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Clinical impact of turn-up anastomosis in the treatment of type A acute aortic dissection

Takeshi Shimamoto[1,2], Tatsuhiko Komiya[2] and Takehiko Matsuo[2]

Abstract

Background: The management of anastomosis and hemostasis of the dissected aorta remains challenging. This study aims to establish an optimal surgical strategy for type A acute aortic dissection by reviewing single-center data using the turn-up anastomosis technique.
Methods: Between 2003 and 2015, 264 consecutive patients with type A acute aortic dissection who underwent emergency surgery within 14 days of symptom onset were enrolled.
Results: The mean age of the patients was 67.7 ± 13.4 years, and 129 were males. The operative time and surgical bleeding were 390.9 ± 144.5 min and 2983.8 ± 3026.5 mL, respectively. In-hospital mortality was observed in 25 patients (9.4%), and 3 (1.1%) experienced uncontrolled bleeding (from the aortic root in two patients and coagulopathy due to dabigatran in one patient). Immediate reopening for bleeding was performed in 20 patients, and bleeding from the aortic anastomosis was observed at three proximal and two distal sites. Proximal re-dissection was observed in 18 patients; in all of which, glue was used, although two re-ruptures of the aortic root were observed among those without glue use. The rates of freedom from all-cause death, aortic death, and aortic events at postoperative 5 years were 78.5 ± 2.7%, 86.8 ± 2.1%, and 74.4 ± 2.9%, respectively. When these values were stratified according to the operative extent, no significant differences were observed.
Conclusions: Turn-up anastomosis facilitates short circulatory arrest, short operative time, and stable hemostasis, with few anastomotic complications during surgery for type A acute aortic dissection.

Keywords

type A acute aortic dissection, aortic event, aortic intervention, turn-up, anastomosis

Introduction

The early outcomes of emergency surgery for type A acute aortic dissection (TAAAD) have dramatically improved over the past 20 years.[1,2] Owing to the improvements in emergency surgery, the long-term fate of the residual native aorta after undergoing TAAAD has received attention. The sinus of Valsalva and distal aorta may dilate and cause re-dissection or pseudoaneurysm, which necessitates reparative aortic root and/or distal arch surgery or endovascular treatment. Although several reapproximation and anastomosis methods have been advocated,[3–6] restoration of the aortic wall while achieving hemostasis and obliterating the flow to the false lumen is crucial to avoid life-threatening complications. We reported a turn-up anastomosis, in which both the proximal and distal ends of the Dacron graft are everted for the secure anastomosis in the surgical management of TAAAD.[7] This study aims to establish an optimal surgical strategy for TAAAD by reviewing single-center data on the turn-up anastomosis technique.

Patients and methods

Study population

The Institutional Review Board of Kurashiki Central Hospital approved this study and waived the need for an

[1]Department of Cardiovascular Surgery, Hamamatsu Rosai Hospital, Shizuoka, Japan
[2]Department of Cardiovascular Surgery, Kurashiki Central Hospital, Okayama, Japan

Corresponding author:
Takeshi Shimamoto, Department of Cardiovascular Surgery, Hamamatsu Rosai Hospital, 25 Shogen-cho, Higashi-ku, Hamamatsu, Shizuoka, 430-8525, Japan.
Email: takeshishimamoto@hamamatsuh.johas.go.jp

informed consent owing to its retrospective design. Between February 2003 and December 2015, consecutive 264 patients, who were diagnosed with TAAAD, were admitted to our hospital within 14 days of the symptom onset and underwent surgery via the turn-up anastomosis technique.

Surgery

All surgeries were performed on an emergency basis. Extracorporeal circulation was instituted by the placement of an arterial cannula in the right axillary artery and the femoral or left axillary artery and venous cannulas in the superior vena cava and inferior vena cava. Once the vesical temperature reached 30 °C, systemic circulation was temporarily terminated, and the ascending aorta was opened to confirm the location of the entry tear and to decide the degree of the required repair. Subsequently, an aortic cross-clamp was used. The ascending aorta was opened, and the false lumen was approximated. Under the circulatory arrest with the vesical temperature of 28 °C, the primary tear was resected whether in the ascending aorta or in the transverse arch. A frozen elephant truck was used if the entry was located deep within the distal arch. Antegrade selective cerebral perfusion was performed in every patient through the right axillary artery after clamping the base of the brachiocephalic artery with a balloon-tipped cannula inserted directly into the left common carotid artery and the left subclavian artery.

Turn-up anastomosis

The use of surgical glue in the false lumen of the aortic root and its type was determined based on the surgeon's preference. The surgical glue used was mainly gelatin–resorcinol–formaldehyde glue (Cardial SA, Saint Etienne, France) or BioGlue (CryoLife Inc., Kennesaw, GA, USA). The turn-up anastomosis technique has been reported previously.[7] Briefly, after trimming the end of the aorta where the anastomosis with the Dacron graft was intended, five to eight pairs of U-stay 4-0 polypropylene sutures were placed on the aorta at a depth of 1 cm with external reinforcement using a felt strip externally (Figures 1(a) and 2(a)). The number of U-sutures varied depending on the vessel circumference and the surgeon's preference. After the U-stay sutures were placed at a similar depth to the Dacron graft with the corresponding ratio, sutures were tied down, and we took care to evert the end of the graft and fit a similar length of the graft and the aorta circumferentially to establish an excellent cross-sectional exposure of the aortic wall and graft (Figures 1(b) and 2(b)) and to maximize the joining surface of the wall and graft. Continuous 4-0 polypropylene sutures were then placed (Figures 1(c) and 2(c)). Both the distal and proximal sutures of the Dacron graft were performed using the same method (Figure 3). In the case of aortic root repair with remodeling technique, the anastomosis was completed with turn-up technique as well, with first-line everting suture placed at the nadir of repaired cusp.

Definition

Patients who survived discharge underwent regular follow-up evaluations at the outpatient clinic. Follow-up computed tomography (CT) scans were performed every 6–12 months according to the aortic morphology and the physician's discretion. Moreover, telephone follow-ups were carried out for patients who did not attend the outpatient clinic.

We evaluated preoperative and postoperative false lumen thrombosis on enhanced CT, which was analyzed by the corresponding board-certified cardiovascular staff surgeon (TS) using software with three-dimensional reconstruction

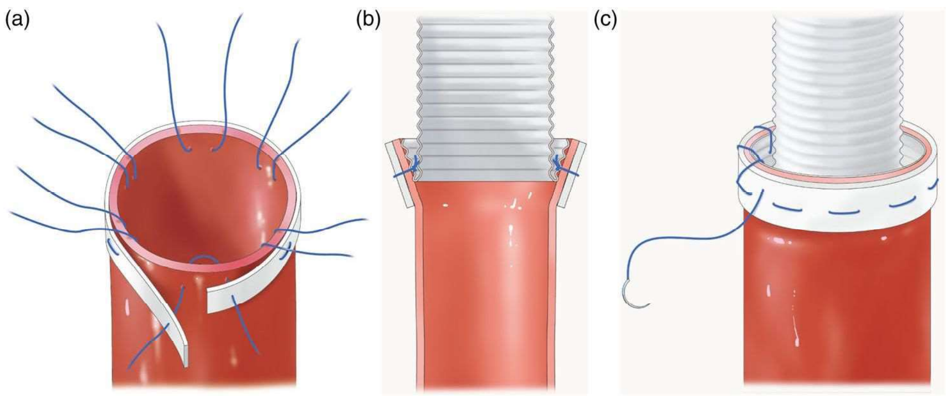

Figure 1. Schematic representation of the turn-up anastomosis technique. The five to eight pairs of U-stay 4-0 polypropylene sutures are placed on the aorta at a depth of 1 cm with external reinforcement using a felt strip (a). After the U-stay sutures are placed at a similar depth to the Dacron graft with the corresponding ratio, the sutures are tied down, with a great care to evert the end of the graft and fit a similar length of the graft and aorta circumferentially to establish an excellent cross-sectional exposure of the aortic wall and graft (b), and continuous 4-0 polypropylene sutures are placed as the second layer of anastomosis (c).

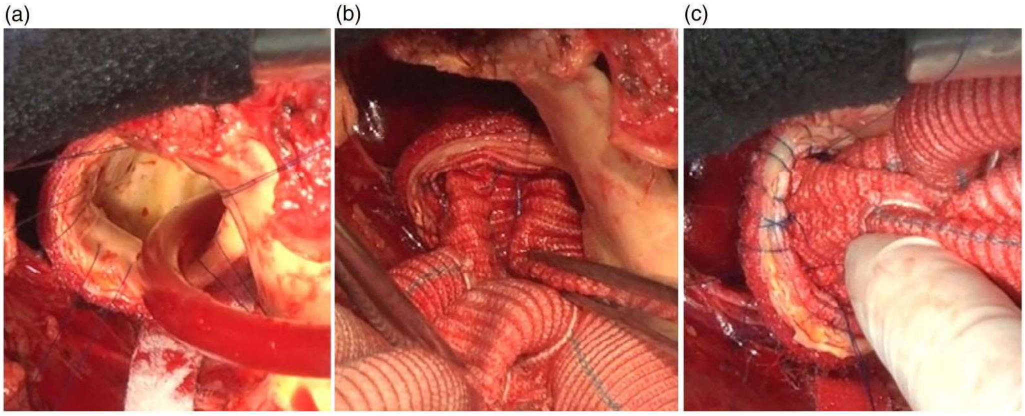

Figure 2. Intraoperative photograph of distal anastomosis using the turn-up technique. By placing the sutures of the first layer circumferentially (a) and tying those sutures to evert the end of Dacron prosthesis (b), surgeons can easily place continuous over-and-over sutures of the second layer on the maximized joining surface of both the native aorta and the prosthesis (c).

Figure 3. Representative postoperative three-dimensional computed tomography image with contrast. Note the secure transition between the aorta and the prosthesis with smooth three-dimensional configuration.

(syngo.via Advanced Visualization System, Siemens Healthcare GmbH, Erlangen, Germany). A homogeneously contrast-enhanced false lumen was considered completely patent. A false lumen with a thrombus in any part and limited flow was considered partially thrombosed. A false lumen that completely lacked blood flow was considered completely thrombosed.[8] The amount of intraoperative bleeding was defined as the suction volume after weaning from cardiopulmonary bypass and arrival at the intensive care unit. Shock was defined as clinical evidence of peripheral hypoperfusion with a systolic blood pressure of <90 mm Hg. Transfusion amounts were defined as those during the intraoperative interval and 24 h after leaving the operating room. Respiratory failure was defined as a state that requires respiratory support with intubation longer than 24 h postoperatively or a PaO2/FiO2 ratio of <200. Chronic obstructive pulmonary disease is defined as a progressive lung disease with clinical and/or radiological signs of emphysema, chronic bronchitis, refractory and nonreversible asthma, and some forms of bronchiectasis. Aortic valve incompetence was defined as a moderate aortic regurgitation. Aortic events during follow-up were defined as death of aortic dissection, aortic reoperation (either surgical or endovascular), aortic arch dilatation of >55 mm, aortic root dilatation of >50 mm, or more than moderate aortic regurgitation due to aortic root dilatation caused by TAAAD.

Statistical analysis

Three comparison groups were created based on the extent of the surgery: ascending/hemiarch (no reconstruction of the arch branch), partial arch (reconstruction of one or two arch branches), and total arch (reconstruction of three arch branches) replacements. The clinical characteristics of each group are presented as frequencies and percentages for categorical variables and as means $\pm$ standard deviations for continuous variables. Univariate differences among the three groups were compared using the chi-square test for categorical variables and the analysis of variance for continuous variables. Freedom from all-cause death, aorta-related death, and aortic events were computed using the Kaplan–Meier technique, and event-free curves were compared using the log-rank test. If the p-value was <0.05, then the p-value of the pairwise comparison was computed with adjustment using the Bonferroni method. Data analysis was performed using the R software (R Foundation for Statistical Computing, version 3.4.1).

Results

Basic and clinical characteristics

Table 1 summarizes the preoperative patient characteristics. The mean age of the patients was 67.7 ± 13.4 years, and 125 were males. The false lumen status was patent in 150 patients, partially thrombosed in 38, and completely thrombosed in 76. The degree of replacement was ascending/hemiarch in 155 patients, partial arch (reconstruction of one or two arch branches) in 71, total arch in 32, and total arch plus frozen elephant trunk in six. Concomitant surgeries included the Bentall procedure in nine patients, coronary artery bypass grafting in 16, aortic valve repair/replacement in four, mitral valve repair in two, and tricuspid annuloplasty in three. The mean follow-up time was 67.7 ± 13.4 months, with a follow-up rate of 92%. During the study period, five staff surgeons performed the surgeries on an emergency basis. The operative time, cardiopulmonary bypass time, cross-clamp time, lower body circulatory arrest time, and surgical bleeding were significantly longer and greater if the surgery was extended to the aortic arch.

In-hospital mortality

In-hospital mortality occurred in 25 patients (9.4%). The causes of death were uncontrolled bleeding in three patients (from the aortic root in two patients and diffuse bleeding with

Table 1. Patient characteristics.

	All	Ascending/hemiarch	Partial arch	Total arch	*p* value
No	264	155 (58.7)	71 (26.9)	38 (14.4)	
Male	129(48.9)	58 (37.4)	41 (57.7)	30 (78.9)	<0.001
Mean age	67.7 ± 13.4	69.7 ± 13.0	66.9 ± 11.6	60.8 ± 15.65	<0.001
Height	159.8 ± 10.0	157.4 ± 8.8	162.2 ± 10.9	165.1 ± 10.34	<0.001
weight	59.6 ± 15.1	57.3 ± 13.7	61.8 ± 17.5	65.1 ± 14.6	0.009
Marfan syndrome	7 (2.7)	3 (1.9)	2 (2.8)	2 (5.3)	0.517
Preoperative shock	40 (15.2)	29 (18.7)	6 (8.5)	5 (13.2)	0.127
Preoperative tamponade	53 (20.2)	42 (27.1)	7 (9.9)	4 (10.8)	0.003
Preoperative CPA	12 (4.5)	8 (5.2)	2 (2.8)	2 (5.3)	0.716
HT	181 (68.6)	107 (69.0)	44 (62.0)	30 (78.9)	0.188
PAD	6 (2.3)	4 (2.6)	0 (0.0)	2 (5.3)	0.197
DM	19 (7.2)	14 (9.0)	4 (5.6)	1 (2.6)	0.328
COPD	5 (1.9)	4 (2.6)	1 (1.4)	0 (0.0)	0.544
Smoking history	92 (34.8)	45 (29.0)	29 (40.8)	18 (47.4)	0.048
Current smoker	51 (19.3)	27 (17.4)	12 (16.9)	12 (31.6)	0.117
History of CVD	29 (11.0)	18 (11.6)	9 (12.7)	2 (5.3)	0.462
Family history	17 (6.4)	7 (4.5)	9 (12.7)	1 (2.6)	0.043
Preoperative creatinine	1.1 ± 0.8	1.1 ± 1.0	0.9 ± 0.3	1.13 ± 0.6	0.224
HD	1 (0.4)	1 (0.7)	0 (0.0)	0 (0.0)	0.703
HL	41 (15.5)	28 (18.1)	11 (15.5)	2 (5.3)	0.149
Debakey type					
I	189 (71.6)	109 (70.3)	59 (83.1)	21 (55.3)	<0.001
II	42 (15.9)	34 (21.9)	8 (11.3)	0 (0.0)	
III	33 (12.5)	12 (7.7)	4 (5.6)	17 (44.7)	
Preoperative organ malperfusion					
Cerebral	37 (14.0)	20 (12.9)	12 (16.9)	5 (13.2)	0.714
Coronary	26 (9.8)	11 (7.1)	11 (15.5)	4 (10.5)	0.143
Intestine	8 (3.0)	3 (1.9)	4 (5.6)	1 (2.6)	0.318
Kidney	28 (10.6)	14 (9.0)	10 (14.1)	4 (10.5)	0.519
Spinal cord	7 (2.7)	2 (1.3)	5 (7.0)	0 (0.0)	0.024
Leg	33 (12.5)	18 (11.6)	9 (12.7)	6 (15.8)	0.79
Preoperative false lumen status					
Patent	150 (56.8)	69 (44.5)	52 (73.2)	29 (76.3)	<0.001
Partially thrombosed	32 (12.1)	16 (10.3)	11 (15.5)	5 (13.2)	
Thrombosed	82 (31.1)	70 (45.2)	8 (11.3)	4 (10.5)	
Valvalva diameter at onset	37.4 ± 6.1	37.3 ± 5.7	36.3 ± 5.6	39.8 ± 7.6	0.027
Diameter at distal anastomosis	40.4 ± 6.3	41.0 ± 6.7	40.3 ± 5.7	38.1 ± 5.4	0.066

CPA: cardiopulmonary arrest; HT: hypertension; PAD: peripheral artery disease; DM: diabetes mellitus; COPD: Chronic Obstructive Pulmonary Disease; CVD: cerebrovascular disease; HD: hemodialysis; HL: hyperlipidemia.

coagulopathy due to dabigatran in one patient), sudden aortic rupture of the unreplaced descending aorta in three patients with no sign of anastomotic dehiscence, acute respiratory distress syndrome in one patient, arrhythmia in one patient, coronary malperfusion in six patients (three patients preoperatively and three patients intraoperatively), cerebral malperfusion in seven patients (diffuse injury due to preoperative shock in one patient, preoperative malperfusion caused by aortic dissection in three patients, and diffuse injury due to intraoperative hypotension in three patients), and visceral malperfusion in two patients.

Freedom from death and aortic events

The rates of freedom from all-cause death, aortic death, and aortic events at postoperative 5 years were $78.5 \pm 2.7\%$, $86.8 \pm 2.1\%$, and $74.4 \pm 2.9\%$, respectively. When these values were stratified according to the operative extent, a significant difference was observed only in the aortic events ($p = 0.04$) (Figure 4).

Bleeding

Immediate reopening for bleeding was observed in 20 patients (ascending/hemiarch in 7, partial arch in 9, and total arch in 4), and bleeding from the turn-up anastomosis was observed in three proximal and two distal anastomoses. Among the three patients with bleeding from the proximal anastomosis, two patients underwent concomitant partial remodeling in which a tongue-shaped Dacron patch was used for cusp reconstruction. Intraoperative bleeding and drained blood within 24 h were 2983.8 ± 3026.5 and 989.3 ± 720.4 mL, respectively, and they increased significantly as the extent of surgery became more extended toward the arch (Table 2).

Postoperative distal lumen status

Table 3 summarizes the postoperative outcomes. Distal anastomotic leak was absent in 61.4% of patients, and the false lumen distal to the anastomosis site was thrombosed in 49.8% and partially thrombosed in 22.4%.

The location of the bleeding at reopening

The locations of bleeding are summarized in Table 4. At reopening, no causal bleeding was identified in nine patients.

Discussion

The surgical management of TAAAD is technically challenging because of the fragility of the dissected aortic wall and the technical demand to achieve good hemostasis.[9] Since TAAAD is an emergency condition and the surgery should be performed by multiple surgeons with different experience levels, the anastomosis technique should be technically less demanding and good in hemostasis.[4] Although several types of technique have been reported for anastomosis, those can be categorized into three types of technique: single-layer anastomosis with outer felt reinforcement with or without inner felt reinforcement[10] and adventitial inversion technique with or without felt reinforcement,[3,6] multiple-layer anastomosis with felt reinforcement as turn-up anastomosis,[7] and telescope technique using prosthesis inside the dissected aorta.[11]

We believe that there are several components of the ideal anastomosis technique, particularly in aortic dissection surgery, and that turn-up anastomosis offers good exposure, ease of suture placement, and hemostatic security. However, the greater the operative extent, the more the patient bleeds. Since the surgeon can place sutures in the first layer by confirming the pitch and depth of the suture both inside and outside the aorta, the surgeon cannot miss the intima or adventitia. Regarding the number of U-sutures, although some advocate that only four U-sutures are sufficient for the first layer, we suggest five to eight U-sutures to avoid bulging of the prosthesis after tying the first layer. After dissecting around the anastomosis plane as the surgeon places the U-suture, the exposure improves as the second suture placement is facilitated through the traction of the first suture. By gently pulling the five to eight U-sutures of the first layer with some adjustments, we can visualize and optimize the entire perspective of the anastomotic plane, including balance, depth, and tension of the sutures, as well as tilt and angle. While all U-sutures are placed on the prosthesis on the sternal retractor, the pitch and bite on the prosthesis are easy to confirm and are associated with a lower chance of handling the needle deep in the surgical field. While tying the sutures of the first layer, surgeons may easily evert the edge of the prosthesis on the aorta, facilitating the second layer of continuous over-and-over sutures, thus creating a firm and sufficient hemostatic plane, not a line, between the aorta and the prosthesis. Even in cases of unexpected bleeding, placing additional sutures is an easy task, and with the aforementioned manipulation, the anastomotic plane is clearly visualized. The bleeding portion, usually from the dog-ear redundancy of the prosthesis, is everted in both the prosthesis and the aorta and is, thus, graspable. If hemostasis from the proximal anastomosis was not feasible, a rescue procedure of partial remodeling was performed, which was extremely rare (2/264 cases).

Anastomotic methods should be evaluated based on multiple perspectives; the ease of suture placement should be evaluated according to circulatory arrest and operative time. Oda et al. reported that with the adventitial inversion technique, hemiarch replacement was performed in 36 patients with a mean operative time of 376 min, comparable with our outcome.[3] Hemostatic security was evaluated

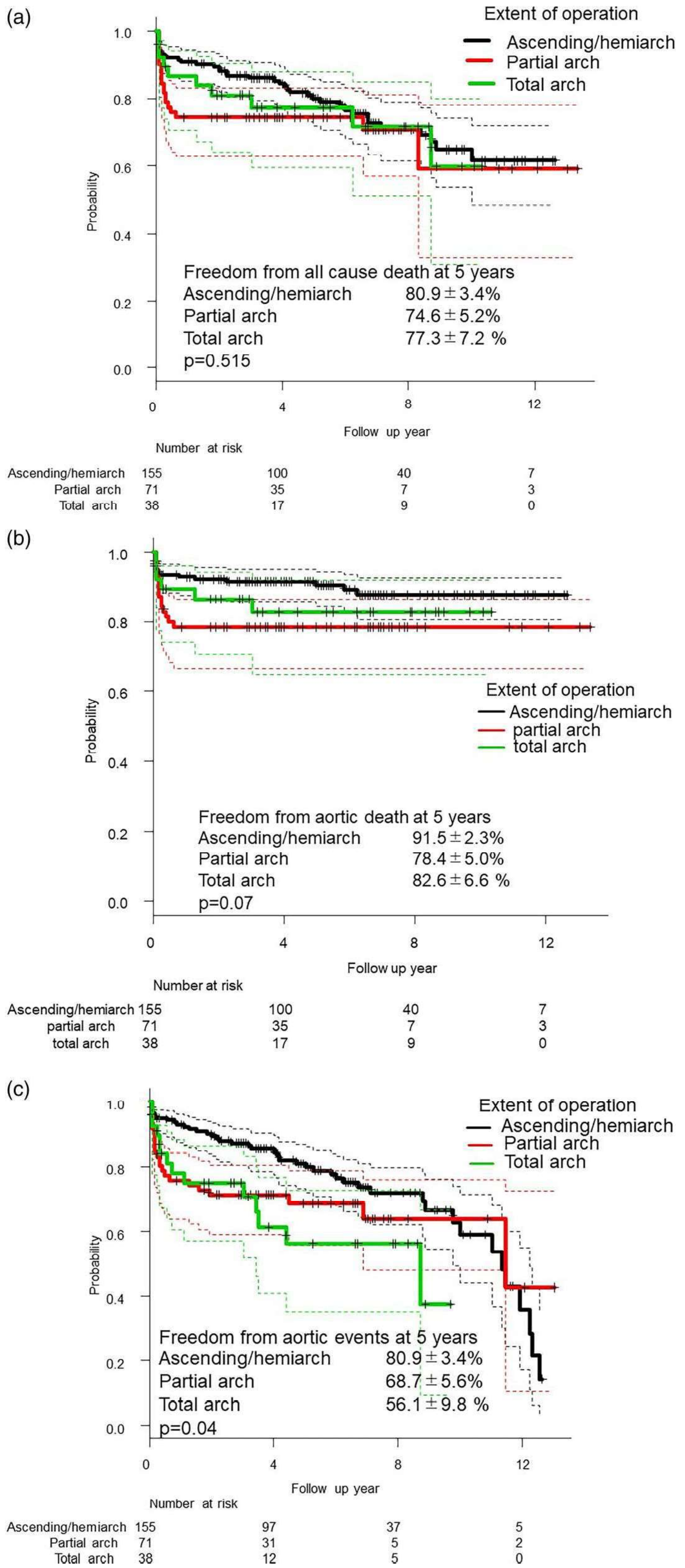

Figure 4. A Kaplan–Meier curve showing freedom from all-cause death (a), aortic death (b), and aortic events (c) stratified according to the operative extent. The dotted lines depict a 95% confidence interval accordingly.

Table 2. Operative outcome.

	All	Ascending/hemiarch	Partial arch	Total arch	*p* value
Confirmed entry resection	233 (88.2)	141 (91.0)	67 (94.4)	31(81.6)	0.09
Use of turn-up anastomosis					
Proximal	251 (95.1)	151(97.4)	67 (94.3)	37(97.3)	0.63
Distal	264(100)	155(100)	71(100)	38(100)	1
Operative time(minutes)	390.9 ± 144.5	345.8 ± 109.2	412.9 ± 123.5	534.1 ± 198.9	<0.001
Cardiopulmonary bypass time(minutes)	215.0 ± 70.8	192.3 ± 49.8	226.6 ± 71.3	280.6 ± 91.1	<0.001
Aortic cross-clamp time(minutes)	126.2 ± 51.5	108.9 ± 34.6	133.6 ± 55.8	180.5 ± 58.5	<0.001
Lower body circulatory arrest time(minutes)	46.5 ± 16.4	40.2 ± 11.5	48.9 ± 11.2	67.2 ± 21.2	<0.001
Surgical Glue					
Glue in root false lumen	241 (91.2)	140 (90.3)	67(94.3)	34(89.5)	0.294
GRF	149 (56.4)	99 (63.9)	33 (46.5)	17 (44.7)	0.015
Bioglue	92 (34.8)	41 (26.5)	34 (47.9)	17 (44.7)	0.003
Surgical bleeding(cc)	2983.8 ± 3026.5	2259.1 ± 2218.4	3186.4 ± 2642.4	5533.8 ± 4705.7	<0.001
24 h drained blood	989.3 ± 720.4	856.1 ± 689.8	1079.6 ± 734.3	1369.6 ± 673.4	<0.001
Packed red blood cells(unit)	7.9 ± 5.1	7.4 ± 4.6	8.5 ± 5.4	8.6 ± 5.9	0.224
Fresh frozen plasma(unit)	12.5 ± 7.8	10.8 ± 6.8	13.8 ± 7.6	16.7 ± 9.7	<0.001
Concomitant procedures					<0.001
CABG		7	7	2	
AVP/AVR		2/1	0/1	0/0	
MVP/MVR		2/0	0/0	0/0	
TAP		1	1	1	
Root repair/replacement		11/4	3/4	4/1	
Pulmonary vein isolation		1	0	0	
FF bypass		3.	3	0	
Frozen elephant trunk		0	0	6	
Reexploration for surgical bleeding	20 (7.6)	7 (4.5)	9 (12.7)	4 (10.5)	0.075

GRF: gelatin resorcinol formaldehyde; CABG:coronary artery bypass grafting; AVP: aortic valvuloplasty; AVR: aortic valve replacement; MVP: mitral valvuloplasty; MVR: mitral valve replacement; TAP: tricuspid annuloplasty; FF: femoral artery to femoral artery; CHDF: continuous hemodiafiltration.

Table 3. Postoperative outcome.

Hospital death	25 (9.4)	10(6.5)	11(15.5)	4(10.5)	0.506
Major adverse event					
Stroke	63 (23.9)	35 (22.6)	18 (25.4)	10 (26.3)	0.838
Major	42 (15.9)	22 (14.2)	12 (16.9)	8 (21.1)	0.564
Postop new major stroke	15 (5.7)	10 (6.5)	3 (4.2)	2 (5.3)	0.793
Respiratory failure	162 (61.4)	89 (57.4)	44 (62.0)	29 (76.3)	0.1
Intubation hours	72.8 ± 101.4	65.1 ± 93.4	71.3 ± 83.5	105.9 ± 147.1	0.096
Tracheostomy	30 (11.4)	16 (10.3)	10 (14.1)	4 (10.5)	0.699
Postoperative peak creatinine	2.1 ± 2.0	1.9 ± 1.7	2.2 ± 1.9	2.7 ± 2.9	0.099
Temporary CHDF	21 (8.7)	8 (5.2)	9 (12.7)	4 (10.5)	0.125
Permanent hemodialysis	5 (1.9)	4 (2.6)	0 (0.0)	1 (2.6)	0.390
Mediastinitis	6 (2.3)	2 (1.3)	4 (5.6)	0 (0.0)	0.075
Paraplegia	12 (4.5)	9 (5.8)	2 (2.8)	1 (2.6)	0.502
Postoperativ					
Aortic valve incompetence	10 (3.8)	7 (4.5)	0 (0.0)	3 (7.9)	0.092
Residual proximal dissection	11 (4.2)	8 (5.2)	1 (1.4)	2 (5.3)	0.396
Distal lumen status					0.009
Patent	71 (27.8)	34 (22.5)	25 (36.8)	12 (33.3)	
Partially thrombosed	57 (22.4)	29 (19.2)	15 (22.1)	13 (36.1)	
Thrombosed	127 (49.8)	88 (58.3)	28 (41.2)	11 (30.6)	
Intensive care unit stay (days)	11.8 ± 16.6	10.1 ± 12.2	15.1 ± 24.0	12.8 ± 14.4	0.101
Hospital stay (days)	29.2 ± 27.9	25.9 ± 21.8	32.6 ± 35.8	36.1 ± 32.0	0.061
Late redissection					
Proximal	18 (6.8)	14 (9.0)	1 (1.4)	3 (7.9)	0.524
Distal	12 (4.5)	9 (5.8)	2 (2.8)	1 (2.6)	0.502

CHDF: continuous hemodiafiltration.

Table 4. The locations of surgical bleeding at reexploration.

	Proximal anastomosis	distal anastomosis	Between vascular grafts	anastomosis between branch and graft
Ascending/hemiarch	2	1	0	0
Partial arch	0	0	1	2
Total arch	1	1	0	0

based on postoperative bleeding and re-exploration of bleeding. Our re-exploration rate was 7.6%, which is better than that reported in other reports.[3] False lumen obliteration is important for improving long-term outcomes. With the adventitial inversion and felt sandwich techniques, the rates of the patent false lumen were reported to be as high as 21.2%–30.8% and 42%–63.0% of the patients,[3,12,13] respectively. With turn-up anastomosis, a patent false lumen was observed in only 27.8% of patients, which appeared to offer the surgeon a more secure anastomosis line.

We performed total arch replacement in a very limited number of patients, particularly younger patients with entry located in the arch. Many surgeons have debated the appropriate extent of aortic replacement during the initial surgery for TAAAD.[14] Although some surgeons[15,16] reported no discernible downside to total arch replacement, many surgeons reported a negative opinion of it.[17,18] Patients with severe preoperative hemodynamic compromise tended to undergo ascending artery replacement. Our data revealed that the greater the extent of aortic repair, the longer the operative time and the higher the surgical bleeding. In this study, although in-hospital mortality did not show any significant differences according to the extent of surgery, mortality was slightly higher in patients who underwent partial arch replacement most probably because of the higher frequency of perioperative organ malperfusion. Moreover, the aortic events showed significant differences; this may be owing to less confirmed entry resection achieved in total arch repair in the index surgery, and patients with ascending/hemiarch replacement were older, smaller, and more likely to have a thrombosed false lumen, although no definitive explanation can be given.

As a limitation, this was a single-center study, and turn-up anastomosis has been the technique of choice in our hospital since 2003. Therefore, comparison with other anastomosis techniques was not feasible within our hospital. Moreover, the study had a small sample size, a limited follow-up period, an observational study design, a lack of treatment randomization, and differences in experience based on different surgeons. We acknowledge that these factors can introduce bias in patient and treatment selection. In addition, long-term follow-up is required, particularly for the formation of pseudoaneurysms at the anastomotic site. In conclusion, turn-up anastomosis facilitates short circulatory arrest, shorter operative time, and stable hemostasis, with few anastomotic complications.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval

The Institutional Review Board of Kurashiki Central Hospital approved this study and waived the need for an informed consent because of its retrospective design. This study was approved by the Institutional Review Board of Kurashiki Central Hospital on July 25, 2017 (No. 2538).

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Informed consent

Not applicable.

ORCID iDs

Takeshi Shimamoto https://orcid.org/0000-0002-0781-538X
Takehiko Matsuo https://orcid.org/0000-0001-6336-853X

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