Acute aortic dissections with entry tear in the arch: A report from the International Registry of Acute Aortic Dissection

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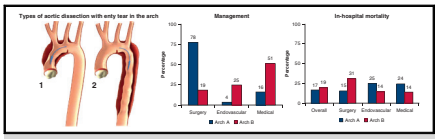
ABSTRACT

Objective: To analyze presentation, management, and outcomes of acute aortic dissections with proximal entry tear in the arch.

Methods: Patients enrolled in the International Registry of Acute Aortic Dissection and entry tear in the arch were classified into 2 groups: arch A (retrograde extension into the ascending aorta with or without antegrade extension) and arch B (only antegrade extension into the descending aorta or further distally). Presentation, management, and in-hospital outcomes of the 2 groups were compared.

Results: The arch A (n = 228) and arch B (n = 140) groups were similar concerning the presence of any preoperative complication (68.4% vs 60.0%; $P = .115$), but the types of complication were different. Arch A presented more commonly with shock, neurologic complications, cardiac tamponade, and grade 3 or 4 aortic valve insufficiency and less frequently with refractory hypertension, visceral ischemia, extension of dissection, and aortic rupture. Management for both groups were open surgery (77.6% vs 18.6%; $P < .001$), endovascular treatment (3.5% vs 25.0%; $P < .001$), and medical management (16.2% vs 51.4%; $P < .001$). Overall in-hospital mortality was similar (16.7% vs 19.3%; $P = .574$), but mortality tended to be lower in the arch A group after open surgery (15.3% vs 30.8%; $P = .090$), and higher after endovascular (25.0% vs 14.3%; $P = .597$) or medical treatment (24.3% vs 13.9%; $P = .191$), although the differences were not significant.



Classification, management, and in-hospital mortality of acute aortic dissections with primary entry tear in the arch.

Central Message

Acute aortic dissections with primary entry tear in the arch are managed with open surgery when there is retrograde extension, whereas antegrade extension is treated with a patient-specific approach.

Perspective

Although current guidelines suggest surgical repair for all acute aortic arch dissections, in current practice only those dissections with retrograde extension into the ascending aorta are commonly treated with open surgery, whereas arch dissections with extension into the descending aorta and no ascending involvement are treated endovascularly or medically, if uncomplicated.

See Editorial Commentary page 74.

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Abbreviations and Acronyms
AAD = acute aortic dissection
ET = entry tear
IRAD = International Registry of Acute Aortic Dissections

Conclusions: Acute aortic dissection patients with primary entry tear in the arch are currently managed by a patient-specific approach. In choosing the management type of these patients, it may be advisable to stratify them based on retrograde or only antegrade extension of the dissection.
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Optimal management of acute dissections generally depends on the location and extent of the dissection, and its associated complications.[1-3] Currently, the most-used classification for acute dissection is the Stanford classification, in which Stanford type A refers to dissection involving the ascending aorta and the aortic arch, whereas Stanford type B refers to dissections confined to the descending aorta.[2] Treatment of type A dissection typically requires immediate surgery, irrespective of the patient's clinical condition, whereas for type B dissection, endovascular or surgical methods are typically reserved for patients presenting with aortic aneurysms or clinical complications.[2,4,5]

For patients with acute aortic dissection (AAD) presenting with the proximal entry tear (ET) in the arch, most current guidelines suggest either surgical repair, or remain inconclusive on the optimal strategy.[4,5] For AAD with arch ET and involvement of the ascending aorta, an aggressive surgical approach, even including total arch replacement in the acute setting, is usually preferred.[6] However, when there is no ascending aorta involvement, ''immediate surgery would be recommended by some, if feasible and the patient is viable, [whereas] others would select medical management if the patient has only an arch dissection without proximal extension, malperfusion, or bleeding, as long as repeat imaging demonstrates stability.''[5] In current practice, aortic centers frequently approach AAD with ET in the arch with medical therapy in the absence of ascending aorta involvement. Such patients, sometimes characterized as ''non-A, non-B aortic dissection,''[7] are treated as a type B dissection.

The International Registry of Acute Aortic Dissection (IRAD) was developed in 1996 to provide more insight into the presentation, management, and outcomes of acute dissection.[8] After more than 20 years of enrolling patients, IRAD offers the opportunity to provide a comprehensive study of AAD with arch ET. The purpose of this study is to analyze treatment and outcomes of AAD with arch ET, comparing retrograde versus antegrade extension, to report current management, and to identify patterns in outcomes that may inform future practice.

METHODS

IRAD is an ongoing, multinational, multicenter registry that enrolls patients with AAD at 52 aortic centers. Its inception and structure has been described previously.[6] Patient and procedure-related data were collected using forms with 290 variables that are submitted to the IRAD coordinating center at the University of Michigan and checked for face and analytical validity. Institutional review committees at all participating IRAD institutions approved the study and all subjects gave informed consent.

Patients with AAD were identified either prospectively at presentation or retrospectively by searching hospital discharge diagnosis records and/or surgery, pathology, and imaging databases. The diagnosis was based on autopsy; surgical visualization; or imaging, which could be computed tomography, magnetic resonance imaging, or echocardiography. IRAD is an observational registry and the participating centers each have their own treatment strategy for patients with dissection; however, each participating center is an aortic center capable of offering the full range of surgical, endovascular, and medical treatment options.

For the present study, all patients enrolled in the registry from January 1996 through August 2017 were analyzed. Patients were excluded when data regarding ET location was not available or when multiple ETs were present. In addition, patients were excluded when data regarding the extent of the dissection was not reported. Based on the ET location and the extension of the dissection, patients were classified into 2 groups (Figure 1). The first group, arch A, consisted of patients with the ET in the aortic arch with retrograde extension into the ascending aorta with or without presence of antegrade extension (Figure 2). The second group, arch B, had an ET in the aortic arch, no ascending involvement, and antegrade extension into the descending and/or abdominal aorta, including those with isolated arch involvement (Figure 3). The 2 groups were compared regarding demographic characteristics, medical history, presence of complications at presentation, management, and in-hospital mortality. In-hospital mortality was defined as death during the initial hospitalization period for AAD.

Statistical Analysis

Data are shown as frequencies, percentages, mean ± standard deviation, or median (25th-75th percentile). Both groups were compared using χ^2 tests (or Fisher exact tests where appropriate) to analyze categorical variables. Student *t* test was used to analyze continuous variables with a normal distribution, and nonparametric tests of medians were used to analyze non-normally distributed categorical variables. Data analysis was performed by a statistician (DM) with the use of SPSS version 24.0 (IBM-SPSS Inc, Armonk, NY).

RESULTS

Baseline Characteristics

A total of 368 patients (248 men; mean age, 60.9 years) were included in this analysis (Figure 4). The arch A group consisted of 228 patients, the arch B group consisted of 140 patients. The 2 groups were not significantly different concerning demographic data or medical history (see Table 1). The median aortic diameter was typically larger at the level of the ascending aorta for arch A compared with arch B (4.7 vs 4.0 cm; $P < .001$), although it was not significantly different at the level of the arch (3.8 vs 3.7 cm; $P = .605$) or the descending aorta (3.5 vs 3.7 cm; $P = .089$). The incidence of any preoperative complication was similar in the groups (68.4% vs 60.0%; $P = .115$) but the types of

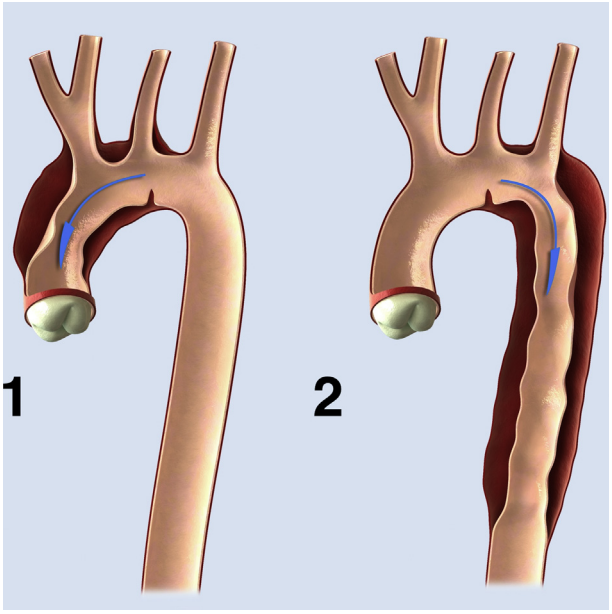

FIGURE 1. Acute aortic dissection with primary entry tear in the arch and retrograde extension into the ascending aorta, with or without extension into the descending aorta (arch A group, 1) or no ascending involvement and antegrade extension into the descending aorta or further distally (arch B group, 2).

complications were different (Table 1). The arch A group presented more commonly with shock (30.7% vs 15.0%; $P = .001$), neurologic complications (13.6% vs 5.7%; $P = .022$), cardiac tamponade (13.2% vs 0.0%; $P < .001$), and grade 3 or 4 aortic valve insufficiency (5.3% vs 0.7%; $P = .021$) and less frequently with refractory hypertension (0.0% vs 5.0%; $P = .001$), visceral ischemia (3.1% vs 12.9%; $P < .001$), extension of dissection (6.6% vs 14.3%; $P = .017$), and aortic rupture (0.4% vs 3.6%; $P = .032$). Also, the time from diagnosis to intervention was significantly shorter in the arch A group (4.1 vs 20.0 hours; $P < .001$) (Table 1).

Management and In-hospital Outcomes

Open surgery was most frequently adopted for arch A group patients, whereas it was infrequently adopted for arch B group patients (77.6% vs 18.6%; $P < .001$). Endovascular treatment was used rarely for arch A patients, compared with a quarter of arch B patients (3.5% vs 25.0%; $P < .001$), and medical treatment only was employed in a small proportion of arch A patients and about half of arch B patients (16.2% vs 51.4%; $P < .001$). (Figure 5).

The presence of preoperative complications led to more frequent adoption of invasive management options. Within the arch A group, complicated preoperative status was present in 69.5% of patients treated with open surgery (n = 177), compared with 100% in patients who underwent endovascular treatment (n = 8), and 59.5% in patients who received medical therapy only (n = 37) ($P = .056$). Within the arch B group, complicated preoperative status was present in 65.4% of patients treated with open surgery (n = 26) compared with 74.3% in patients who underwent endovascular treatment (n = 35) and 48.6% in patients who received medical therapy only (n = 72) ($P = .031$).

The overall in-hospital mortality was similar for both groups (16.7% vs 19.3%; $P = .574$). However, those patients treated surgically showed a trend toward a lower mortality rate in the arch A group compared with the arch B group (15.3% vs 30.8%; $P = .090$). Mortality after

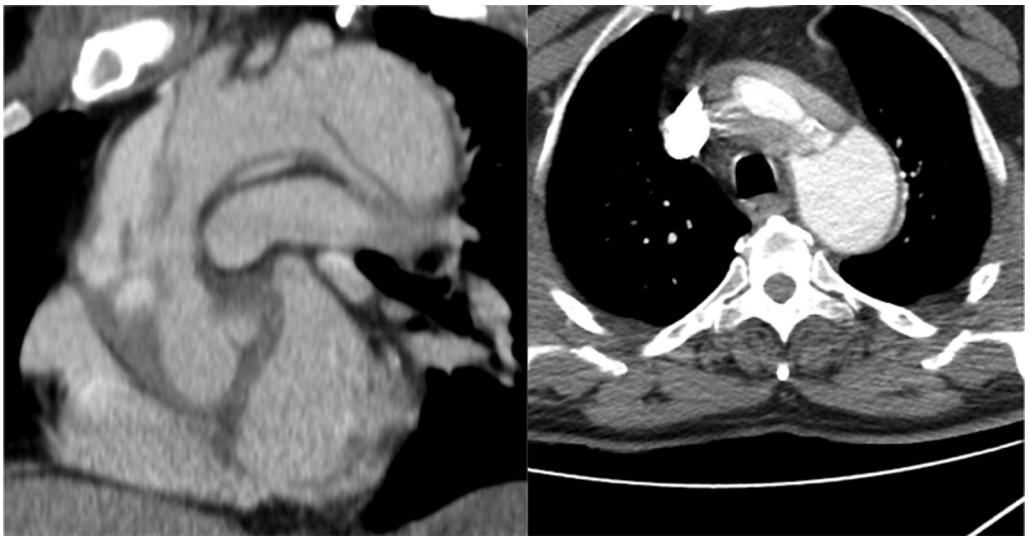

FIGURE 2. Computed tomography angiography scan of a patient with acute aortic dissection and primary entry tear between the innominate artery and the left common carotid artery with retrograde extension of dissection into the ascending aorta and antegrade extension into the descending aorta (arch A).

FIGURE 3. Computed tomography angiography scan of a patient with acute aortic dissection and primary entry tear between the origin of the innominate artery and the left common carotid artery and no ascending involvement (arch B).

endovascular or medical treatment were higher for arch A, although the difference was not significant (25.0% vs 14.3%; $P = .597$ and 24.3% vs 13.9%; $P = .191$, respectively) (Figure 6). The causes of death were not significantly different for both groups (Table 2), although aortic rupture was more frequently reported as a cause of death for arch A patients (26.3% vs 18.5%; $P = .462$) and neurologic complications for arch B patients (15.8% vs 29.6%; $P = .181$). Antegrade or retrograde extension of dissection during the hospitalization period (preoperatively or when the patient was initially managed medically) occurred more frequently in arch B patients (6.6% vs 13.8%; $P = .028$).

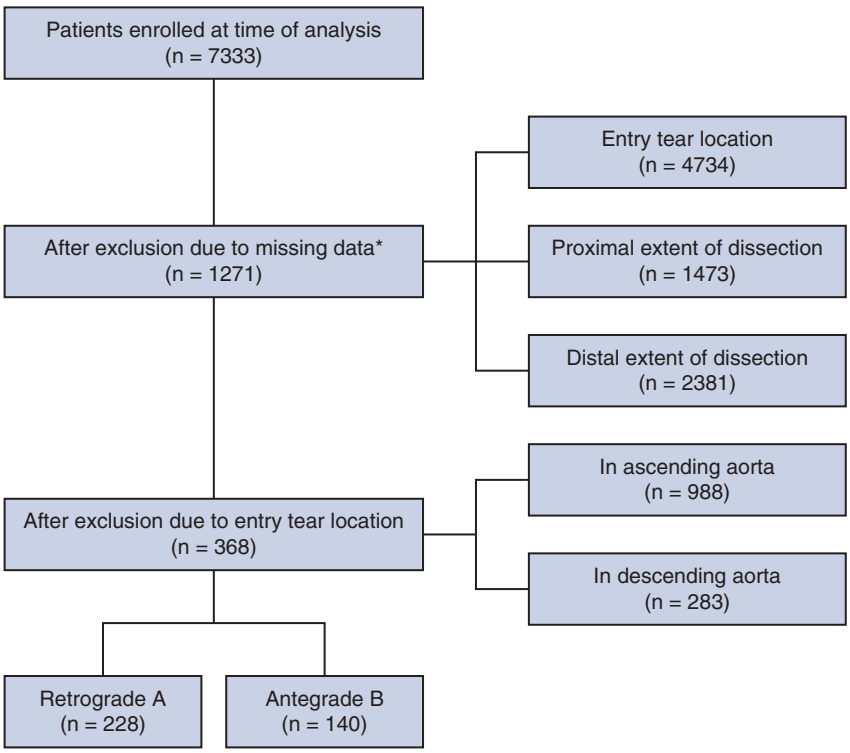

FIGURE 4. Flow chart describing numerically the number of patients excluded for each reason. *In some patients, there was more than 1 reason for exclusion.

TABLE 1. Baseline characteristics of acute aortic dissections with primary entry tear in the arch

	Arch A	Arch B	*P* value
N	228	140	
Demographic characteristics			
Age (y)	60.7 ± 13.8	61.3 ± 13.7	.678
Female	69 (30.3)	51 (36.4)	.252
White race	167 (77.0)	99 (73.3)	.447
Medical history			
Hypertension	175 (78.8)	114 (83.2)	.339
Atherosclerosis	50 (22.9)	35 (25.9)	.609
Diabetes	13 (6.0)	12 (8.8)	.394
Bicuspid aortic valve	11 (5.4)	4 (3.3)	.428
Marfan disease	8 (3.7)	5 (3.7)	1.000
Renal insufficiency	9 (6.3)	8 (8.6)	.609
Chronic obstructive pulmonary disease	11 (7.7)	9 (9.8)	.635
Imaging			
Ascending diameter (cm)	4.7 (4.0-5.2)	4.0 (3.5-4.4)	<.001
Arch diameter (cm)	3.8 (3.4-4.4)	3.7 (3.4-4.3)	.605
Descending diameter (cm)	3.5 (3.0-4.0)	3.7 (3.3-4.3)	.089
Clinical status			
Complicated	156 (68.4)	84 (60.0)	.115
Shock	70 (30.7)	21 (15.0)	.001
Spinal cord ischemia	4 (1.8)	2 (1.4)	1.000
Coma	30 (13.2)	12 (8.6)	.237
Periaortic hematoma	42 (18.4)	19 (13.6)	.250
Descending diameter > 5.5 cm	10 (4.4)	5 (3.6)	.792
Refractory pain	7 (3.1)	6 (4.3)	.570
Refractory hypertension	0 (0.0)	7 (5.0)	.001
Limb ischemia	22 (9.6)	14 (10.0)	1.000
Visceral ischemia	7 (3.1)	18 (12.9)	<.001
Extension of dissection	15 (6.6)	20 (14.3)	.017
Aortic rupture	1 (0.4)	5 (3.6)	.032
Acute renal failure	16 (7.0)	15 (10.7)	.248
Neurologic complication	31 (13.6)	8 (5.7)	.022
Cardiac tamponade	30 (13.2)	0 (0.0)	<.001
Congestive heart failure	13 (5.7)	6 (4.3)	.634
Aortic insufficiency grade 3 or 4	12 (5.3)	1 (0.7)	.021
Myocardial complication	13 (5.7)	6 (4.3)	.634
Time from symptom onset to diagnosis (h)	4.5 (2.7-12.0)	4.8 (2.7-10.2)	.806
Time from diagnosis to intervention (h)	4.1 (2.3-10.0)	20.0 (3.8-72.0)	<.001

Values are presented as mean ± standard deviation, n (%), or median (25th-75th percentile).

DISCUSSION

Treatment strategies for AAD patients with primary arch ET remain a subject of debate because contemporary classifications do not specifically stratify for these patients. This IRAD analysis shows that current practice differs from the recommendations, and that management and outcome of AAD is related to the extension of dissection. In particular, AAD with no ascending aorta involvement is not managed with open surgery in more than 4 out of 5 cases. A patient-specific approach appears to be preferred, depending on a patient's morphologic and clinical characteristics. Based on this observation, and due to the lack of a specific classification of AAD patients with proximal ET at the level of the arch, a new subcategorization of the Stanford classification might be considered as arch A, when the ascending is involved, and arch B when it is not.

Changes in surgical treatment and perioperative management have improved outcomes in arch dissection patients, but overall mortality remains high, 17.7% in this study,

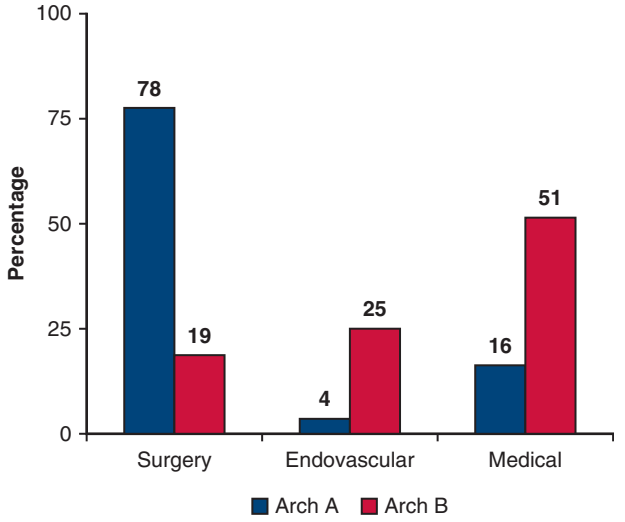

FIGURE 5. Management of acute aortic dissections with primary entry tear in the arch. The remaining 2.7% of patients in group 1 and 5.0% in group 2 were treated with hybrid surgical/endovascular methods.

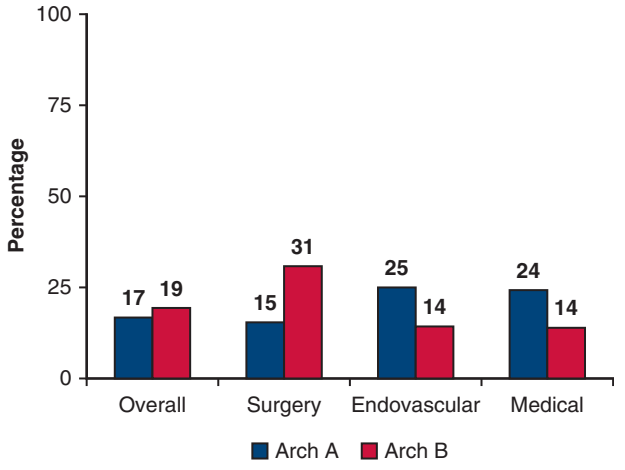

FIGURE 6. In-hospital mortality. Overall and by management type of acute aortic dissections with primary entry tear in the arch.

TABLE 2. Causes of in-hospital death

Cause	Arch A (n = 38)	Arch B (n = 27)	*P* value
Aortic rupture	10 (26.3)	5 (18.5)	.462
Neurologic	6 (15.8)	8 (29.6)	.181
Cardiac	5 (13.2)	3 (11.1)	.804
Visceral ischemia	5 (13.2)	2 (7.4)	.461
Major organ failure	2 (5.3)	3 (11.1)	.383
Bleeding	1 (2.6)	1 (3.7)	.805
Unspecified or unknown	9 (23.7)	5 (18.5)	.618

Values are presented as n (%).

which is comparable to the results of previous studies.[9-11] The majority (77.6%) of AAD patients with ascending aorta involvement (arch A) underwent surgical repair. Open surgery is the gold standard, and was associated with a lower in-hospital mortality rate compared with endovascular or medical treatment, respectively (15.3% vs 25.0% vs 24.3%; $P = .289$). Nevertheless, about 16% of arch A patients were managed medically. Previous studies have shown that this can be a realistic treatment option for patients at extreme surgical risk.[12,13] For AAD patients with primary ET in the arch specifically, the distance between the ET in the arch may result in relatively less pressurization of the false lumen and reduced risk for severe aortic valve regurgitation, dissection extension into the coronary arteries, or pericardial tamponade—particularly when the retrograde false lumen is thrombosed—compared with classic type A dissection with an ET in the ascending aorta.[12,13] Dissections involving the ascending aorta are not typically candidates for endovascular repair.

In contrast to the arch A group, surgery was associated with a higher in-hospital mortality rate than endovascular or medical treatment in the arch B group (30.8% vs 14.3% vs 13.9%; $P = .790$). These outcomes cannot be explained by the different prevalence of preoperative complications in the 3 cohorts because these were even higher in the group that was treated endovascularly compared with patients who underwent open surgery (74.3% vs 65.4%). A potential reason for the high surgical mortality in arch B patients may be that open treatment of patients with descending thoracic AAD necessitates adjuncts like cardiac and cerebral protection, which are technically more difficult to perform through a left posterolateral thoracotomy and are associated with higher mortality and morbidity.[14-16] Technical difficulties might also play a role when a rather proximal arch tear is repaired through a left thoracotomy approach. Alternatively, hybrid procedures through a median sternotomy, with extensive adoption of frozen elephant trunk, have been described for treating dissection of the ascending aorta and arch, showing satisfactory results.[17-19] However, as the results of the current study show, the surgical approach to dissections with ET in the arch extending to the descending aorta can be associated with poorer results. Although endovascular management of complicated descending dissection is recommended,[4,5] severe preoperative complications may represent a reason, in some centers, for open surgery.[20,21]

Less invasive management, either endovascular or medical, appears beneficial in patients without ascending aorta involvement, if the situation allows this approach.[20-22] In the current study, this is underlined by the shorter median time from diagnosis to intervention in arch A compared with arch B patients (4 vs 20 hours; $P < .001$), and by the fact that approximately half of the patients in IRAD without ascending aorta involvement were managed medically only. Rylski and colleagues[7] studied dissections with ET location in the arch but only antegrade extension (n = 22) and noted 28% of patients with medical management and an overall in-hospital mortality of 14% (compared with 19.3% in the current study). Rylski and colleagues[7] also included a cohort with ET location in the descending and retrograde extension into the arch but not ascending aorta (n = 21), and noted initial medical management in 28% with an in-hospital mortality of 5%.[7] A previous IRAD report on a cohort with the same characteristics concerning ET location and extension showed that medical management was used in 53.7%, endovascular therapy in 32.8%, and open treatment in 11.9% of patients, with an overall in-hospital mortality of 10.7%.[23] In general, these 2 studies and the current study show that ET location in the arch may have worse outcomes than ET in the descending.[7,23] Although presentation of AAD may need less-aggressive treatment when there is no ascending aorta involvement, the risk of extension of dissection during medical treatment was considerable (13.8%) and may have contributed to the relatively high percentage of neurologic deaths in arch type B patients.

The findings of the present study should be viewed in light of its limitations. Patients were not randomized to a predetermined management strategy, and therefore a selection bias was present in the treatments provided. Furthermore, the ETs were not always detectable on imaging studies, and in some patients, multiple ETs were seen. To minimize bias, such patients were excluded from analysis. Moreover, some cases may have been included in which an ascending ET was identified intraoperatively, whereas only an arch tear was visible on preoperative imaging. Because primary entry tear in the arch is rare, a relatively small cohort could be studied. The crude numbers of mortality give a good impression, but do not reach significance for differences between management types within each group. Imaging protocols differed among centers, although imaging was performed by experienced physicians in aortic centers that are typically equipped with state-of-the-art technologies.

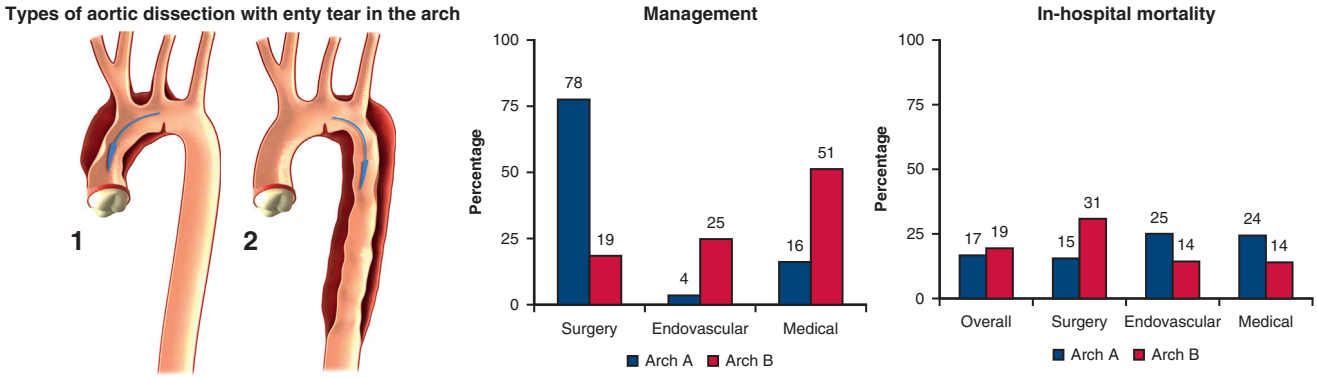

FIGURE 7. Classification, management, and in-hospital mortality of acute aortic dissections with primary entry tear in the arch.

CONCLUSIONS

Although current guidelines suggest surgical repair for AAD with proximal ET into the arch, IRAD shows that these patients are currently managed by a patient-specific approach (Figure 7). In choosing the management type of this cohort, it may be advisable to stratify AAD based on retrograde or only antegrade extension of the dissection.

Webcast

You can watch a Webcast of this AATS meeting presentation by going to: https://aats.blob.core.windows.net/media/18AO/26-br-1545-trimarchi-v2.mp4.

Conflict of Interest Statement

Authors have nothing to disclose with regard to commercial support.

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