Relationship between primary entry tear and surgical outcomes for acute type A aortic dissection: A single-center experience

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Abstract

Introduction: The location of the primary entry tear not only affects the prognosis but also the treatment strategy for aortic dissection. This study evaluated the relationship between the primary entry tear and surgical outcomes for acute type A aortic dissection.

Patients and methods: A retrospective descriptive study of consecutive patients with acute type A aortic dissection who underwent surgery at Viet Duc University Hospital between 2021 and 2022.

Results: There were 89 patients included in this study. The primary entry tear in the ascending aorta accounted for 43.8%; the group with the primary entry tear in the aortic arch and the group with the primary entry tear in the descending aorta had quite an equal percentage. False lumen thrombosis most frequently occurred in the group with primary entry tear in the descending aorta. The location of the primary entry tear influenced the surgical technique, in which the majority of patients with primary entry tears at the aortic arch underwent hemiarch or total arch replacement. Postoperatively, the early mortality rate and early reoperation rate were 11.2% and 5.6%, respectively. The most common cause of early death was multiorgan failure, and the most common cause of reoperation was bleeding. The early mortality rate tended to be higher in the group with lesions at the aortic arch ($p = 0.08$), while those with primary entry tears at the ascending aorta showed more bleeding complications ($p = 0.07$).

Conclusion: Acute type A aortic dissection is a life-threatening disease with a high mortality rate. The location of the primary entry tear plays an important role in planning surgical treatment and predicting the initial outcomes of surgery as well as the long-term progression of this disease after surgery.

Keywords: Aortic dissection, primary entry tear, surgery.

Introduction

Type A Aortic Dissection (AAD) is a life-threatening disease with a high mortality rate. AAD that develops within the first two weeks from onset is defined as acute(1). Today, emergency surgery is still the gold standard for saving patients' lives. Previous research has shown that the location and size of the primary entry tear are factors that determine the high-risk group of patients with AAD (2). For AAD, the location of the primary entry tear is a predictor for the progression of disease, especially organ malperfusion (3). Therefore, it plays an important role in the treatment strategy of AAD, and one of the most important goals in acute AAD surgery is to remove the primary entry tear (3). However, the relationship between the location of the primary entry tear and the surgical outcomes of AAD remains unclear. We performed this study to evaluate the characteristics of the distribution of the locations of primary entry tears in patients with AAD and their impacts on the techniques and results of AAD surgery.

Patients and methods

The selection criteria are:

Patients diagnosed with AAD were admitted and operated on at Viet Duc University Hospital from January 2021 to December 2022.

Medical records with clinical and subclinical data, surgical protocol, and post-operative period were sufficient.

The exclusion criteria are:

AAD patients refused surgery or died before surgery.

AAD patients who underwent surgery at another hospital were transferred to Viet Duc University Hospital.

This was a retrospective, non-controlled, descriptive study with a comparison between patient groups of the location of the primary entry tear. The data were analyzed using IBM SPSS 20.0 software.

Results

The study included all AAD patients who underwent surgery at Viet Duc University Hospital from 2021 to 2022. Of the total 89 patients, the data were analyzed for 3 groups according to the location of the primary entry tear, including the ascending aorta, the aortic arch, and the descending aorta. The preoperative characteristics of patients are shown in Table 1.

Table 1. Preoperative characteristics (N=89)

	Descending aorta (N = 24)	**Ascending aorta (N = 39)**	**Aortic arch (N = 26)**	**P**
Age	60.7 ± 11.3	61.1 ± 9.7	58.3 ± 6.9	0.487
Gender (n%)				0.740
Male	15 (62.5%)	27 (69.2%)	19 (73.1%)	
Female	9 (37.5%)	12 (30.8%)	7 (26.9%)	
History (n%)				
Hypertension	19 (79.2%)	26 (66.7%)	19 (73.1%)	0.573
Previous Aortic disease	1 (4.2%)	5 (12.8%)	1 (3.8%)	0.402
Diabetes	1 (4.2%)	5 (12.8%)	0 (0.0%)	0.115

Chest pain (n%)	22 (91.7%)	36 (92.3%)	24 (92.3%)	1.000
Organ malperfusion (n%)	13 (27.1%)	3 (18.9%)	4 (20.0%)	0.827
Pericardial effusion (n%)	12 (50.0%)	17 (43.6%)	17 (65.4%)	0.222
Pleural effusion (n%)	12 (50.0%)	21 (53.8%)	12 (46.2%)	0.830
Cardiac tamponade (n%)	3 (12.5%)	4 (10.3%)	5 (19.2%)	0.582
Thrombosis in false lumen (n%)	19 (79.2%)	20 (51.3%)	20 (76.9%)	0.033
Diameter of ascending aorta (cm)	4.3 ± 0.9	4.7 ± 0.7	4.5 ± 0.8	0.178
Diameter of aortic arch (cm)	3.4 ± 0.5	3.5 ± 0.9	3.7 ± 0.7	0.166
Use of inotropes (n%)	3 (12.5%)	4 (10.3%)	3 (11.5%)	1.000

There were no significant differences in age, gender, history of aortic disease, clinical presentations, or the diameters of the aorta among the three groups. However, the descending aortic group had a significantly higher rate of false lumen thrombosis. Surgical characteristics are presented in Table 2.

Table 2. Intraoperative characteristics (N=89)

	Descending aorta (N = 24)	**Ascending aorta (N = 39)**	**Aortic arch (N = 26)**	**P**
Cannulation site (n%)				0.512
Right axillary artery	13 (54.2%)	27 (69.2%)	20 (76.9%)	
Femoral artery	6 (25.0%)	8 (20.5%)	4 (15.4%)	
The extent of surgery (n%)				0.002
Ascending aorta	12 (50.0%)	21 (53.8%)	5 (19.2%)	
Aortic root	0 (0.0%)	4 (10.3%)	0 (0.0%)	
Aortic arch	12 (50.0%)	14 (35.9%)	21 (80.8%)	
CPB* time (min)	121.8 ± 27.7	145.5 ± 47.8	146.2 ± 45.3	0.118
ACC** time (min)	80.8 ± 12.5	107.3 ± 33.0	107.7 ± 28.6	0.001
Circulatory arrest (n%)	12 (50.0%)	18 (46.2%)	25 (96.2%)	0.0001
Selective brain perfusion (min)	27.8 ± 6.9	34.2 ± 8.7	38.6 ± 11.6	0.011
Moderate to deep hypothermia (n%)	12 (50.0%)	22 (56.4%)	25 (96.2%)	0.0001

*Cardiopulmonary bypass **Aortic cross clamp

In the study, the right axillary artery was the most popular cannulation site. The extent of surgery had a significant difference among the 3 groups (p = 0.002). The majority of patients in the aortic arch group, accounting for 80.8%, underwent aortic arch surgery. The ascending aortic group had the most diverse types of surgery, in which more than half of patients underwent ascending aorta replacement. In the group with the primary entry tear at the descending aorta, the rate of simple ascending aortic replacement surgery was the same as that of aortic arch surgery. The relationship between the location of the primary entry tear and the early postoperative results is presented in Table 3.

Table 3. The relationship between the location of the primary entry tear and early outcomes after surgery (N=89)

	Descending aorta (N= 24)	**Ascending aorta (N= 39)**	**Aortic arch (N = 26)**	**P**
Death (n%)	0 (0.0%)	5 (12.8%)	5 (19.2%)	0.080
CRRT*** (n%)	2 (16.7%)	10 (25.6%)	3 (11.5%)	0.181
Reoperation (n%)	0 (0.0%)	3 (7.7%)	2 (7.7%)	0.511
Bleeding (n%)	0 (0.0%)	7 (17.9%)	4 (15.4%)	0.070
Neurologic deficit (n%)	0 (0.0%)	2 (5.1%)	2 (7.7%)	0.571
Use of inotropes (days)	5.5 ± 3.4	7.6 ± 7.3	6.3 ± 5.4	0.665
Hospital stays (days)	23.5 ± 6.9	24.4 ± 14.5	21.2 ± 11.5	0.570
Ventilation time (days)	8.3 ± 6.9	10.5 ± 13.3	7.8 ± 7.5	0.816
ICU**** time (days)	18.2 ± 8.5	18.6 ± 15.0	16.2 ± 10.7	0.615

***Continuous renal replacement therapy ***Intensive care unit

No statistically significant difference in early postoperative outcomes among the three groups was noted.

Discussion

The location of the primary entry tear is one of the most important factors in prognosis and planning treatment strategies for acute aortic dissection in general and AAD in particular (3). In recent years, there have been many advances in the treatment of aortic dissection, especially in endovascular intervention and hybrid surgery; however, Stanfords and Debakeys classification did not take into account the location of the primary entry tear and also did not cover all forms of aortic dissection, especially the ones that involved the aortic arch but not the ascending aorta (4). Therefore, a new classification system has been developed to supplement previous classification systems. According to that, the locations of primary entry tears were classified into E1 (the aortic root or the ascending aorta), E2 (the aortic arch), E3 (the descending aorta or retrograde

dissection), and E0 (the undefined primary entry tear) (4).In most cases, the location of the primary entry tear can be determined preoperatively based on imaging modalities, especially computed tomography (5). The previous reports showed quite different results in the proportions of the locations of the primary entry tear. In our study, primary entry tears at the ascending aorta were found in 43.8% of patients, while the rates of the aortic arch group and the descending aortic group were quite equal (29.2% and 26.9%). Some studies reported that the ascending aortic ones accounted for about 70–80%; the rate of the aortic arch group ranged from 9% to 31%, and the patients with the primary entry tear at the descending aorta had a proportion of 12–16% (6,7,8). In another study of 832 AAD patients, Wei-Guo Ma and colleagues reported that in patients with AAD, the proportion of the ascending aortic group, the aortic arch group, and the descending aortic group was 40.3%, 12.5%, and 33.9%, respectively (9). Thus, in general, the most common location of the primary entry tear in AAD patients was the ascending aorta.

The study did not find any significant differences among the three patient groups in terms of age, gender, medical history, clinical symptoms, the need for inotrope drugs, or pathological lesions. Research showed that the aortic arch group was more likely to be older and have a history of hypertension (9). Wei-Guo Ma and colleagues did not also note differences in terms of gender and preoperative organ malperfusion among patient groups of primary entry. Besides, the authors found that age and hypertension were risk factors for aortic dissection with a primary entry tear at the aortic arch (9). We found that the rate of false lumen thrombosis was significantly different among the 3 groups of patients, with the descending aortic group having the highest rate of false lumen thrombosis. This result showed the influence of hemodynamics on the aortic wall at different locations. The study by Yue Shi and colleagues reported the hemodynamic characteristics of AAD patients with different locations and sizes of primary entry tears and noted that the location of the primary entry tear had a strong effect on hemodynamics.When the primary entry tear was located in the proximal segments of the aorta, the pressure in the false lumen was much higher; therefore, the pressure gradient between the false lumen and the true lumen increased. The false lumen tended to expand and compress the true lumen, so it was more difficult to form a thrombus in the false lumen (10). Besides, the closer the entry tear was to the proximal part of the aorta, the greater the shear stress in the false lumen was, thus the risk of progressive dissection was much higher (10). Many previous studies have confirmed this. If the pressure in the false lumen decreased, especially when there was communication between the false lumen and the true lumen through the re-entry tear, the blood flow would increase, leading to a reduced rate of thrombus formation in the false lumen (11).

The location of the primary entry tear and the extent of the dissection in AAD were important factors in planning surgical treatment strategies. In the study, the establishment of CPB was not influenced by the location of the entry tear. The goal of the establishment of CPB was to restore blood flow in the true lumen, so the cannulation site depended on the anatomical characteristics of the aortic arch, the extent of dissection, and the method of protecting the brain, but not the location of the entry tear. However, the location of the entry tear had a notable influence on the extent of surgery. AAD surgery aims to eliminate the entry tear, restore blood flow in the true lumen, and prevent progression and complications. Therefore, the location of the entry tear was one of the indicators for planning a surgical strategy.

However, surgeries on the aortic root or aortic arch were very difficult and complex procedures with very long surgical time, CPB time, and ACC time, so they were not usually performed in cases of elderly and frail patients. In these conditions, ascending aortic replacement was the standard

method to save patients lives. To date, complete removal of the entry tears has become increasingly popular in AAD surgery. Because of that, hemi-arch or total aortic arch replacement was required in most of the cases with a primary entry tear at the ascending aorta or aortic arch. In an analysis of 334 patients with AAD by Yosuke Inoue and colleagues, the patients with the primary entry tear at the ascending aorta accounted for 69%; the rate of the aortic arch group was 25% (6). All of these cases required aortic arch surgery (6). The authors noted that to remove the entry tear, most cases in the ascending aorta group required hemi-arch aortic replacement. By contrast, the majority of patients in the aortic arch group required total aortic arch replacement; these differences were statistically significant (6). In our study, the early mortality rate was 11.2%, with the most common cause of death being multiorgan failure. The early re-operation rate was 5.6%, with bleeding being the most common cause. This showed very excellent outcomes, which may be related to advances in surgery, anesthesia, intensive care, and especially surgeons experiences. Although the study did not find any difference in early postoperative outcomes among groups, early death tended to be more common in the group with entry tear at the aortic arch (19.2% versus 12.8% and 0.0%, p = 0.08). This was reasonable due to the high-risk characteristics of the aortic arch surgery. Bleeding that required reoperation was more common in the ascending aortic group (17.9% versus 15.4% and 0.0%, p = 0.07). The reason may be that inexperienced young surgeons were assigned responsibilities in important phases of procedures.

Conclusion

Acute type A aortic dissection is a life-threatening condition with a high mortality rate. The location of the primary entry tear plays a crucial role in planning the surgical strategy and predicting the primary outcomes of surgery. Further comprehensive research is necessary to clarify this issue.

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