

Clinical outcomes and quality of life after surgery for dilated ascending aorta at the time of aortic valve replacement; wrapping versus graft replacement

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ABSTRACT

Wrapping and graft replacement are two optional procedures for the treatment of dilated ascending aorta at the time of aortic valve replacement (AVR). Wrapping is considered less invasive. The aim of this study was to compare the short- and long-term clinical outcomes as well as the long-term quality of life in patients undergoing these two procedures. This study enrolled 40 consecutive patients with dilated ascending aorta who had undergone either wrapping (WAA group, n=20) or replacement (RAA group, n=20) of the ascending aorta at the time of AVR. Short-term outcomes, long-term deaths, and aortic events were evaluated, as was quality of life using the SF-36 Short Form. Long-term maximal proximal aortic diameter was also obtained. There were no early deaths in either group. Pump time was shorter, and transfusion (55% vs. 95%, p=0.035) and postoperative atrial fibrillation (5% vs. 30%, p=0.036) rates were lower, in the WAA than in the RAA group. At a mean follow-up of 4.9 years, the overall 5 year survival rates in the WAA and RAA groups were 78.1% and 87.5%, respectively. There were no significant between group differences in SF-36 scores in any subcategory of this survey. Long-term maximal aortic diameter remained stable in both groups. Both surgical interventions for dilated ascending aorta at the time of AVR yield favorable and comparable results in patients with suitable anatomy. Furthermore, we found no differences in quality of life between these procedures.

Keywords: thoracic aorta, aortic valve, aortic aneurysm, thoracic surgery

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INTRODUCTION

A large percentage of patients who undergo aortic valve replacement (AVR) have a dilated ascending aorta. Several observational studies showed that, if left untreated, an ascending aortal aneurysm may result in future aortic dissection or rupture^{1,2}. Current practice guidelines therefore recommend surgery on an ascending aorta at the time of AVR if the aortic diameter is greater than 4.5 cm, especially in patients with a bicuspid aortic valve³.

Aorta wrapping and graft replacement are additional procedures performed for a dilated

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aorta at the time of AVR⁴). Wrapping is regarded as less invasive and may be preferred to graft replacement in patients with suitable anatomy⁵). Graft replacement usually requires longer pump times and cardiac ischemia times, and often requires deep hypothermia and circulatory arrest. Although several studies have compared short- and long-term clinical outcomes of these two surgical procedures^{1,5,6}), none, to our knowledge, has compared long-term quality of life. Shorter pump time and cardiac ischemia time, as well as milder hypothermia, may result in better long-term quality of life⁷), thus favoring wrapping over graft replacement.

This study compared short- and long-term clinical outcomes in patients undergoing wrapping or graft replacement for a dilated ascending aorta at the time of AVR. Furthermore, a cross-sectional survey using the SF-36 was used to assess and compare quality of life in these two groups of patients.

PATIENTS AND METHODS

The study was approved by the Institutional Review Board of Nagoya University Hospital.

Patients

Between January 2000 and December 2013, 40 patients with dilated ascending aorta and aortic valve disease underwent either wrapping of the ascending aorta (WAA group, n=20) or replacement of the ascending aorta (RAA group, n=20) at the time of AVR. Patients who underwent surgery for acute aortic dissection and those who underwent total aortic arch replacement were excluded. The decision to operate on the aorta and the choice of procedure are made individually by discussions between surgeons and patients. Generally speaking, surgical intervention is performed at the time of AVR if the diameter of the ascending aorta is >5.0 cm, although the threshold was lower (>4.5 cm) for patients with bicuspid aortic valves. Operations, which included graft replacement with Dacron grafts and wrapping the ascending aorta with Dacron grafts, were performed by several surgeons. The type of surgery recommended to patients was based on evaluation of the anatomical extension of the dilated aorta, the diameter of the aorta, the expected quality of the aortic wall, and the operative risk. Wrapping was usually recommended to patients with mild dilatation of limited extent, whereas graft replacement was usually recommended to patients with larger diameter and/or more extensive dilatation of the ascending aorta.

Surgical procedure

All patients underwent median sternotomy with cardiopulmonary bypass. The aortic cannula was placed in the proximal aortic arch, femoral artery, or right axillary artery.

Commercially available Dacron vascular grafts were used for aorta replacement. In the RAA group, 16 (80%) of the 20 patients underwent surgery under deep hypothermia and circulatory arrest using open distal anastomosis, with or without retrograde or antegrade cerebral perfusion⁸). In the other four (20%) patients, the aorta was clamped proximal to the innominate artery. The aortic valve was replaced by clamping the dilated ascending aorta, or after completing the distal anastomosis.

Aorta wrapping consisted of wrapping the dilated aorta with a Dacron graft. Wrapping was usually performed after completing AVR and decannulation. The chosen sized graft was incised longitudinally. The entire ascending aorta was mobilized from surrounding tissues and wrapped by the graft. The graft incisions were closed with 4-0 polypropylene running sutures, and the graft was anchored to the aortic wall with 4-0 or 5-0 polypropylene sutures. The aortic wall was not resected or plicated.

Patients were managed in the intensive care unit, which is run by a single intensivist team.

Follow-up

The data from all patients who underwent cardiac surgery at our institution after 1989 were prospectively entered into a computer database. Questionnaires were mailed to all of the patients who had undergone valve surgery every 3 to 5 years. If the questionnaires were not returned, telephone or personal interviews were conducted. In addition, patients were sent the SF-36 Short Form QOL questionnaire in October 2015.

The SF-36 includes 36 items in 8 subscales (mental health, emotional role functioning, social role functioning, vitality, general health perceptions, bodily pain, physical role functioning, and physical functioning)⁹. Norm-based scoring used Japanese normative data. The answer to the questionnaire was obtained from 91.6% of patients who were alive. Mean follow-up was 4.9 years (range, 0.6–11.4 years). The follow-up rate was 100%. The mean duration from surgery to the date of mailing the SF-36 was 6.4 years (range, 0.6–11.2 years) in all patients, 4.8 years (range, 0.6–9.6 years) in patients who had undergone wrapping (WAA group), and 8.1 years (range 1.8–11.2 years) in patients who had undergone replacement of the proximal aorta (RAA group).

The maximal proximal aortic diameter was obtained for each patient at three time points, before surgery, immediate after surgery, and at the time of the latest computed tomography. The mean duration from surgery to the latest computed tomography was 2.2 years (range, 1.1–11.0 years)

Statistical analysis

Categorical variables were expressed as numbers and percentages, while continuous variables were expressed as means±SD. Categorical variables were compared using the χ^2 test or Fischer's exact test, and continuous variables were compared using Student's t test. Wilcoxon rank-sum test was used to compare the dates of surgery. Early events were calculated as simple percentages. Survival outcomes were assessed by the Kaplan-Meier method and compared by the log-rank test.

RESULTS

Clinical outcomes

During the study period, 20 patients underwent wrapping (WAA group) and 20 underwent graft replacement (RAA group) of the ascending aorta at the time of AVR. Patient demographic and clinical characteristics are shown in Table 1. Mean age (59.2±2.3 years vs. 64.5±2.2 years, $p=0.11$), the percentage of females (30% [6/20] vs. 40% [8/20], $p=0.44$), and the percentage of patients with bicuspid aortic valves (60% [12/20] vs. 45% [9/20], $p=0.34$) were similar in the WAA and RAA groups. There were no between group differences in the percentages of patients with aortic stenosis and regurgitation. The mean diameter of the ascending aorta was smaller in the WAA than in the RAA group (48.9±6.3 mm vs. 53.5±8.6 mm, $p=0.10$), but the difference was not statistically significant. The median date of surgery was earlier in the study period in the WAA group than in the RAA group ($p=0.02$). To examine the influence of this difference in surgery date, we added post hoc analysis. We divided the patients to the early surgery patient group, the patients operated before December/2010 ($n=24$), and the late surgery patient group, the patients operated after January/2011 ($n=16$). In survival and the results of SF-36, which were primary outcomes of this study, we as well examined the between-group difference in these subgroups of different surgery period, respectively.

Pump time was significantly shorter in the WAA than in the RAA group (138.1±42.0 min

Table 1 Preoperative Patient Demographics.

	Wrapping (n=20) Mean±SD / N(%)	Graft Replacemnet (n=20) Mean±SD / N(%)	p
Age, y	59.2±2.3	64.5±2.2	0.11
Female	6 (28.6)	8 (40.0)	0.44
Diabetes	3(15.0)	3(14.3)	0.89
Hepertention	8(40.0)	9 (42.9)	0.85
COPD	1(5.0)	1(4.8)	0.97
CKD	1(5.0)	1(4.8)	0.97
Previous Sternotomy	0(0.0)	1(4.8)	0.31
Emergency	0	0	1.0
Active			
Infective Endocarditis	0	0	1.0
Aortic Valve Disease			1.0
AS	9(45.0)	11(55.0)	0.52
AR	7(35.0)	7(35.0)	1.0
ASR	4(20.0)	2(10.0)	0.38
Bicuspid Aortic Valve	12(60.0)	9(45.0)	0.34
Atrial Fibrillation	1(5)	3(15)	0.29
NYHA 3,4	2(10.0)	1(5.0)	0.54
LVEF	58.9±2.5	61.8±2.5	0.40
LVDs	41.6±9.7	36.8±11.3	0.21
Ascending Aorta	48.9±6.3	53.5±8.6	0.10
Surgery Date, Median {IQR}	August/2006 {Jan/2004-Jan/2011}	June/2010 {Jan/2008- May/2012}	0.02

SD, standard deviation; N, number; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; AS, aortic stenosis; AR, aortic regurgitation; ASR, aortic stenosis and regurgitation; NYHA, New York Heart Association Functional Class; LVDs, systolic left ventricular dimension; IQR, interquartile range.

vs. 235.2±71.7 min, $p < 0.0001$; Table 2). The lowest core temperature was significantly higher in the WAA than in the RAA group (32.6±2.4 °C vs. 25.0±4.1 °C, $p < 0.0001$).

There were no operative deaths in either group. One patient in the RAA group experienced a perioperative stroke. The transfusion rate (55.0% vs. 95%, $p = 0.035$) and the rate of postoperative atrial fibrillation (5.0% vs. 30.0%, $p = 0.036$) were significantly lower in the WAA than in the RAA group (Table 2).

Long-term survival outcomes are shown in Figure 1. The overall 5 year survival rates were 78.1% in the WAA group and 87.5% in the RAA group ($p = 0.50$). There were no statistically significant difference in survival both in the early surgery patients ($p = 0.51$), and in the late surgery patients (no deaths in both WAA and RAA groups).

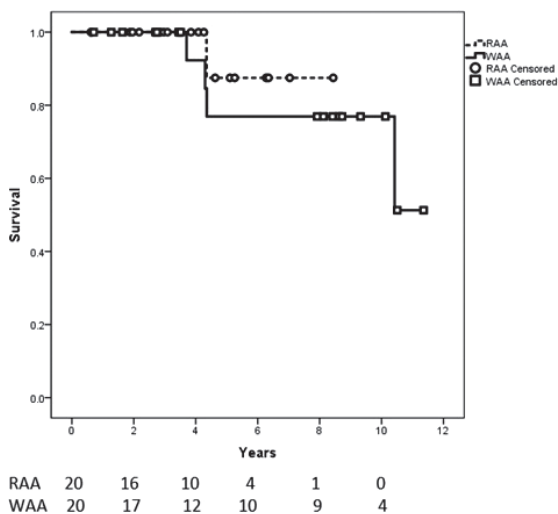
One patient in the WAA group experienced an event in the proximal aorta. This patient

Aorta wrapping vs. replacement

Table 2 Peri-operative data.

	Wrapping (n=20) Mean±SD / N(%)	Graft Replacement(n=20) Mean±SD / N(%)	p
CPB time	138.1±42.0	235.2±71.7	<0.0001
Cardiac Ischemic Time	94.6±34.2	164.3±10.3	<0.0001
Lowest core temperature	32.6±2.4	25.0±4.1	<0.0001
30 day Mortality	0	0	1.0
In hospital Mortality	0	0	1.0
Stroke	0	1(5.0)	0.24
Acute Kidney Insuficiency	0	0	1.0
Chest reopening	1(5.0)	0	0.23
ICU Stay	1.5±1.4	2.0±1.3	0.19
Blood Products	11(55.0)	19(95.0)	0.01
A fib	1(5.0)	6(30.0)	0.036
Biological Aortic Valve	13 (65.0)	17 (81.0)	0.14
Graft Size (mm)	31.4±2.1	27.9±1.7	<0.0001

SD, standard deviation; N, number; CPB, cardio-pulmonary bypass; ICU, intensive care unit; A fib, atrial fibrillation.

**Fig. 1** Kaplan-Meier survival curves according to the type of surgery.

RAA, graft replacement of the ascending aorta; WAA, wrapping of the ascending aorta.

underwent reoperation for late dilatation of the sinus of Valsalva, which had been less than 4.5cm at the time of initial surgery.

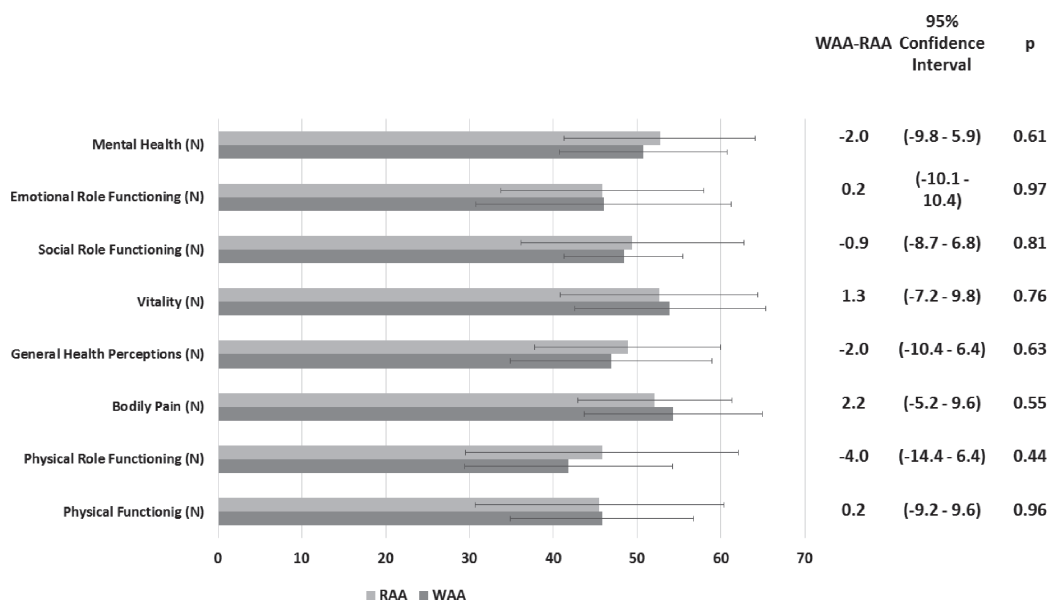


Fig. 2 Quality of life scores assessed by Short Form Health Survey (SF-36).

RAA, graft replacement of the ascending aorta; WAA, wrapping of the ascending aorta; (N), norm-based score.

Quality of life

The results of the SF-36 are shown in Figure 2. Patients in the WAA and RAA groups were evaluated by norm-based scores, with 95% confidence intervals, on the eight subcategories of the SF-36: mental health, emotional role functioning, social role functioning, vitality, general health perceptions, bodily pain, physical role functioning, and physical functioning. There were no between group differences in any of the subcategories. The 95% confidence intervals of norm-based scores in all categories included 50, the mean value of the general population at matched age, indicating that there were no statistically significant differences between these patients and the general population. In post hoc analysis, we did not find any statistically significant between-group difference in the early surgery group and the late surgery group.

Changes in aortic diameter

Maximal proximal aortic diameter remained stable over time in both groups (Figure 3). Only one clinically significant dilatation of the proximal aorta occurred in whole follow-up. The patient was in WAA group, and showed clinically significant late dilatation in sinus of Valsalva, and underwent reoperation as previously described.

DISCUSSION

The optimal management of a moderately dilated aorta at the time of AVR remains unclear. A dilated aorta has been associated with some risk of aortic rupture or dissection if not surgically repaired at the time of AVR^{1,2}. However, replacement of the ascending aorta requires additional cardiac ischemia time and pump time, which may increase surgical risk to the patient. The surgical insult of aortic surgery is generally considered greater when the operation requires a longer pump time. Aorta wrapping¹⁰ is regarded as less invasive than graft replacement, especially when

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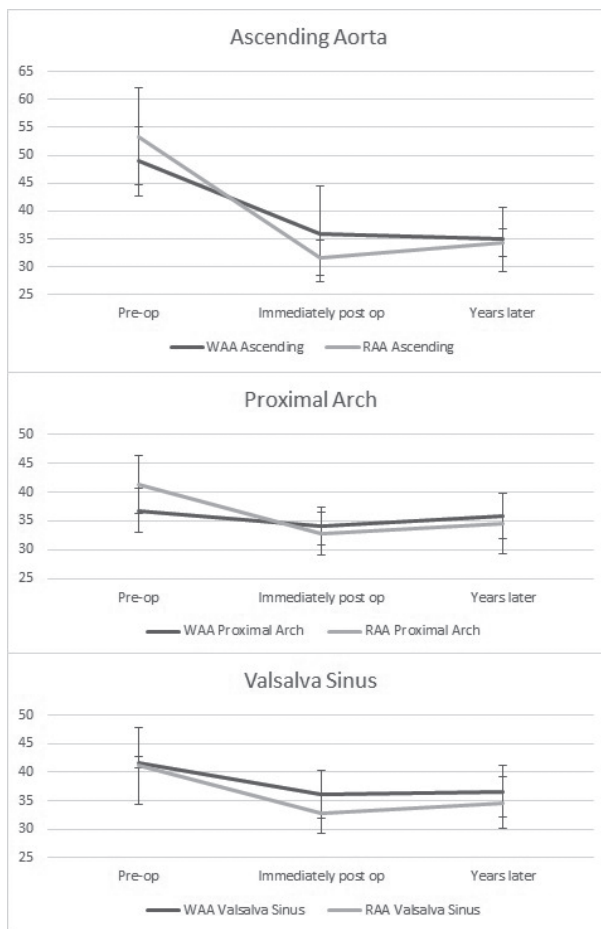


Fig. 3 Changes in maximal diameter of the proximal aorta. WAA, wrapping of the ascending aorta; RAA, replacement of the ascending aorta.

the former is performed as a simple external support procedure without aortoplasty, as in this series^{5,6,11}). Several studies compared short- and long-term clinical outcomes of these procedures^{1,5,6,10,12}), with some of these studies showing better outcomes with the wrapping procedure^{6,12}). By contrast, no study to date has compared quality of life following these two procedures, despite the importance of quality of life in choosing between two different procedures with different levels of invasiveness.

We did not find between-group differences in important patient background data and comorbidities.

Although older studies reported that the wrapping procedure had survival benefits^{6,12}), more recent studies show no differences in short- and long-term mortality rates^{1,5}). Similarly, the operative mortality rate in both groups of the present study was 0%. Improvements in surgical techniques may have resulted in better survival outcomes in patients undergoing graft replacement, thus diminishing the difference between the two procedures. Older studies reported significant mortality rates in patients undergoing both procedures^{6,12}).

Although major operative morbidity rates were similar in the two groups of patients, they

differed significantly in transfusion and postoperative atrial fibrillation rates. These findings are compatible with previous results^{5,11}). Differences in pump time, cardiac ischemia time, and temperature were also statistically significant in the current study. Differences in operative complexity and adjunctive techniques may explain the differences in these perioperative outcomes.

Surgically, the wrapping procedure was a simple external support procedure without resection or plication aortoplasty. Wrapping was performed off-pump after completion of AVR and decannulation. A meta-analysis of the wrapping procedure showed that hospital mortality rates of patients undergoing wrapping with resection aortoplasty and wrapping alone were 2.0% and 0.4%, respectively¹¹). Simple external support is a good and less invasive procedure for selected patients with mild dilatation of the ascending aorta.

There were no significant differences in any of the SF-36 subcategories. Although perioperative data suggested that surgical insult was greater with graft replacement, resulting in a higher incidence of minor complications, there were no differences in long-term quality of life. Moreover, the norm-based scores in these patients did not differ significantly from those of the general population.

Because there were no differences in important short- and long-term clinical outcomes and in long-term quality of life, the choice between WAA and RAA can be based mainly on anatomical considerations, which may be the key to good patient selection.

This study had several important limitations. First, it was retrospective in design, suggesting the possibility of selection bias or that the two patient groups may not have been truly comparative. Although we have tried to include only patients who can be considered as candidates for both types of surgery in this study, some background difference may still have existed. Second, the number of patients was relatively small, although it was similar to that of other studies¹¹). This study may have been underpowered to detect small differences between the two procedures.

CONCLUSIONS

Using current surgical techniques, both wrapping and graft replacement can be performed with favorable short- and long-term clinical outcomes as well as favorable long-term quality of life.

DISCLOSURES

The authors have nothing to disclose.

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