Original Article

Clinical Outcome of the Type A Acute Aortic Dissection Repair Using the "Tailored Stand-Up Collar" Technique

Yukio Umeda,[1] Yuta Inoue,[1] Shohei Mitta,[1] Yukihiro Matsuno,[1] and Shoji Yoshikawa[2]

Purpose: Achieving a secure anastomosis and complete hemostasis is essential for surgically treating type A acute aortic dissection (TAAAD). This study assessed the clinical feasibility of "tailored stand-up collar (TSC)" technique for constructing the distal stump.

Methods: We enrolled 68 patients who underwent ascending aortic repair for TAAAD. Patients were categorized according to the technique for distal stump construction: conventional (C) group using only a felt strip (32 cases); post-aortotomy (P) group, with a Hydrofit-felt strip attached after aortotomy (18 cases), and TSC group, where a Hydrofit-felt strip attached during cooling (18 cases). Pre-operative characteristics, procedural profiles, and post-operative outcomes were evaluated.

Results: The pre-operative characteristics were identical among the groups. The durations of cardiopulmonary bypass, hemostasis, and surgery were significantly shorter in the P and TSC groups. The duration of open distal in the TSC group (21 min) was significantly shorter than the other two groups. Post-operative additional procedures were not required for the TSC group and their post-operative hospital stay was significantly shorter (47.1% of patients were discharged within 2 weeks).

Conclusion: The TSC technique would be practical because of its high reproducibility in terms of ease of use, shorter anastomotic time, and secure hemostasis.

Keywords: type A acute aortic dissection, distal stump construction, Hydrofit, tailored stand-up collar technique

Introduction

Secure anastomosis and complete hemostasis are crucial for restoring the integrity of the aortic wall in the surgical treatment of type A acute aortic dissection (TAAAD). Several techniques have been reported for preventing anastomotic bleeding.[1–3] The most common technique is reinforcing the anastomosis site with a felt strip. However, regarding needle-hole bleeding, trans-felt strip oozing is a concern because of the high porosity of felt strips.

We previously developed the "tailored stand-up collar (TSC)" technique for constructing the distal stump by pre-gluing a felt strip with Hydrofit, a surgical sealant composed of a highly reactive copolymer of polyethylene

[1]*Department of Cardiovascular and Thoracic Surgery, Gifu Prefectural General Medical Center, Gifu, Gifu, Japan*
[2]*Department of Food and Nutritional Science, Toita Women's College, Tokyo, Japan*

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Corresponding author: Yukio Umeda. Department of Cardiovascular and Thoracic Surgery Gifu Prefectural General Medical Center, 4-6-1 Noishiki, Gifu, Gifu 500-8717, Japan
E-mail: yukioumeda@gmail.com

glycol and polypropylene glycol, during systemic cooling to reduce the open distal time and needle hole-bleeding.[4] In this study, we investigated the clinical efficacy and reproducibility of the TSC technique in distal stump construction for acute aortic dissection.

Materials and Methods

Surgical strategy for TAAAD in our institution

In patients with hemodynamic instability, ascending aortic replacement is planned regardless of the location of the intimal tear. Even for patients with hemodynamic stability, the strategy for the arch branches is determined before the procedure begins based on a careful review of the preoperative computed tomography (CT). If the decision was made to perform ascending aortic replacement, even without identifying the intimal tear in the ascending aorta, the strategy would not be altered, assuming strict post-operative CT follow-up.

This strategy is consistent throughout the three groups divided according to the methods employed for distal stump construction described below.

TSC technique

Following median sternotomy, cardiopulmonary bypass (CPB) is initiated with the arterial cannula in the common femoral artery and two venous cannulae in the superior and inferior vena cava. A retrograde cardioplegia cannula is inserted directly into the coronary sinus through the right atriotomy. After circumferentially exposing the ascending aorta in the intra- and extrapericardial cavities, the pericardial reflection is incised along the aorta ventral to the trachea. During systemic cooling, an ePTFE felt strip (15-mm width, 1.65-mm thickness, 150-mm length, USCI Japan Ltd., Tokyo, Japan) applied with Hydrofit is circumferentially placed on the outside of the sufficiently exposed aorta. In most cases of TAAAD, there is a discrepancy between the diameters of the intima and adventitia owing to aortic dissection. To resolve this, we employed adventitial perimeter "tailoring" using a tourniquet. The target tailoring perimeter is determined by adding the thickness of the intima and adventitia to the intimal lumen diameter on the preoperative CT. In the cases where the intimal lumen does not maintain a circular shape, the intimal perimeter is used instead of the intimal lumen diameter. For example, if the intimal lumen diameter on CT is 26 mm, assuming a 2-mm thickness for the intima and the adventitia, the inner diameter of the felt strip is determined to be 30 mm, and its perimeter is calculated as 95 mm. Excessive tailoring may deform the intimal lumen and alter blood flow, resulting in new malperfusion; therefore, we aim to achieve the maximum tailoring perimeter. In this case, to ensure the maximum tailoring perimeter as 95 mm, a 4-0 Prolene (SH needle, Ethicon, Somerville, NJ, USA) U-shaped suture is first placed 5 mm from one end of a 150 mm long felt strip. Subsequently, a double-armed Prolene is pulled out 50 mm from the other end of the felt strip and passed through a tourniquet. Tourniquet is employed because achieving homogenous concentric force over the entire circumference of the adventitia is challenging when fixing the felt strip simply with clips or forceps. Concerns arise that some part of the adventitia might be folded unevenly. Snaring the tourniquet allows one end of the felt strip to slide and overlap the other end around a sufficiently exposed aortic wall, ensuring relatively homogenous concentric force.

Subsequently, we gradually tighten the tourniquet to the maximum tailoring perimeter after lowering the CPB flow. We confirm that there is no change in blood flow, paying particular attention to right radial artery pressure, which indicates malperfusion of the brachiocephalic artery. Furthermore, we reconfirm that there are no significant changes in blood pressure or regional cerebral saturation of oxygen after restoring CPB flow. Afterward, saline solution is poured around the felt strip to induce polymerization of the Hydrofit (**Figs. 1A–C**, **2A**). However, if a change in blood flow is suspected during the tailoring, Hydrofit polymerization is suspended until the blood flow is confirmed to be restored by loosening the tourniquet. Aortotomy is performed under circulatory arrest at a tympanic temperature of 25°C. Cardiac arrest is accomplished by retrograde infusion of cold blood cardioplegia. Repeat doses are infused every 20 min until coronary perfusion is resumed. Retrograde cerebral perfusion is mainly employed to avoid air emboli of the arch branches rather than to provide cerebral protection. The distal stump is constructed by simple transection along the felt strip placed around the aorta. (**Figs. 2B** and **2C**). Distal anastomosis is performed using a 4-0 Prolene continuous running suture, followed by systemic perfusion with rewarming. The proximal stump is constructed with BioGlue applied inside the false lumen and Hydrofit applied felt strip outside the aorta. Anastomosis of the proximal graft stump is performed in the same manner.

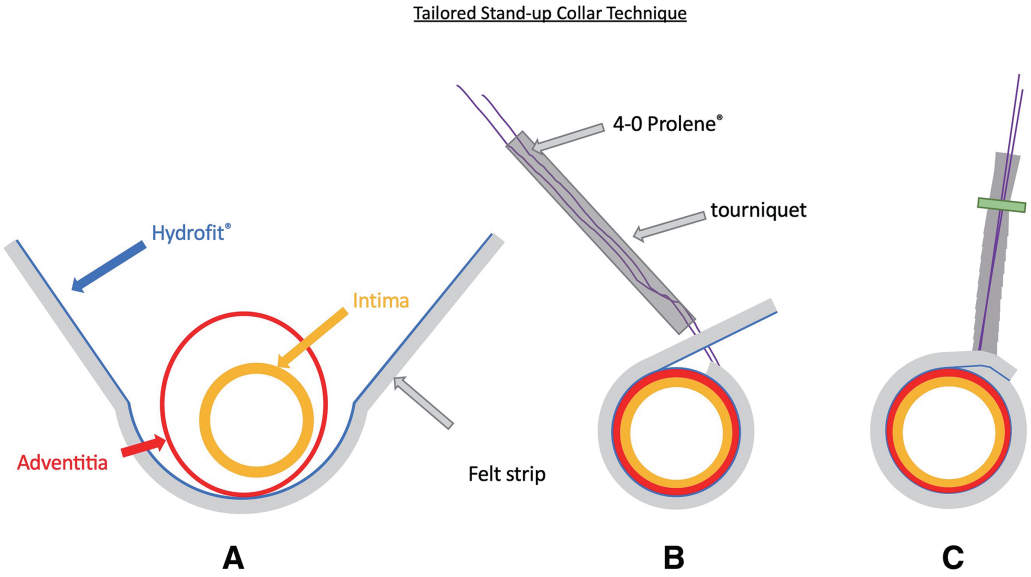

Fig. 1 TSC Technique. (**A**) After circumferential exposure of the ascending aorta in the intra- and extra-pericardial cavity, ePTFE felt strip applied with Hydrofit is circumferentially placed on the outside of the aorta. (**B**) For tailoring, a 4-0 Prolene U-shaped suture is placed at one end of the Hydrofit-applied felt strip, pulled out at the point of the target perimeter, and passed through a tourniquet. (**C**) "Tailoring" is accomplished by snaring the tourniquet while lowering the CPB pump flow. Subsequently, saline solution is poured around the felt strip to induce polymerization of the Hydrofit. TSC, tailored stand-up collar

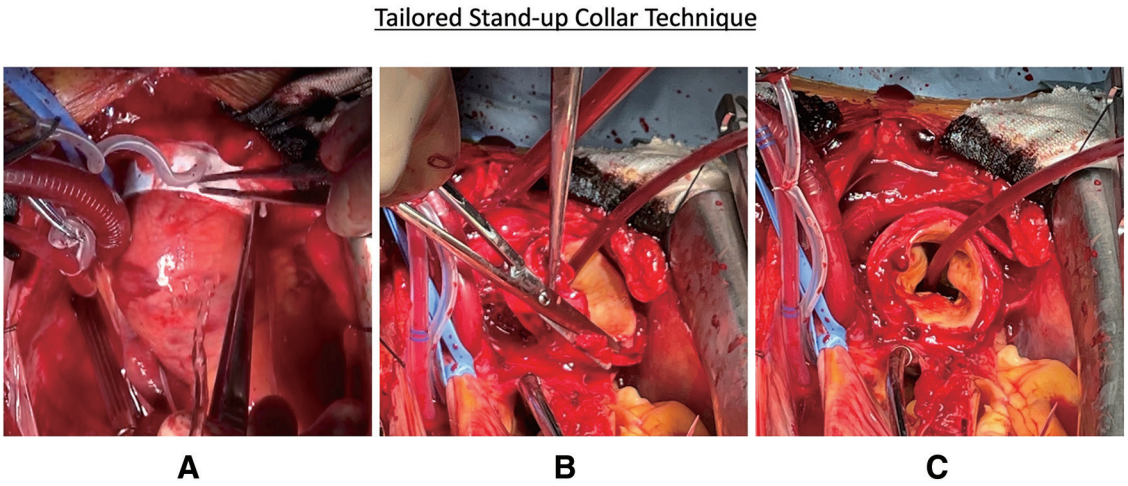

Fig. 2 Distal stump construction and distal anastomosis with TSC Technique. TSC, tailored stand-up collar (**A**) Pre-gluing felt strip with Hydrofit is placed on the outside of the aorta and tailored by snaring the tourniquet during systemic cooling. (**B**) Distal stump is constructed by simple transection along the felt strip. (**C**) Distal anastomosis with a graft is performed using a 4-0 Prolene continuous running suture.

Patients

As we currently apply the TSC technique limited to the ascending aortic repair (AAR) case, in this study, 68 patients who underwent AAR were enrolled from 143 patients with TAAAD who underwent surgical repair in the last decade. These 68 patients were categorized into the following three groups according to the methods employed for distal stump construction: the conventional group (32 patients used felt strip only), the post-aortotomy group (18 patients attached the Hydrofit-applied felt strip after aortotomy), and the TSC group (18 patients attached the Hydrofit-applied felt strip during systemic cooling). Pre-operative, operative, and post-operative factors were compared among the three groups. This retrospective study used prospectively collected data. The study was conducted according to the principles outlined

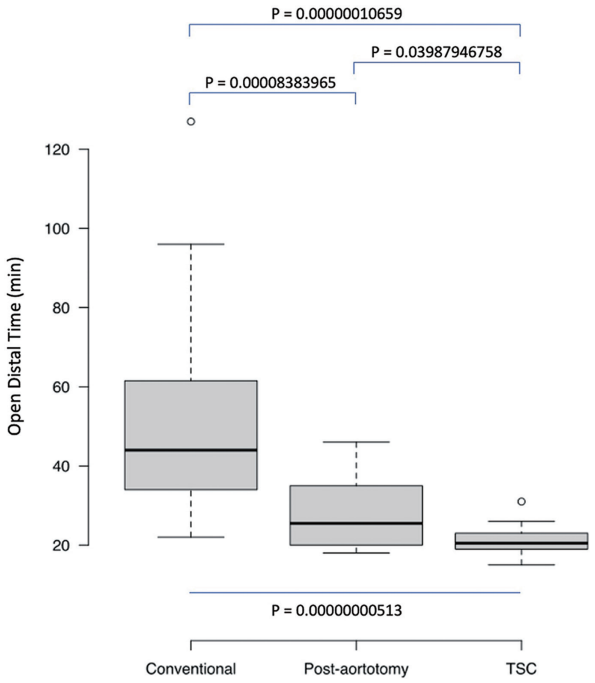

Fig. 3 Duration of distal stump construction & distal anastomosis; open distal time.

in the Declaration of Helsinki and the guidelines of the research ethics committee of Gifu Prefectural General Medical Center. The institutional review board approved it, and informed consent was obtained as an opt-out on the website (GPGMC IRB, Takashi Kuwahara, MD, PhD, #789, October 11, 2022).

Statistical analysis

All data were analyzed using EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphical user interface for R (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables among the three groups were compared using the Kruskal–Wallis test, and post hoc tests were performed using Steel–Dwass's multiple comparisons. Categorical variables for the three independent groups were compared using Fisher's exact test, and post hoc tests were performed using Holm's multiple comparisons. Statistical significance was set at $p < 0.05$.

Results

The baseline patient characteristics and aortic dissection-related patient status were identical among the three groups (**Table 1**). Regarding procedural characteristics, distal first anastomosis and retrograde cardioplegia were significantly more frequent in the post-aortotomy and TSC groups than in the conventional group. In the TSC group, no cases of aortic injury related to exposure of the aorta, placement of the pre-gluing felt strip with Hydrofit, or tailoring of the adventitia were observed. However, in one case, we observed the impairment of right radial artery pressure during tailoring. In that case, we immediately loosened the tourniquet, restored CPB flow, confirmed restoration of the right radial artery pressure, and subsequently performed the polymerization of Hydrofit below the maximum tailoring perimeter. This means that a presumable incorrect target tailoring perimeter was found in one of 18 patients (5.6%); however, excessive tailoring could be avoided in all cases as long as the TSC technique was performed properly. No cases presented significant residual intima-adventitial discrepancy inexpedient for anastomosis at the distal stump after aortotomy. Previously, we "wrapped" the anastomosis site with a vascular prosthesis or resected aortic wall, and Hydrofit was injected under the wrapping to control needle hole-bleeding. No cases required the "wrapping" procedure in the recent two groups with Hydrofit present between the aortic wall and the felt strip before anastomosis. In addition, anastomotic bleeding other than needle hole-bleeding did not require additional stitches in most patients with the TSC technique, and the amount of Surgicel used was significantly less. The open distal time, reflecting the duration of distal stump construction and anastomosis was significantly shorter in the TSC group (median, 21 min) than in the other two groups (**Fig. 3**). Duration of CPB, CPB-off to Op-end time (potentially reflecting hemostasis for minor bleeding), and operation time were significantly shorter in the post-aortotomy and TSC groups than in the conventional group (**Table 2**). Intraoperative blood transfusion was identical among the three groups; however, post-operative packed RBC use was significantly lower in the TSC group. No additional post-operative procedures were required in the TSC group, and the post-operative hospital stay was significantly shorter (**Table 3**).

Discussion

Hydrofit (outside of Japan; AQUABRID, Terumo Corporation, Tokyo, Japan) is a viscous liquid consisting of a polyether-based fluorinated urethane prepolymer with reactive isocyanate groups at both ends. Hydrofit reacts with blood or water, releases carbon dioxide gas, and sequentially polymerizes to form a

Table 1 Patient characteristics

Group	Conventional	Post aortotomy	TSC technique	*p* =
N=	32	18	18	
Age, yo	71 (62–79)	75 (68–79)	67 (55–74)	0.269
> 80 yo	8 (25.0)	4 (22.2)	3 (16.7)	0.929
Male gender	17 (53.1)	8 (44.4)	10 (55.6)	0.859
Current smoker	3 (9.4)	1 (5.6)	3 (16.7)	0.676
Past smoker	3 (9.4)	3 (16.7)	4 (22.2)	0.464
COPD	1 (3.1)	1 (5.6)	3 (16.7)	0.242
CAD	2 (6.2)	0 (0)	0 (0)	0.494
HT	23 (71.9)	14 (77.8)	12 (66.7)	0.738
HL	7 (21.9)	1 (5.6)	2 (11.1)	0.303
DM	4 (12.5)	4 (22.2)	0	0.123
Chronic AF	1 (3.1)	2 (11.1)	0	0.338
CKD	8 (25)	6 (33.3)	1 (5.6)	0.103
HD	1 (3.1)	0	0	>0.99
Marfan syndrome	1 (3.1)	0	0	>0.99
CVD	0	0	1 (5.6)	0.529
Liver disease	3 (9.4)	2 (11.1)	0	0.584
Aortic dissection related patient status				
Aortic regurgitation	8 (25)	3 (16.7)	4 (22.2)	0.929
Pre-op. malperfusion	7 (21.9)	5 (27.8)	8 (44.4)	0.246
Cardiac tamponade	12 (37.5)	5 (27.8)	4 (22.2)	0.496
PEA	10 (31.2)	3 (16.7)	3 (16.7)	0.433
LOC	11 (34.4)	4 (22.2)	2 (11.1)	0.199
Pre-op. ECMO	3 (9.4)	0	1 (5.6)	0.803
JapanSCORE death, %	9.1 (6.9–15.2)	9.1 (5.9–11.7)	7.1 (4.8–14.3)	0.413

AF, atrial fibrillation; CAD, coronary artery disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CVD, cerebrovascular disease; DM, diabetes mellitus; ECMO, extra-corporeal membrane oxygenation; HD, hemodialysis; HL, hyperlipidemia; HT, hypertension; LOC, loss of consciousness; PEA, pulseless electrical activity; TSC, tailored stand-up collar

gel-like flexible polymer that adheres to the vascular anastomosis to stop bleeding. In contact with blood or water, Hydrofit forms an elastic layer within 3 to 5 min. Because this polymerized material possesses moderate elasticity and strength, it withstands blood pressure and follows the pulsation of blood vessels.[5–7] Compared with the use of BioGlue, Hydrofit has no concern with tissue necrosis associated with the glutaraldehyde and does not require a completely bloodless field for polymerization.[8,9] Therefore, we introduced Hydrofit to construct the distal stump during acute aortic dissection repair. The crux of our "TSC" technique is to construct the stump using Hydrofit pre-gluing felt strip during systemic cooling while eliminating the discrepancy between the intima and the adventitia by tailoring. The initially considered advantages of this technique are as follows: (1) Feasible while waiting for cooling, (2) Reduce embolus risk related to Hydrofit, (3) Mimic the diametric discrepancy between the intima and adventitia by tailoring, (4) Quick stump construction by simple transection along the felt strip; (5) Make a self-standing round shape stump by antagonizing the Extension force of the felt strip and the adhesive force of Hydrofit each other, (6) Make the anastomosis extremely easy and fast; and (7) Making open distal time shortened.[4]

According to the results of this study, the TSC technique can be safely performed during systemic cooling without aortic injury and without an additional Hydrofit application after aortotomy. Tailoring minimizes the discrepancy between the intima and adventitia at the distal stump, facilitating easy and quick anastomosis. The initially considered advantages of the technique were completely demonstrated. The TSC group also had a better post-operative course, with a median hospital stay of 15 days; 47.1% of the patients were discharged within

Table 2 Procedural characteristics

Group	Conventional	Post aortotomy	TSC technique	p =	p <0.05		
					C vs. P	C vs. T	P vs. T
Injury of the aorta by TSC-tech.	–	–	0				
Distal first anastomosis	8 (25.0)	16 (88.9)	17 (94.4)	<0.001	*	*	
Retrograde cardioplegia	8 (25.0)	18 (100)	18 (100)	<0.001	*	*	
Concomitant procedure	8 (25.0)	0	3 (16.7)	0.058			
AVR	2 (6.2)		1 (5.6)				
CABG	5 (15.6)		1 (5.6)				
Peripheral bypass	2 (6.2)		1 (5.6)				
Root procedure	5 (15.6)		1 (5.6)				
Surgicel, pack	6.0 (3–10)	6.0 (3–9)	3.5 (1–5)	0.017		*	*
Anastomosis site wrapping	7 (21.9)	0	0	0.013			
Intra-op. RBC, U	12 (10–14)	10 (10–17)	11 (8–14)	0.823			
Intra-op. FFP, U	20 (10–26)	14 (10–18)	15 (15–22)	0.075			
Intra-op. PC, U	20 (20–20)	20 (20–20)	20 (20–20)	0.026			
Anesthesia, min	465 (415–511)	316 (292–379)	315 (294–357)	<0.001	*	*	
Operation, min	349 (322–399)	221 (199–279)	238 (210–264)	<0.001	*	*	
CPB, min	225 (196–241)	128 (109–167)	123 (115–135)	<0.001	*	*	
Open distal, min	44 (34–61)	26 (20–34)	21 (19–23)	<0.001	*	*	*
CPB-off to Op-end, min	90 (70–140)	62 (55–91)	72 (66–88)	0.006	*	*	
Post-op. ECMO	3 (9.4)	1 (5.6)	0	0.803			

*p <0.05.

AVR, aortic valve replacement; CABG, coronary artery bypass grafting; CPB, cardio-pulmonary bypass; ECMO, extra-corporeal membrane oxygenation; FFP, fresh frozen plasma; RBC, packed red blood cells; PC, platelet concentrate; TSC, tailored stand-up collar

2 weeks, whereas only 11.8% required a hospital stay of more than 1 month.

The TSC technique achieved a shorter anastomosis time with minimal variation, as shown in the box-and-whisker diagram (**Fig. 3**). The stability of the open distal time within an acceptable range indicates the potential for raising the target cooling temperature in the future. Furthermore, the TSC technique may have effectively controlled massive anastomotic bleeding, which requires hemostasis during CPB, and minor needle hole bleeding between the aortic wall and the felt strip. We believe that controlling massive anastomotic bleeding is reflected in shorter CPB time, while control of minor needle hole bleeding contributes to shorter CPB-off to Op-end time. In fact, in the conventional group, wrapping was often required to control needle hole bleeding, but with the application of the Hydrofit, wrapping was no longer necessary.

Eliminating the intima-adventitial discrepancy through tailoring was expected to reduce the probability of the so-called "suture entry." Post-operative contrast-enhanced CT revealed suggestive findings of the "suture entry" in two cases from the TSC group. On the other hand, in accordance with our institution's strategy described earlier, for patients who decided to undergo ascending replacement preoperatively, the range of interposition was limited to the ascending aorta throughout the three groups. This might contribute some extent to residual dissection, which is considered suture entry.

Currently, we apply the TSC technique only for AAR. However, it can also be applied to total arch replacement using an open stent graft, where the distal anastomosis is placed proximal to the brachiocephalic bifurcation, combined with selective cerebral circulation. Furthermore, this method is applicable for constructing the proximal stump when a longer time is required to achieve the target temperature for circulatory arrest.

The initial outcome of the TSC technique was favorable, with no additional procedures related to aortic dissection during hospitalization or early after discharge, but mid- to long-term follow-up is required for the evaluation of pseudoaneurysm formation, enlargement, or rupture of the residual false lumen, and the appearance of new malperfusion.

Conclusions

Procedural stability and favorable post-operative outcomes of the TSC technique were confirmed in this study. We believe that the highly reproducible TSC

Table 3 Post-op. Patient characteristics

Group	Conventional	Post aortotomy	TSC technique	p =	p <0.05		
					C vs. P	C vs. T	P vs. T
Re-thoracotomy	3 (9.4)	2 (11.1)	1 (5.6)	>0.99			
Post-op. RBC, U	8 (4–13)	7 (4–14)	2 (0–6)	0.015		*	*
Post-op. FFP, U	4 (0–13)	7 (1–15)	4 (0–6)	0.465			
Post-op. PC, U	0 (0–20)	0 (0–20)	0 (0–10)	0.562			
Extubation, POD	4 (2–6)	2 (2–6)	2 (1–4)	0.359			
POAF	1 (3.1)	2 (11.1)	2 (11.1)	0.438			
ARF required HD	3 (9.4)	4 (22.2)	0	0.095			
Deep sternum infection	5 (15.6)	2 (11.1)	0	0.331			
Stroke	6 (18.8)	3 (16.7)	1 (5.6)	0.556			
Post-op. malperfusion	2 (6.2)	2 (11.1)	1 (5.6)	0.846			
Pneumonia	2 (6.2)	0	1 (5.6)	0.793			
Prolonged ventilation (>72 h)	17 (70.8)	10 (58.8)	8 (44.4)	0.264			
Tracheostomy	1 (3.1)	4 (22.2)	0	0.031			
Additional procedure	9 (28.1)	8 (44.4)	0	0.003		*	*
TAR	2 (6.2)	1 (5.5)	0				
Root repair	1 (3.1)	0	0				
Procedure for malperfusion	2 (6.2)	3 (16.7)	0				
Open drainage for deep sternum infection	4 (12.4)	2 (11.1)	0				
Others	0	2 (11.1)	0				
Dissection related additional procedure	5 (15.6)	4 (22.2)	0	0.099			
Post-op. hospital stay, POD	27 (20–44)	41 (18–54)	15 (10–27)	0.006		*	*
Discharge before 14 POD	2 (8.3)	2 (12.5)	8 (47.1)	0.010		*	
Discharge after 31 POD	10 (41.7)	9 (56.2)	2 (11.8)	0.025			*
Hospital death	8 (25.0)	2 (11.1)	1 (5.6)	0.166			

*p <0.05.

ARF, acute renal failure; FFP, fresh frozen plasma; HD, hemodialysis; PC, platelet concentrate; POAF, post-operative atrial fibrillation; POD, post-operative day; RBC, packed red blood cells; TAR, total arch replacement; TSC, tailored stand-up collar

technique would be very effective and favorable especially for inexperienced surgeons who are often involved in the emergency setting of acute aortic dissection repair, with promising outcomes.

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Declarations

Ethics approval and consent to participate

The study was conducted according to the principles outlined in the Declaration of Helsinki and the guidelines of the research ethics committee of Gifu Prefectural General Medical Center. The institutional review board approved it, and informed consent was obtained as an opt-out on the website (GPGMC IRB, Takashi Kuwahara, MD, PhD, #789, October 11, 2022).

Consent for publication

Consent for publication of the manuscript was also obtained in the form of opt-out on the website.

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Conflict of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Data availability

The data associated with the paper are available on reasonable request from the corresponding author.

Author contributions

All authors have contributed equally to this work. All authors read and approved the final version of the manuscript. Yukio Umeda; Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Yuta Inoue; Data curation, Shohei Mitta; Data curation, Yukihiro Matsuno; Supervision, Shoji Yoshikawa; Supervision on statistical analysis.

References

1) Bachet J, Goudot B, Dreyfus G, et al. The proper use of glue: a 20-year experience with the GRF glue in acute aortic dissection. J Card Surg 1997; **12(Suppl)**: 243–53; discussion, 253-5.
2) García-Rinaldi R, Carballido J, Mojica J, et al. Surgical treatment of aortic dissections: initial experience with the adventitial inversion technique. Ann Thorac Surg 1998; **65**: 1255–9.
3) Ishii H, Endo H, Tsuchiya H, et al. Enhanced hemostasis with a sealant consisting of Hydrofit and Surgicel. J Card Surg 2017; **32**: 576–8.
4) Umeda Y. Distal stump construction for acute aortic dissection by pre-gluing felt strip with Hydrofit® during systemic cooling. J Cardiovasc Surg (Torino) 2021; **62**: 408–10.
5) TERUMO AQUABRID® Surgical Sealant. Accessed June 16, 2023. https://www.terumo-europe.com/en-emea/products/aquabrid®-surgical-sealant?TermStoreId=70aa3b4e-82ed-47d3-b1dc-9d7951d9228f&TermSetId=2fa1bbfb-d558-4262-9605-3c31f742e996&TermId=92dfe96b-f903-40ff-b901-8b4c0edcf489.
6) Eto M, Morita S, Sugiura M, et al. Elastomeric surgical sealant for hemostasis of cardiovascular anastomosis under full heparinization. Eur J Cardiothorac Surg 2007; **32**: 730–4.
7) Oda S, Morita S, Tanoue Y, et al. Experimental use of an elastomeric surgical sealant for arterial hemostasis and its long-term tissue response. Interact Cardiovasc Thorac Surg 2010; **10**: 258–61.
8) Passage J, Jalali H, Tam RK, et al. BioGlue Surgical Adhesive-an appraisal of its indications in cardiac surgery. Ann Thorac Surg 2002; **74**: 432–7.
9) Kawashima T, Hatori K, Mizoguchi T, et al. In vitro evaluation of the hemostatic effect of method involving the combined use of Hydrofit® and Spongel®. Gen Thorac Cardiovasc Surg 2020; **68**: 932–7.