Original Article
Early and late outcomes of non-total aortic arch replacement for repair of acute Stanford Type A aortic dissection

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Abstract: Objective: This study evaluated the early and late outcomes of non-total aortic arch replacement for acute Stanford A aortic dissection. Methods: 131 cases of acute Stanford Type A aortic dissection with no rupture admitted to our hospital from January 2016 to December 2019 were selected for non-total aortic arch replacement. According to different surgical methods, 51 patients with tear-oriented ascending/hemiarch replacement were included in Group A, and 80 patients who underwent total arch replacement surgery were enrolled in Group B. The perioperative indicators, 30-day mortality rate, and the incidence of postoperative complications were compared between the two groups, and the survival rate of patients were compared by follow-up after discharge. Results: The cardiopulmonary bypass time, cardiac perfusion time, invasive ventilation and ICU hospitalization in Group A were critically shorter than those in Group B (*P<0.05*). The incidence of transient cerebral dysfunction in Group A was substantially lower than that in Group B (*P<0.05*). The difference of comparison in perioperative mortality, incidence of permanent neurological dysfunction, and incidence of acute kidney and liver damage between the two groups was statistically insignificant (*P>0.05*). In addition, the two groups had statistically insignificant difference in survival during postoperative follow-up (*P>0.05*). Conclusion: For acute Stanford type A aortic dissection without rupture in aortic arch, the non-total aortic arch replacement has simple surgical method with high perioperative safety and long-term efficacy that similar to total arch replacement.

Keywords: Non-total aortic arch replacement, acute Stanford Type A aortic dissection, early outcome, late outcome

Introduction

Acute Stanford Type A aortic dissection has very dangerous onset. The deterioration rate in patients is rapid, with fatality rate increases by 1% per 1 h since the onset of the disease, and reaches as high as 30-50% within 48 h provided no timely medical intervention was taken. Surgical replacement of diseased vessels is an effective way to treat acute Stanford Type A aortic dissection [1, 2]. The Stanford Type A aortic dissection, in the light of the different position of initial intima tear, can be divided into the Stanford Type A aortic dissection with or without tear. At present, there is no dispute of total arch replacement treated for patients with rupture in intima of the arch. However, there are still different views on whether total arch replacement is necessary for those without rupture in intima of arch [3, 4]. Most

Chinese experts consider that total aortic arch replacement can largely replace the diseased vessels in the aortic arch, and the long-term outcome is explicit [5]. While cardiac surgeons in Europe, America and Japan believe that non-total aortic arch replacement surgery has high surgical safety and can effectively reduce the death threat of patients [6, 7]. This study evaluated the early and late outcomes of non-total aortic arch replacement for repair of acute Stanford A aortic dissection so as to further explore the effects brought by two surgical methods.

Materials and methods

Research objects

During January 2016 to December 2019. 131 cases of acute Stanford Type A aortic dissec-

tion with no rupture were selected for non-total aortic arch replacement. According to different surgical methods, 51 patients with tear-oriented non-total aortic arch replacement were included in Group A, and 80 patients who underwent total arch replacement surgery were enrolled in Group B. The research was carried out under permission of the hospital ethics committee.

Inclusive and exclusive criteria

Inclusive criteria: (1) Patient met the diagnostic criteria for acute Stanford A aortic dissection; (2) Patient with no rupture in aortic arch, and the intima of the branches was intact; (3) Patient aged between 18-60 years old; (4) The time from onset to operation was less than 24 hours; (5) No large aneurysm was formed in the descending aorta of patient; and (6) The family members of patients voluntarily signed the informed consent.

Exclusive criteria: (1) Patients with immune system or endocrine system diseases; or (2) Patients with malignant tumors.

Methods

Patients in Group A underwent tear-oriented ascending/hemiarch replacement. The right axillary artery for perfusion was perfused on patients, and the aortic arch was obstructed at low temperature between the proximal innominate artery or the innominate artery, and the left common carotid artery, and ascending or hemiarch replacement was conducted. The lower part of the patient's arch next to the beginning of innominate artery was clipped to the descending aortic isthmus. According to the diameter of the true lumen of descending aorta, a stent-type artificial vessel (with a diameter of 1-2 mm larger than the true lumen and a length of 60 mm) was selected for implantation into the true lumen of descending aorta. The stent-type artificial blood vessel was fixed with 5 discontinuous sutures of 4-0 propylene thread, and the sutures passed through the blood vessel, intima and adventitia in the descending aorta cavity to tie knots with the felt sheet outside the vessel wall. The incision of the arch was repaired with felt strips inside and outside the adventitia, and 4-0 acrylic suture was used to suture the artificial blood vessel for anastomosis. In cases where dissection involves the aortic root and results in severe aortic insufficiency or aortic root dilation, added with the Bentall's or Wheat's surgery. For patients with intima tear, the coronary artery bypass grafting (CABG) was performed at the same time.

Group B received total arch replacement surgery. The deep hypothermic circulatory arrest (DHCA) and the selective antegrade cerebral perfusion (SACP) were performed. Aortic arch replacement was completed by antegrade stent placement in descending aorta, and the treatment principle of aortic root was the same as that in Group A.

Observation of indexes

(1) Perioperative indicators, including cardio-pulmonary bypass, cardiac perfusion time, invasive ventilation and ICU hospitalization of the two groups were recorded.

(2) The mortality within 30 days after operation and postoperative complications including permanent neurological dysfunction, transient cerebral dysfunction, and acute kidney and liver damage were recorded.

(3) After discharged, the objects were followed up in the outpatient clinic for reexamination of CT and cardiac color ultrasound every 6 months, and by telephone every 3 months to track their living quality and changes in status. The deadline of follow-up was September 1, 2020 and the end point of follow-up was the all-cause death of patients.

Statistical analysis

We treated the data and analysis with statistical software SPSS 22.0. The comparison of measurement data was by t-test, the enumeration data was by X^2 test, the survival stage by drawing of Kaplan Meier survival curve and the survival conditions was by Log-rank test. The difference was statistically significant if $P< 0.05$. The graphic software was by Graphpad prism9.

Results

Clinical data

There was no significant difference in clinical data between the two groups ($P>0.05$) (**Table 1**).

Table 1. Comparison of clinical data between the two groups

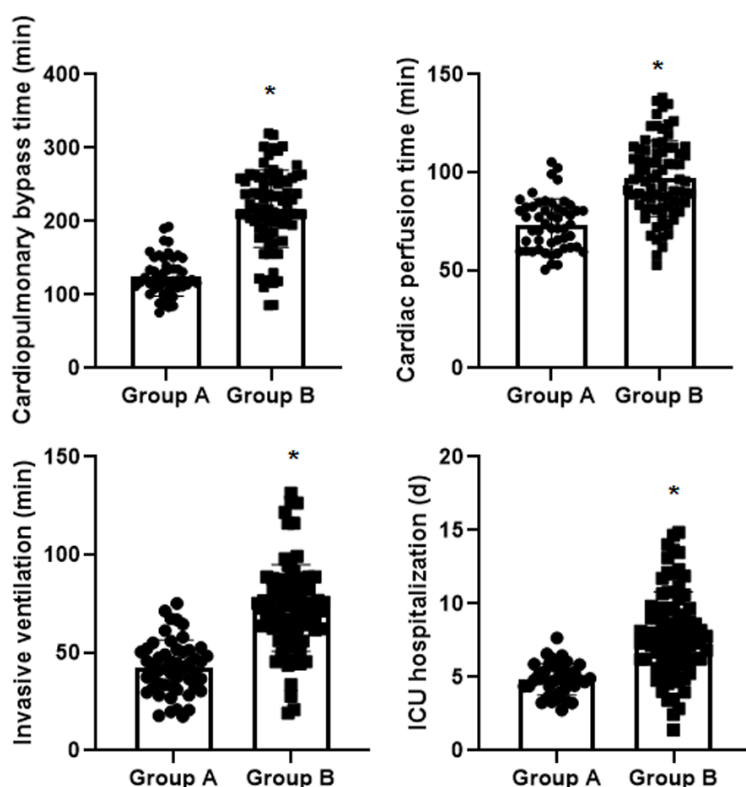| Group	Number of cases	Gender		Age (years old, $\bar{x} \pm s$)	BMI (kg/m^2, $\bar{x} \pm s$)	Pericardial effusion (n, %)	Abnormal renal function (n, %)	Neurological dysfunction (n, %)
		Male	Female					
Group A	51	37	14	47.39±12.04	24.74±2.41	12 (23.53)	10 (19.61)	7 (13.73)
Group B	80	61	19	48.96±13.11	24.38±2.73	18 (22.50)	17 (21.25)	10 (12.50)
t/X^2	-	0.226		0.690	0.770	0.019	0.051	0.041
P	-	0.634		0.492	0.443	0.891	0.821	0.839

Figure 1. Comparison of perioperative-related indexes between the two groups. Note: Compare with group A, *P<0.05.

Comparison of perioperative-related indexes between the two groups

The cardiopulmonary bypass time, cardiac perfusion time, invasive ventilation and ICU hospitalization in Group A were critically shorter than those in Group B [(121.68±25.04) min vs. (217.83±50.49) min; (74.95±15.22) min vs. (94.68±20.16) min; (40.17±15.39) min vs. (70.59±20.55) min; (4.93±1.24) d vs. (8.07± 2.85) d] (*P<0.05*) (**Figure 1**).

Comparison of perioperative mortality and complications

The incidence of transient cerebral dysfunction in Group A was substantially lower than that in

Group B (23.53% vs. 41.25%) (*P<0.05*); The difference of comparison in perioperative mortality, incidence of permanent neurological dysfunction, and incidence of acute kidney and liver damage between the two groups was statistically insignificant (5.88% vs. 6.25%; 1.96% vs. 5.00%; 25.49% vs. 23.75%; 17.65% vs. 18.75%) (*P>0.05*) (**Table 2**).

Comparison of survival between the two groups

The two groups had statistically insignificant difference in survival during postoperative follow-up (*P>0.05*) (**Table 3** and **Figure 2**).

Discussion

The incidence of acute aortic dissection in China is much higher than that of other types of aortic diseases. Among them, Stanford Type A aortic dissection is mainly caused by the long-term uncontrolled hypertension in body, which accounts for about 60-70% of aortic diseases [8, 9]. The mortality rate of the disease is as high as 50% for patients who did not receive surgery within 48 h of onset. The surgical treatment is the most effective treatment at present [10, 11]. The success rate of Stanford Type A aortic dissection has been significantly improved with the development and progress of cardiopulmonary bypass and surgical techniques [12].

Accompanied by the development and progress of modern technology in recent years, experts in clinical treatment tend to adopt relatively positive surgical treatment strategy on Stanford Type A aortic dissection. That is, to

Table 2. Comparison of perioperative mortality and complications between the two groups [n (%)]

Index	Group A (N=51)	Group B (N=80)	X^2	P
Mortality	3 (5.88)	5 (6.25)	0.083	0.773
Transient cerebral dysfunction	12 (23.53)	33 (41.25)	4.337	0.037
Permanent neurological dysfunction	1 (1.96)	4 (5.00)	0.174	0.676
Acute kidney damage	13 (25.49)	19 (23.75)	0.051	0.821
Acute liver damage	9 (17.65)	15 (18.75)	0.025	0.874

Table 3. Comparison of survival between the two groups

Group	Number of cases	Follow-up period (month, $\bar{x} \pm s$)	Estimated follow-up time (month)			Mortality rate (n, %)	Survival analysis	
			Estimated month	Standard error	95% CI		X^2	P
Group A	48	30.47±6.20	44.24	3.15	38.07~50.40	4 (8.33)	0.490	0.484
Group B	75	31.74±7.38	42.19	2.41	37.47~46.92	6 (8.00)		
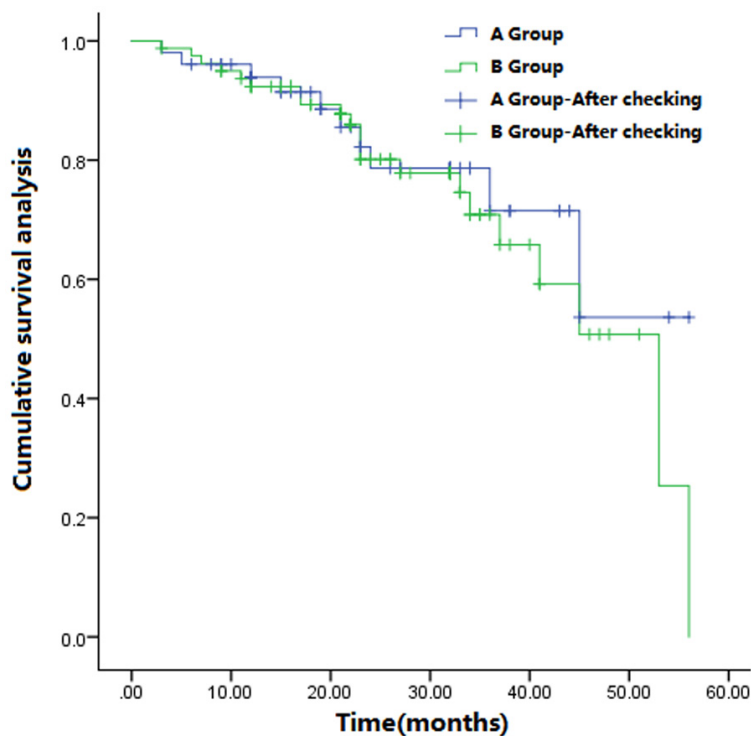
Figure 2. Follow-up survival analysis of patients between the two groups.

perts who proposed that this method may increase the early postoperative risk of patients, such as more wounds, complex surgical procedures, prolonged cardiopulmonary bypass time, circulatory arrest time and blocking time, thus leading to the prolonged postoperative mortality and ICU hospitalization. At the same time, it increased the incidence of postoperative complications such as neurological dysfunction and recurrent nerve injury [17, 18]. Some scholars reported that [19] the incidence of neurological complications after total arch replacement was higher, and the long-term survival rate was lower.

The non-total aortic arch replacement includes the replacement of the ascending aorta and the right hemi-aortic arch, in which the diseased vessels in the arch cannot be completely replaced, and its long-term prognosis has been challenged by scholars. This study evaluated the early and late impact of non-total aortic arch replacement of acute Stanford A aortic dissection. The results of this study showed that the cardiopulmonary bypass time, cardiac perfusion time, invasive ventilation and ICU hospitalization in Group A were critically shorter than those in Group B, and the

replace the total aortic arch and implement the descending aortic stent [13, 14]. This procedure can eliminate the arch dissection and promote the closure of false lumen in descending aorta. The results of long-term follow-up confirmed that the closing rate of the false lumen near descending aorta was close to 100%, which effectively reduced the incidence of long-term complications of aorta and the risk of reoperation [15, 16]. However, there were ex-

incidence of transient cerebral dysfunction in Group A was substantially lower than that in Group B. In general, the replacement of non-total aortic arch does not required to conduct under deep hypothermia, and anastomotic stoma is easily to be exposed with less surgical trauma and fewer postoperative complications, which is consistent with the results reported by scholars [20, 21]. The advantage of aortic arch replacement is that a wide range of diseased blood vessels is replaced to avoid the formation of hemangiomas in aortic arch and facilitate the closure of distal vascular dissection [22]. However, the perioperative mortality of patients for total aortic arch replacement cannot be overlooked, and it seems that it is difficult to obtain a balance between the low perioperative mortality and the ideal long-term outcome. At present, there are few follow-up studies on these two surgical methods, and it is considered that the long-term effect of non-total aortic arch replacement is satisfactory [23]. The follow-up data of this study showed that there was statistically insignificant difference in the survival of the two groups of patients. It is consistent with the results as reported [24, 25], suggesting that there is no significant difference in late therapeutic effect between non-total aortic arch replacement and total aortic arch replacement. Compared with total aortic arch replacement surgery, the non-total surgery is easier to master, and can be performed independently for most cardiac surgery. For critically ill patients under limited medical conditions, the implementation of non-total aortic arch replacement can reduce the transfer of patients and the waiting time of surgery, and is expected to reduce the perioperative mortality [26, 27].

However, the sample size included is relatively limited, and there may be deviation lied in the results. Therefore, more large-sample prospective studies are needed so that more reliable clinical research results can be acquired to improve the clinical prognosis of patients.

In summary, for cute Stanford Type A aortic dissection without rupture in aortic arch, the non-total aortic arch replacement is a simple surgery with high perioperative safety and long-term efficacy that is similar to that of total arch replacement. It is worthwhile to further expand the sample size for in-depth observation and analysis.

Disclosure of conflict of interest

None.

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