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Role of False Lumen Area Ratio in Late Aortic Events After Acute Type I Aortic Dissection Repair

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ABSTRACT

BACKGROUND The aim of this study was to investigate whether distal aortic maximum false lumen area (MFLA) ratio predicts late aortic dilation and reintervention after open repair of acute type I aortic dissection.

METHODS We analyzed 309 nonsyndromic acute type I aortic dissection patients who were treated with a repair to the proximal aorta between 1994 and 2017. In 230 patients who did not show completely thrombosed false lumen on postoperative computed tomography, the MFLA ratio (MFLA/aortic area) on the descending thoracic aorta (DTA) was measured with postoperative computed tomography. Patients were divided into 3 groups according to the quartile range of MFLA ratio: low MFLA, <0.62 (n = 57); intermediate MFLA, 0.62 to 0.81 (n = 116); and high MFLA, ≥0.82 (n = 57).

RESULTS The aortic expansion rate was significantly higher in the high MFLA group (11.1 ± 21.2 mm/y) compared with intermediate (3.0 ± 7.4 mm/y; *P* < .01) and low (0.6 ± 6.6 mm/y; *P* < .01) MFLA groups. High MFLA was found to be an independent risk factor for significant aortic expansion (adjusted hazard ratio, 5.26; 95% CI, 1.53-18.12; *P* < .01) and aorta-related reintervention (hazard ratio, 4.99; 95% CI, 2.23-11.13; *P* < .01), and the MFLA ratio was significantly related to proximal DTA reentry tears (adjusted odds ratio, 12974.3; *P* < .001; area under curve, 0.807).

CONCLUSIONS A high MFLA ratio on the DTA after acute type I aortic dissection repair is associated with increased risk of late aortic reintervention and distal aortic dilation. A high MFLA ratio is strongly associated with proximal DTA reentry tears.

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Acute type A aortic dissection (ATAAD) is one of the most life-threatening cardiovascular events and requires immediate open surgical repair; the primary objective of surgical procedures to treat ATAAD is to excise the primary entry tear, with recommended "tear-oriented surgery."[1] As surgical outcomes of ATAAD have steadily improved, late complications after surgical repair have also been recognized as an important issue in addition to survival without stroke or end-organ malperfusion.[2] Most of the long-term problems originate from distal aorta dilation caused by lack of an excised entry tear or large reentry tear of the proximal descending thoracic aorta (DTA) and a distal patent false lumen.[3-5]

The importance of distal aortic false lumen after ATAAD repair for late complications has been reported in multiple studies.[5-7] Moreover, 1 study reported that thoracic endovascular aortic repair (TEVAR) was associated with improved 5-year aorta-specific survival and delayed disease progression, even in the case of uncomplicated type B aortic dissection.[8] However, most studies of false lumen after ATAAD repair focused on the thrombosis status or diameter of the false lumen.[5,7]

The Supplemental Figures can be viewed in the online version of this article [https://dx.doi.org/10.1016/j.athoracsur.2022.03.054] on http://www.annalsthoracicsurgery.org.

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Because false lumen of the aorta has complex, dynamic, and 3-dimensional features, such studies could not accurately reflect the features of a false lumen. We hypothesized that a high false lumen area ratio is associated with adverse effects of distal aortic dilation and aorta-related events. We therefore investigated whether the distal aortic maximum false lumen area (MFLA) ratio could predict late aortic dilation or reintervention after open repair of nonsyndromic acute type I aortic dissection and the association between the MFLA ratio and reentry tears.

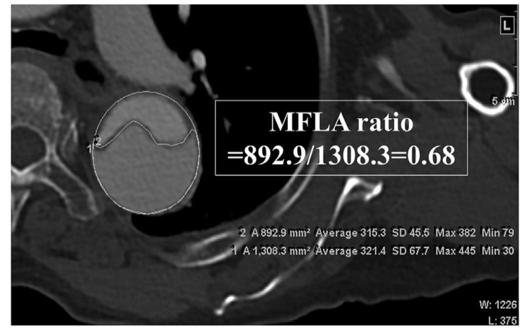

FIGURE 1 The maximum false lumen area (MFLA) ratio was calculated by dividing the false lumen area by the descending thoracic aortic area on the immediate postoperative computed tomography scan.

PATIENTS AND METHODS

This retrospective study was approved by the Institutional Review Board of Yonsei University Health System, Severance Hospital (4-2020-0383). The requirement for patient consent was waived because courses of treatment were unchanged and the study database was designed to protect the patients' anonymity.

STUDY POPULATION. Between January 1994 and December 2017, 542 patients underwent open repair for ATAAD in our institution. We excluded patients who had type II aortic dissection (n = 108), patients who had Marfan syndrome (n = 42), and patients who did not have available immediate postoperative computed tomography (CT) before discharge (n = 83). Patients who had completely thrombosed false lumen or partially thrombosed false lumen, in which the false lumen was not clearly identified on the DTA, were also excluded (n = 79). Finally, 230 patients who underwent open repair for nonsyndromic acute type I aortic dissection and who had patent false lumen of the DTA on immediate postoperative CT were enrolled in this study.

The patients were divided into 3 groups according to the quartile range of the MFLA ratio (Supplemental Figure 1): low MFLA, <0.62 (n = 57); intermediate MFLA, 0.62 to 0.81 (n = 116); and high MFLA, ≥0.82 (n = 57). The MFLA ratio was defined as the maximum value calculated by dividing the false lumen area by the DTA area on the immediate postoperative CT scan (Figure 1) using the area measurement tool of the Centricity PACS Radiology RA1000 Workstation (GE Healthcare).

CT SURVEILLANCE. All enrolled patients were assessed by immediate postoperative CT before discharge. Axial images were obtained in serial 1.0- to 2.5-mm-thick sections. The MFLA ratio and number and location of reentry tears connecting the true lumen and false lumen were recorded for all patients. The proximal DTA was defined as extending from the left subclavian artery to the left upper pulmonary vein level. Patients were followed up by CT at our outpatient clinic 6 to 12 months after hospital discharge and annually thereafter. The maximum aortic diameter was measured, and the false lumen was examined by the same procedures used for predischarge CT. The MFLA ratio was measured by a single radiologist who was not related to this study to ensure objectivity and consistency.

SURGICAL PROCEDURES. The principal objective of our surgical strategy for treating acute type I aortic dissection was to excise the primary entry tear. In addition, for patients who had an enlarged aortic arch (≥45 mm), Marfan syndrome, or malperfusion of supra-aortic arteries, total arch replacement proceeded regardless of location of the primary entry tear. Hemiarch replacement included the aortic arch on the lesser curvature beyond the level of the innominate artery but not the aortic arch on the greater curvature. Partial arch replacement required reconstruction of only the innominate artery or both the innominate and left carotid arteries. Total arch replacement involved the entire aortic arch, with the arch branch vessels being reimplanted with individual 4-branched grafts.

Arterial cannulation sites were determined according to patient status, preoperative organ malperfusion, and preference of the surgeon; however, the right axillary artery was the most frequent choice, followed by the femoral artery. Total circulatory arrest with antegrade cerebral perfusion was used for all enrolled patients. Since 2008, total circulatory arrest with mild hypothermia (≥28 °C) has been the basic strategy. Proximal and distal anastomosis was reinforced with double-layered (inside and outside) Teflon felt.

DATA COLLECTION AND OUTCOME MEASUREMENTS. Preoperative and perioperative data and postoperative early outcomes were collected retrospectively from databases at our institution. Postoperative follow-up data were collected by review of medical records, patient telephone interviews, and

TABLE 1 Baseline Characteristics

Variables	High MFLA (n = 57)	Intermediate MFLA (n = 116)	Low MFLA (n = 57)	*P* value
Age, y	47.2 ± 12.7	56.2 ± 12.4	67.3 ± 10.6	<.001
Male	70 (70.2)	68 (58.6)	22 (38.6)	.002
BSA, m^2	1.83 (1.68-2.00)	1.81 (1.66-1.90)	1.59 (1.47-1.71)	<.01
Hypertension	33 (57.9)	82 (70.7)	49 (86.0)	.004
Diabetes mellitus	1 (1.8)	7 (6.0)	9 (15.8)	.017
Chronic kidney disease	9 (15.8)	23 (19.8)	18 (31.6)	.096
Dyslipidemia	5 (8.8)	9 (7.8)	3 (5.3)	.761
Stroke	3 (5.3)	11 (9.5)	7 (12.3)	.422
COPD	2 (3.5)	4 (3.4)	9 (15.8)	.011
PAOD	3 (5.3)	2 (1.7)	3 (5.3)	.391
CAOD	8 (14.0)	11 (9.5)	12 (21.1)	.110
Preoperative shock	4 (7.0)	11 (9.5)	9 (15.8)	.276
Previous cardiac operation	8 (14.0)	9 (7.8)	4 (7.0)	.329
pDTA reentry tear[a]	47 (82.5)	62 (53.4)	6 (10.5)	<.001
Number of reentry tears[a]	3.3 ± 1.8	2.4 ± 1.6	0.7 ± 1.0	<.001
Maximum DTA diameter[a]	37.0 (32.0-43.0)	36.0 (32.0-41.0)	35.0 (33.0-39.0)	.387

[a]On immediate postoperative computed tomography. Data are presented as median (interquartile range), mean ± SD, and number (%). BSA, body surface area; CAOD, coronary artery occlusive disease; COPD, chronic obstructive pulmonary disease; MFLA, maximum false lumen area; PAOD, peripheral artery occlusive disease; pDTA, proximal descending thoracic aorta.

cause of death statistics provided by Statistics Korea. Collection of long-term outcome data was completed for all patients. The mean follow-up duration was 9.7 ± 6.2 years (median, 9.3 years; interquartile range [IQR], 3.7-14.4 years), and the mean CT follow-up duration was 6.9 ± 5.5 years (median, 5.2 years; IQR, 1.7-9.6 years).

The study end points were aortic expansion rate, significant aortic expansion, aorta-related reintervention, and all-cause death. Significant aortic expansion was defined as the last follow-up maximum aortic diameter ≥1.5 times the immediate postoperative maximum aortic diameter or an aortic expansion rate ≥10 mm/y. Aorta-related reintervention included aorta reoperation, TEVAR, endovascular aneurysm repair, and a hybrid procedure.

STATISTICS. All data are expressed as the mean ± standard deviation or frequency and percentage. The Shapiro-Wilk test was used for normality tests. If continuous variables were not normally distributed, they were expressed as median and IQR. Continuous variables were compared using the 1-way analysis of variance, applying Pearson χ^2 test or Fisher exact test for categorical variables between the 3 groups. If continuous variables were not normally distributed, the Kruskal-Wallis test was used to compare the continuous variables between the 3 groups.

Long-term survival, freedom from aorta-related reintervention, and significant aortic expansion were analyzed using the Kaplan-Meier method. The log-rank test was used to compare differences between survival curves. The Cox proportional hazards regression model was used to identify risk factors of aorta-related reintervention and significant aortic expansion. The logistic regression model and receiver operating characteristic curve were used to verify associations between the MFLA ratio and location of the reentry tear. In all tests, statistical significance was defined as a *P* value < .05. Statistical analyses were performed using SPSS statistical software for Windows version 25.0 (IBM).

RESULTS

Preoperative baseline characteristics of the patients are described in Table 1. In the high MFLA group, patients were younger, and there were more men. Patients in the high MFLA group also had larger body surface area, and fewer patients had hypertension and diabetes mellitus. Chronic obstructive pulmonary disease was more common in the low MFLA group. On CT scans performed immediately after operation, significantly more reentry tears in the proximal DTA were found in the high MFLA group than in the intermediate and low groups (82.5%, 53.4%, and 10.5%, respectively; $P < .01$). The number of reentry tears was also higher in the high MFLA group, with an average of 3.3, compared with the intermediate and low groups, with averages of 2.4 and 0.7, respectively ($P < .01$). Axillary artery cannulation was used to a similar extent in all 3 groups (54.4%, 53.5%, and 54.4%, respectively; $P = .99$). The high MFLA group showed a tendency to undergo more total arch replacement (26.3%), whereas the low group showed a tendency to undergo more hemiarch replacement (78.9%), although the difference was not statistically significant ($P = .14$) (Supplemental Figure 2).

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TABLE 2 Surgical Data

Variables	High MFLA (n = 57)	Intermediate MFLA (n = 116)	Low MFLA (n = 57)	*P* value
Emergent operation	55 (96.5)	111 (95.7)	52 (91.2)	.500
Concomitant operation	26 (45.6)	40 (34.5)	14 (24.6)	.061
Root replacement	13 (22.8)	19 (16.4)	5 (8.8)	.124
Aortic valve operation	15 (26.3)	21 (18.1)	11 (19.3)	.655
Mitral valve operation	0 (0.0)	3 (2.6)	0 (0.0)	.432
Coronary artery bypass	4 (7.0)	8 (6.9)	4 (7.0)	>.999
Others	1 (1.8)	3 (2.6)	1 (1.8)	.809
Axillary cannulation	31 (54.4)	62 (53.5)	31 (54.4)	.990
Type of operation				.137
Hemiarch	36 (63.2)	77 (66.4)	45 (78.9)	
Partial arch	6 (10.5)	8 (6.9)	6 (10.5)	
Total arch	15 (26.3)	31 (26.7)	6 (10.5)	
Classic elephant trunk insertion	2 (3.5)	5 (4.3)	2 (3.5)	>.999
CPB time, min	201.5 (150.8-281.5)	220.0 (167.5-295.0)	179.4 (140.5-217.5)	.009
ACC time, min	112.0 (89.0-160.0)	129.0 (100.5-181.0)	97.5 (73.5-124.5)	.001
TCA time, min	38.0 (26.0-52.0)	47.0 (34.0-65.0)	36.5 (27.0-50.3)	.022
Lowest BT, °C	26.1 (18.9-28.0)	24.9 (19.2-28.0)	28.0 (24.8-28.1)	.027
In-hospital death	5 (8.8)	16 (13.8)	9 (15.8)	.508

Data are presented as number (%) or median (interquartile range). ACC, aortic cross-clamp; BT, body temperature; CPB, cardiopulmonary bypass; MFLA, maximum false lumen area; TCA, total circulatory arrest.

No patient underwent a frozen elephant trunk procedure or concomitant antegrade stent implantation. In-hospital death was 13.0% (8.8% in the high group, 13.8% in the intermediate group, and 15.8% in the low group; *P* = .51). The surgical data are summarized in Table 2.

LATE AORTIC DILATION. Figure 2A shows the mean maximum aortic diameter change on the last follow-up CT scan compared with the immediate postoperative scan. This value increased from 39 mm to 54.3 mm in the high MFLA group and from 37.6 mm to 45.1 mm in the intermediate group. However, the low group showed no difference, with the postoperative scan showing 35 mm and the last follow-up scan showing 34.9 mm. The average annual aortic expansion rate was 11.1 ± 21.2 mm/y in the high group, 3.0 ± 7.4 mm/y in the intermediate group, and 0.6 ± 6.6 mm/y in the low group (*P* < .01; Figure 2B). The freedom from

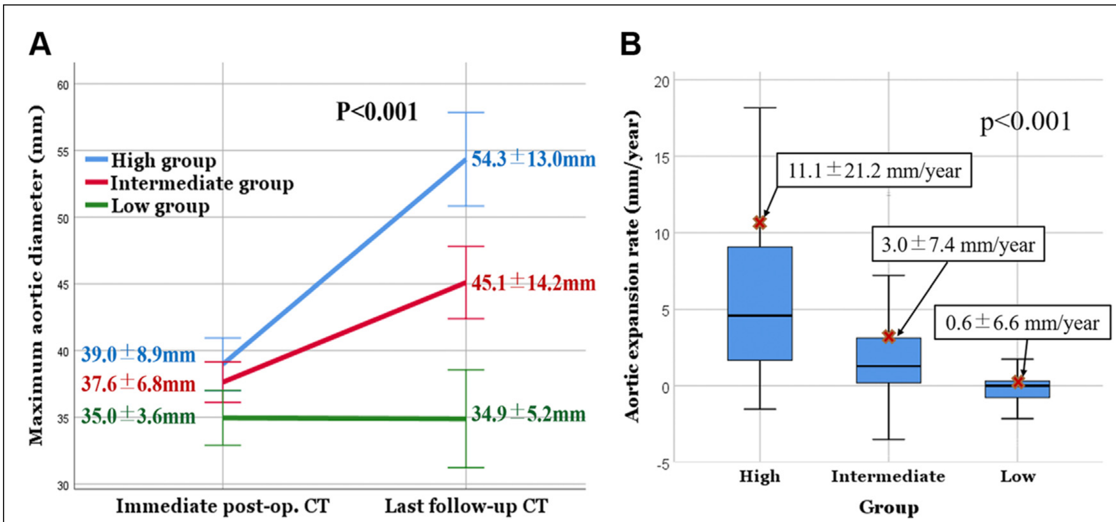

FIGURE 2 (A) Change in maximum aortic diameter on the last follow-up computed tomography (CT) scan compared with the immediate postoperative scan for high, intermediate, and low maximum false lumen area groups. (B) Average annual aortic expansion rate.

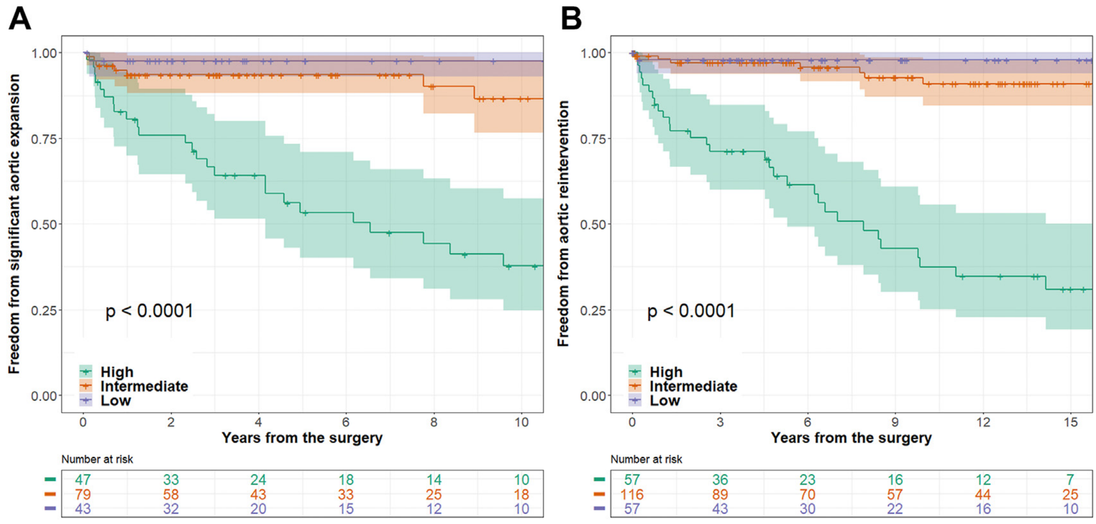

FIGURE 3 (A) Freedom from significant aortic expansion rate curves and (B) freedom from aortic reintervention rate curves for the high maximum false lumen area (MFLA) group (green line), the intermediate MFLA group (orange line), and the low MFLA group (purple line) using the Kaplan-Meier method with 95% CIs.

significant aortic expansion rate at 10 years was significantly lower in the high MFLA group (37.7% ± 8.1%) than in the intermediate (86.6% ± 5.4%; $P < .01$) or low (97.6% ± 2.4%; $P < .01$) group (Figure 3A). Multivariate regression analysis showed that a high MFLA ratio (hazard ratio [HR], 3.97; 95% CI, 1.86-8.52; $P < .01$) and proximal DTA reentry tear (HR, 5.26; 95% CI, 1.53-18.12; $P < .01$) were independent risk factors for significant aortic expansion (Table 3).

TABLE 3 Predictors of Significant Aortic Expansion and Aorta-Related Reintervention

	Univariate		Multivariate	
Variables	HR (95% CI)	*P* value	HR (95% CI)	*P* value
Significant aortic expansion				
High MFLA ratio group	5.70 (3.02-10.74)	<.001	3.97 (1.86-8.52)	<.001
Proximal DTA reentry tear	7.05 (2.78-17.89)	<.001	5.26 (1.53-18.12)	.009
Age, per year	0.98 (0.95-1.00)	.018	–	–
BSA, per m^2	10.65 (2.37-47.93)	.002	–	–
PAOD	9.35 (2.19-39.82)	.003	–	–
Previous cardiac operation	2.62 (1.20-5.69)	.015	3.08 (1.27-7.52)	.013
Axillary cannulation	3.11 (1.52-6.37)	.002	–	–
Lowest BT, per °C	1.16 (1.06-1.27)	.001	1.23 (1.11-1.35)	<.001
Number of reentry tears	1.29 (1.11-1.51)	.001	–	–
Aorta-related reintervention				
High MFLA ratio group	11.93 (5.84-24.40)	<.001	5.25 (2.28-12.08)	<.001
Proximal DTA reentry tear	10.41 (3.70-29.45)	<.001	3.31 (1.06-10.30)	.039
Age, per year	0.93 (0.91-0.96)	<.001	0.97 (0.94-0.99)	.022
HTN	0.49 (0.67-0.91)	.025	–	–
PAOD	4.86 (1.17-20.27)	.030	7.64 (1.56-37.48)	.012
Previous cardiac operation	3.17 (1.51-6.69)	.002	–	–
Number of reentry tears	1.45 (1.24-1.70)	<.001	–	–
Maximum DTA diameter, per mm	1.05 (1.02-1.09)	.002	–	–

BSA, body surface area; BT, body temperature; DTA, descending thoracic aorta; HR, hazard ratio; HTN, hypertension; MFLA, maximum false lumen area; PAOD, peripheral artery occlusive disease.

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TABLE 4 Late Results

Variables	High MFLA (n = 57)	Intermediate MFLA (n = 116)	Low MFLA (n = 57)	P value
Late death	9 (15.8)	15 (12.9)	4 (7.0)	.337
Overall death	15 (26.3)	31 (26.7)	13 (22.8)	.850
Aorta-related reintervention	31 (54.4)	9 (7.8)	1 (1.8)	<.001
DTA reintervention	29 (50.9)	9 (7.8)	1 (1.8)	<.001
Reoperation	20 (35.1)	4 (3.4)	0 (0.0)	<.001
TEVAR	11 (19.3)	6 (5.2)	1 (1.8)	.001
Hybrid	2 (3.5)	1 (0.9)	0 (0.0)	.305
AA reintervention	1 (1.8)	1 (0.9)	0 (0.0)	.747

Data are presented as number (%). AA, abdominal aorta; DTA, descending thoracic aorta; MFLA, maximum false lumen area; TEVAR, thoracic endovascular aortic repair.

AORTA-RELATED REINTERVENTION. The overall mortality was not significantly different in the 3 groups. Aorta-related reintervention, especially DTA reintervention, including reoperation and TEVAR, was performed significantly more in the high group compared with the intermediate and low groups. Late clinical outcomes are described in detail in Table 4. The median duration of reintervention was 6.5 years (IQR, 2.6-13.4 years) from the initial proximal repair. The freedom from aortic reintervention rate at 15 years was significantly lower in the high MFLA group (30.9% ± 7.6%) than in the intermediate (91.0% ± 3.4%; $P < .01$) or low (97.9% ± 2.1%; $P < .01$) group (Figure 3B). Multivariate regression analysis showed that high MFLA ratio (HR, 5.25; 95% CI, 2.28-12.08; $P < .01$) and proximal DTA reentry tear (HR, 3.31; 95% CI, 1.06-10.30; $P = .04$) were independent risk factors for aorta-related reintervention (Table 3).

MFLA RATIO AND PROXIMAL DTA REENTRY TEAR. Figure 4A shows the probability of proximal DTA reentry tear related to the MFLA ratio using logistic regression. It shows that MFLA ratio is a significant predictive value for DTA reentry tear (odds ratio, 12974.3; 95% CI, 155.1-1085003.5; $P < .01$). The receiver operating characteristic curve also showed a relatively high area under the curve value (0.81; $P < .01$) between proximal DTA reentry tear and MFLA ratio.

COMMENT

Distal aortic false lumen after ATAAD repair has been known to play an important role in determining the need for late aortic reintervention. A patent false lumen and larger false lumen diameter are recognized as risk factors for late reintervention because they are likely to lead to distal aorta enlargement,[5-7,9] and a proximally located reentry tear in the DTA was also associated with an increased risk of late aorta-related reintervention and distal aortic dilation.[4] The large false lumen and a proximally located reentry tear indicate the high pressure in the false lumen and persistent high flow throughout the patent false lumen of the proximal DTA, increasing aortic wall tension and aggravating the aortic aneurysmal dilation.[4,10]

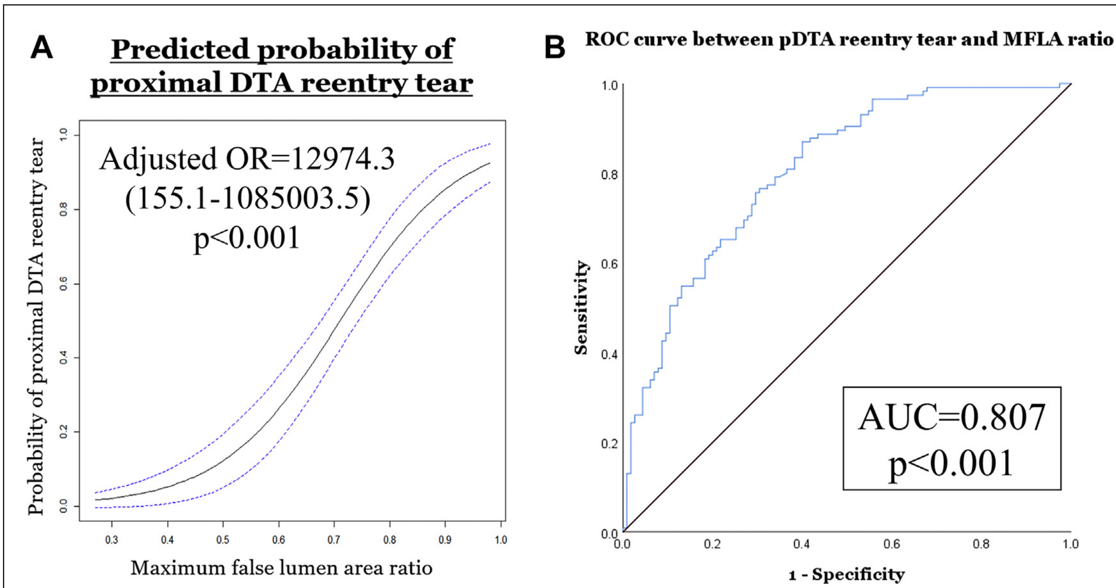

FIGURE 4 (A) Predicted probability of proximal descending thoracic aorta (DTA) reentry tear for the maximum false lumen area (MFLA) ratio using logistic regression. (B) Receiver operating characteristic (ROC) curve between proximal DTA (pDTA) reentry tear and the MFLA ratio. (AUC, area under curve; OR, odds ratio.)

Our study showed that the proximally located reentry tear is significantly associated with large false lumen. After the primary entry tear is resected, blood flow into the false lumen is dependent on the blood flow from the reentry tear and is affected by multiple factors, such as entry size and number, as well as by the location of false lumen.[10,11] Several experimental and clinical studies showed that proximally located reentry tears on the DTA played a major role in false lumen pressure affecting false lumen size.[12-14] Shi and colleagues[14] investigated the influence of hemodynamics on ATAAD with different tear sizes and locations, supporting our result. Using computational fluid dynamics, they demonstrated that the intimal tear location significantly altered the hemodynamic characteristics and that false lumen wall pressure was higher than true lumen wall pressure when the intimal tear was proximally located, causing continual expansion of the false lumen and compression of the true lumen.

Our results may serve as preliminary data supporting extended distal aortic intervention for residual aortic dissection after ATAAD repair (eg, preemptive TEVAR or concomitant frozen elephant trunk) for patients at high risk of late aortic events. There have been 2 randomized studies of preemptive TEVAR for uncomplicated type B aortic dissection. Nienaber and colleagues[8] reported a benefit of TEVAR in addition to optimal medical treatment for all-cause mortality (0% vs 16.9%; $P = .0003$), aorta-specific mortality (0% vs 16.9%; $P = .0005$), and disease progression (4.1% vs 28.1%; $P = .004$). Another study also reported remodeling with thrombosis of the false lumen and reduction of its diameter induced by the preemptive TEVAR.[15] Based on these findings, Iida and colleagues[16] reported the results of preemptive TEVAR for residual distal aortic dissection after ATAAD repair. Technical success of TEVAR was 100%, and all patients were alive during the postoperative follow-up period (21 ± 15 months) without aorta reintervention. They concluded that aggressive coverage of the DTA by extended TEVAR might prevent aortic events in the future and play an important role in achieving preemptive treatment for the downstream aorta.

The frozen elephant trunk procedure and antegrade stent implantation at the time of initial repair for ATAAD have been recognized as viable options for extended distal aortic intervention in terms of survival and freedom from reintervention.[17-19] One of the most dreadful drawbacks of the frozen elephant trunk procedure is spinal cord ischemia due to occlusion of the excessive intercostal arteries or thromboembolism.[20,21] As experience with the frozen elephant trunk procedure has accumulated, important risk factors of spinal cord ischemia, such as extensive length of stent and insufficient collateral development of the intercostal artery in patients with history of abdominal aortic aneurysm repair, have been reported in several studies.[20,22] Therefore, recent studies showed that the frozen elephant trunk procedure did not increase the risk of spinal cord ischemia in selected patients by avoiding extensive stent length.[23,24]

This study was limited by its retrospective design. We used multivariate regression to adjust the risk factors; however, selection bias or unidentified confounding variables may have influenced the results despite these precautions. Moreover, 312 (57.5%) patients who received ATAAD repair were excluded because of the study design and lack of postoperative CT data. Thus, it is not representative of the whole population, and CT follow-up duration was relatively short compared with the clinical follow-up duration. The size of reentry tear could be an important prognostic factor for late aortic events as known from type B aortic dissection. However, our study could not investigate the size of the reentry tear because of the quality of the old images. The suture site or anastomotic tear of distal anastomosis could contribute to late aortic outcomes, but there were no data about that in our study because it was difficult to define objectively on the image. There were 30 patients (13.0%) who died during hospitalization, and these patients could be potential confounding factors for long-term aortic events. Postoperative medications such as beta blockers, blood pressure, and smoking status are important prognostic factors for aortic expansion or aortic events; however, this information was not available for all patients in this study.

In conclusion, our study showed that a larger false lumen area because of persistent high pressure in the false lumen played an important role in terms of long-term aortic events after open repair of nonsyndromic acute type I aortic dissection. A high MFLA ratio on the distal aorta after acute type I aortic dissection repair was associated with increased risk of late aortic reintervention and distal aortic dilation, and a high MFLA ratio was strongly associated with a proximal DTA reentry tear. Further research should be carried out to confirm the impact of false lumen area, location of reentry tears, and false lumen pressure on late aortic events after acute type I aortic dissection repair. This study may serve as preliminary evidence supporting extended distal aortic interventions, such as preemptive TEVAR, concomitant frozen elephant trunk procedure, or antegrade stent insertion for residual aortic dissection, after ATAAD repair for patients at high risk of a late aortic event.

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Preventing Large Residual False Lumen: Next Step in Evolution of Surgical Treatment of Debakey Type I Dissection

INVITED COMMENTARY:

Historically standard emergency open surgical repair of Debakey Type I dissections has focused on resecting the ascending aorta and addressing proximal complications to survive a catastrophic medical condition. The fact that the residual aorta almost always remained dissected was accepted by surgeons because they knew if the residual dissected aortic exhibited aneurysm formation, redo aortic surgery, although complicated, could be done at an elective setting. Over the past decade improved operative mortality rates for emergency repair of Debakey Type I dissections have led innovative surgeons to take interest in extending the extent of aortic repair at the time of the initial operation to address both acute malperfusion and long-term aneurysm formation.

In this issue of *The Annals of Thoracic Surgery*, Kim and colleagues[1] explore the implication of a residual false lumen after open surgery for Debakey Type 1 dissection. Study methodology involved a retrospective review of 309 Debakey Type 1 dissection patients over 25 years. Patients with Marfan disease and no immediate