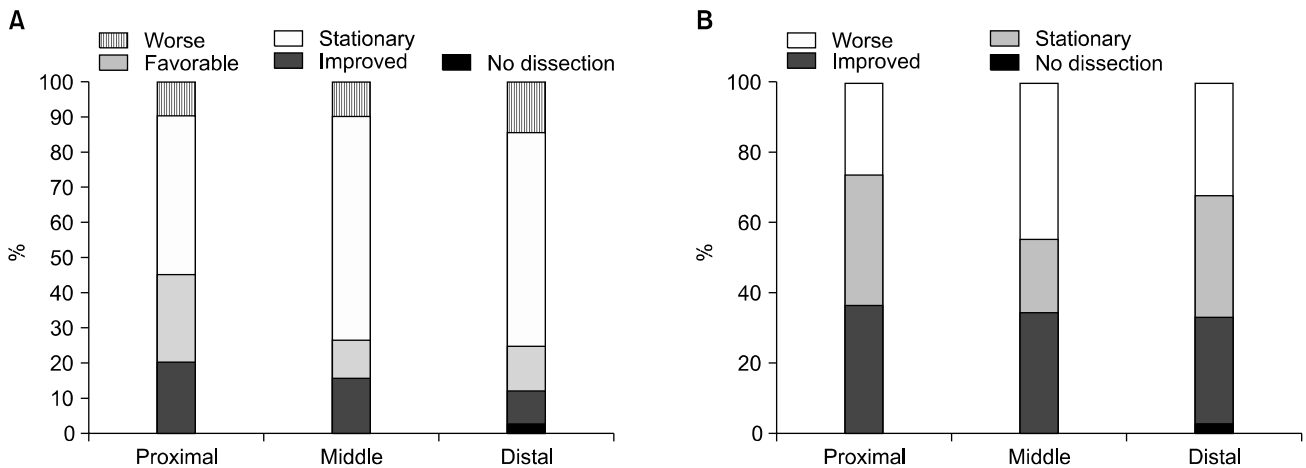


Fig. 2. (A) Early and (B) late changes in the false lumen in the proximal, middle, and distal descending thoracic aorta.

RESULTS

1) Early postoperative outcomes

In the early postoperative period, 46.0% of the patients (29 of 63) showed improved or favorable changes in the false lumen of the proximal thoracic aorta, which was significantly more frequent than favorable changes in the middle descending thoracic aorta (27.0%, 17 of 63) or the distal descending thoracic aorta (22.2%, 14 of 63) (Fig. 2A). In univariate and multivariate analysis, preoperative features of the false lumen, arch replacement, and the presence of Marfan syndrome were

not associated with improved or favorable early postoperative changes. Preoperative false lumen thrombosis showed a significant positive association with improved or favorable outcomes in univariate analysis, but not in multivariate analysis. The only factor found to show a significant positive association with improved or favorable outcomes in both univariate and multivariate analysis was thrombosis of the false lumen adjacent to the distal anastomosis. The false lumen of the proximal thoracic aorta showed favorable early changes in 78.6% of patients in whom a false lumen immediately distal to the graft anastomosis (juxta-anastomotic false lumen) was

Table 1. Factors associated with favorable early changes in the proximal descending thoracic aorta after surgery for acute type A aortic dissection

Factors	Mean value or incidence		p-value	
	Improved or favorable	Stationary or worse	Univariate	Multivariate
Male gender	35.0% vs. 65.2%	65.0% vs. 34.8%	0.021	0.04
Marfan syndrome	30.8% vs. 50.0%	69.2% vs. 50.0%	NS	NS
Preoperative features				
Preoperative aortic diameter (mm)	33.5±4.9	32.1±3.8	NS	NS
Preoperative TL width (mm)	15.1±5.3	13.0±4.9	NS	NS
Preoperative FL width (mm)	18.6±6.7	19.1±5.0	NS	NS
Preoperative TL ratio (TL width/aortic diameter, %)	45.2±15.8	40.4±14.3	NS	NS
Preoperative FL thrombosis	100.0% vs. 41.4%	0% vs. 58.6%	0.03	NS
Operative procedure				
Root replacement	29.4% vs. 52.2%	70.6% vs. 47.8%	NS	NS
Total arch replacement	61.5% vs. 42.0%	38.5% vs. 58.0%	NS	NS
Distal stump neomedia	50.0% vs. 42.9%	50.0% vs. 57.1%	NS	NS
Thrombosis of FL adjacent to distal anastomosis	78.6% vs. 20.0%	21.4% vs. 80.0%	<0.001	0.001

NS, not significant; TL, true lumen; FL, false lumen.

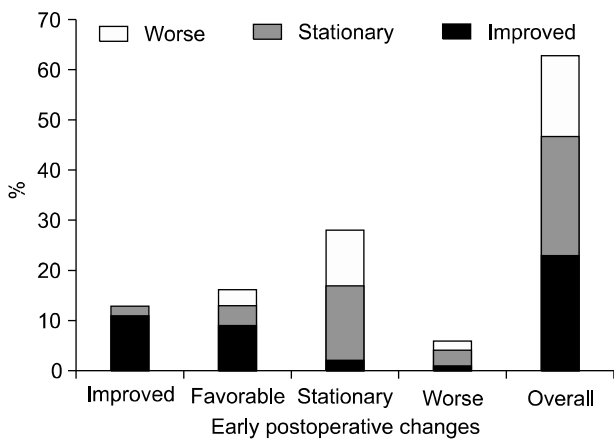


Fig. 3. Late changes in the proximal descending false lumen according to early postoperative changes in the false lumen.

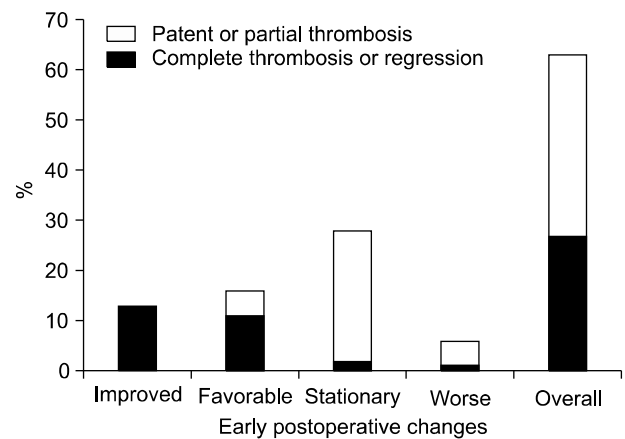


Fig. 4. Late thrombosis of the proximal descending false lumen according to early postoperative changes in the false lumen.

completely thrombosed. In contrast, favorable early changes occurred in only 20.0% of patients with a patent juxta-anastomotic false lumen (Table 1).

2) Later improvement of the false lumen during follow-up

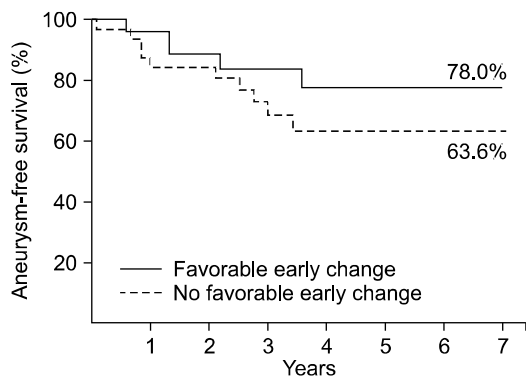
In the late follow-up CT images, 36.5% of the patients (23 of 63) showed improved changes in the false lumen of the proximal thoracic aorta, compared to 34.9% (22 of 63) in the middle thoracic aorta and 30.2% (19 of 63) in the distal thoracic aorta. In contrast, unfavorable late changes, reflecting

a rapid increase of the aortic diameter or further collapse of the true lumen, were found in 25.4% of the patients (16 of 63) in the proximal aorta, 44.4% (28 of 63) in the middle aorta, and 31.7% (20 of 63) in the distal aorta (Fig. 2B). If early postoperative changes were improved or favorable, the proximal descending thoracic aorta showed further late improvement in 84.6% (11 of 13) and 56.3% (9 of 16) of the cases, respectively. In contrast, if early postoperative changes were stable or unfavorable, only 7.1% (2 of 28) and 16.7% (1 of 6) of the patients showed further late improvement, re-

Table 2. Factors associated with late improvement of the false lumen in the proximal descending thoracic aorta after surgery for acute type A aortic dissection

Factors	Mean value or incidence		p-value	
	Improved or favorable	Stationary or worse	Univariate	Multivariate
Male gender	22.5% vs. 60.9% (9/40 vs. 14/23)	77.5% vs. 39.1%	0.002	NS
Marfan syndrome	23.1% vs. 40.0% (3/13 vs. 20/50)	76.9% vs. 60.0%	NS	NS
Operative procedure				
Root replacement	5.9% vs. 47.8% (1/17 vs. 22/46)	94.1% vs. 52.2%	0.002	NS
Total arch replacement	69.2% vs. 28.0% (9/13 vs. 14/50)	30.8% vs. 72.0%	0.009	NS
Early postoperative features				
Early postoperative aortic diameter (mm)	33.4±3.6	34.1±4.3	NS	NS
Early postoperative TL width (mm)	20.6±5.1	15.3±5.4	< 0.001	NS
Early postoperative FL width (mm)	12.9±4.5	18.8±5.3	< 0.001	NS
Early postoperative TL ratio (TL width/aortic diameter, %)	61.5±13.2	44.8±14.6	< 0.001	NS
Early postoperative FL thrombosis	86.7% vs. 20.8% (13/15 vs. 10/48)	13.3% vs. 79.2%	< 0.001	NS
Favorable early postoperative change	69.0% vs. 8.6% (20/29 vs. 3/35)	31.0% vs. 91.4%	< 0.001	0.032
Thrombosis or resolution of FL adjacent to distal anastomosis	59.0% vs. 0% (23/39 vs. 0/24)	41.0% vs. 100.0%	< 0.001	NS
Follow-up interval (mo)	30.6±21.3	31.3±20.7	NS	NS

NS, not significant; TL, true lumen; FL, false lumen.



	Patients						
Favorable early change	27	19	15	14	9	4	2
No favorable early change	28	24	18	10	9	7	6

Fig. 5. Aneurysm-free survival rates for patients with early favorable changes (solid line) versus those without early favorable changes (dotted line).

spectively (Fig. 3). Complete thrombosis or resolution of the proximal descending false lumen occurred in 42.9% of the patients in the late images (Fig. 4). Favorable early changes in the proximal thoracic aorta were the only factor that was found by multivariate analysis to have a statistically significant association with later improvement (Table 2). The

seven-year aneurysm-free survival rate was higher in patients with favorable early changes (78.0%) than in patients with stable or unfavorable early changes (63.6%) (Fig. 5).

DISCUSSION

Current discussions regarding the management of acute type A dissection involve the following issues: (1) determining strategies and techniques for improving early outcomes, including cerebral protection and hemostasis; (2) identifying the optimal strategy for high-risk patients, such as patients aged 80 years and older and patients with severe malperfusion; and (3) determining what extent of surgical replacement is necessary to ensure improved long-term prognoses. With regard to issue (3), no compelling evidence supports the long-term benefit of total arch replacement compared to less extensive replacement procedures such as replacement of the ascending aorta or hemiarch. However, many surgeons seem to believe that more extensive replacement procedures are generally preferable. Even more controversy exists about whether even more extensive surgical procedures, such as the FET procedure, are generally beneficial. The basis for such debates

is the extremely unfavorable long-term prognosis of acute type A dissection. Approximately 20%–40% of patients have been reported to require a at least one more operation for a descending aortic aneurysm in the 5–10 year period after the initial repair of an acute type A dissection [1-5]. When patients who did not undergo surgical intervention are included, the operation rate has been reported to be high as 60% within 10 years after the initial treatment [5].

Most previous studies have focused on unfavorable changes in the descending aorta, and the residual patent false lumen has been identified as a common risk factor for faster descending aortic dilatation [4,5,9-12]. In our previous study, we attempted to determine whether immediate postoperative characteristics are predictive of the later long-term outcome of the descending aortic false lumen. The data from that study showed not only a high incidence of descending aortic dilatation (45.7%) after repair of acute type A dissection, but also showed shrinkage or even the complete resolution of the thoracic false lumen in some patients (29.5%). Corresponding to the findings of other reports, early postoperative thrombosis of the false lumen was found to be a positive prognostic factor [8]. In the present study, favorable remodeling of the proximal descending false lumen occurred in more than one third of patients after conventional repair of acute type A dissection without FET. For the most part, positive remodeling was found to begin with favorable early changes, which were significantly associated with thrombosis of the juxta-anastomotic false lumen.

Bachet et al. [13] reported that the presence of Marfan syndrome favors secondary dilatation of the descending aorta independently from the presence of a patent false lumen. Immer et al. [14] identified the following factors to be significantly predictive of secondary aortic dilatation: the extent of the aortic dissection, the involvement of supra-aortic branches or malperfusion, the presence of a patent false lumen, and an enlarged diameter of the descending aorta. In contrast, in the present study, preoperative aortic diameter, preoperative features of the false lumen, and the presence of Marfan syndrome were not found to be statistically significant factors associated with postoperative changes in the descending aorta. The discrepancies between these two studies might have resulted from the following characteristics of our study pop-

ulation: (1) only a few patients had a large (diameter >40 mm) descending aorta preoperatively, (2) patients with extensive preoperative thrombosis at the false lumen (intramural hematoma) were excluded, (3) the number of patients with Marfan syndrome was not large enough for an adequate statistical analysis.

Pressurization of the remaining false lumen and subsequent dilatation after surgical repair of type A dissection may be caused by the following factors: (1) a newly developed iatrogenic tear at the anastomotic site; (2) a persistent intimal tear remaining at the unresected aortic arch or the descending thoracic aorta; (3) a primary tear at the distal aorta in the case of retrograde type A dissection; and (4) a re-entry tear at the far distal aorta, most frequently observed around the visceral branches [15-19]. The experience of the surgeon as well as the specific surgical techniques employed could affect such factors, thereby altering the prognosis of the remaining false lumen. In order to avoid creating new iatrogenic intimal tears at the distal anastomosis site through large needle holes or cut-through of the intimal flap, we believe that attention should be paid to meticulous handling and the use of proper methods of buttressing the internal suture lines with inverted adventitia, Teflon felt, or strips of vascular graft. For total arch replacement, we prefer inserting a short sleeve of surgical graft into the true lumen to exclude small intimal tears adjacent to the anastomosis [16]. In almost all patients in our series in whom this short surgical elephant trunk was used, the juxta-anastomotic and adjacent false lumen underwent favorable postoperative changes, which corresponds to previously reported results [18].

We believe that it is beneficial for the long-term prognosis to resect all tears found in the aortic arch and performing total or partial arch replacement, as long as the surgeon is confident that the risk does not differ between ascending aorta replacement and total arch replacement [20-24]. As a shorter suture line made at a smaller stump may have less expansile surface tension, resulting in a lower chance of a new intimal tear, it is advisable to replace the entire ascending aorta, which is almost always dilated in patients with dissection. For the same reason, we prefer partial arch replacement, with an anastomosis made in the middle of the arch perpendicularly to the long axis, for patients with an arch tear, even if

it is considered manageable by hemiarch replacement with a long suture line. We also tend to replace transverse arches larger than 3.5–4.0 cm, especially in young patients.

In the case of primary or re-entry tears located in the thoracic part of the descending aorta, the FET technique can be beneficial. It has been reported that 90% or more of patients who underwent a FET procedure showed complete thrombosis of the proximal thoracic false lumen [6,7]. Favorable outcomes after the FET procedure may be attributable not only to the exclusion of re-entry tears, but also to a more hemostatic distal anastomosis, which also can be achieved using a short surgical elephant trunk. Despite the advantages of the FET technique in remodeling the descending false lumen, further risk-benefit analysis assessing the rate and severity of complications is needed before this technique is adopted as a routine procedure [25-27]. Intraoperative transesophageal echocardiography, intraoperative aortography in a hybrid operating room, and examination with an angioscope during circulatory arrest may be helpful in identifying the patients who can most benefit from the FET procedure.

The present study has several limitations. First, it is subject to all the limitations of a retrospective, nonrandomized study. Second, the follow-up duration was not long enough to show long-term changes in the descending aorta. Third, the study population was relatively small. As the number of patients and the length of follow-up continue to increase, we expect that differences in the aneurysm-free survival rate depending on early postoperative changes in the proximal thoracic aorta may become more evident. Despite the above limitations, we conclude that favorable remodeling of the proximal descending false lumen may occur in more than one third of patients after conventional repair of acute type A dissection, even without a FET. For the most part, positive remodeling started immediately after surgery and was associated with thrombosis of the juxta-anastomotic false lumen. This finding suggests that long-term outcomes may be significantly improved by refinement of surgical techniques or strategies to avoid making or leaving large intimal tears at or adjacent to the anastomosis.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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