

## Short-term Outcomes of Aortic Wrapping for Mild to Moderate Ascending Aorta Dilatation in Patients Undergoing Cardiac Surgery

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**Background:** The adequate management of mild to moderate dilatation of the ascending aorta during cardiac operations remains controversial. In this study, we present the short-term outcomes of 90 patients undergoing ascending aortic wrapping with a Dacron graft during other cardiac operations. **Materials and Methods:** From March 2008 to January 2011, 90 consecutive patients underwent treatment for ascending aortic aneurysm using the external wrapping technique during the concomitant procedure. The study group consisted of 49 male and 41 female patients with a mean age of  $58.7 \pm 13$  years. The primary cardiac surgical procedures were coronary artery bypass grafting (CABG) in 3, aortic valve replacement in 2, and aortic valvuloplasty in 85 patients (isolated in 62 and combined with CABG or mitral valvuloplasty in 23). The ascending aorta diameter was measured using a computed tomography scan within 4 weeks after surgery, and was compared with the preoperative value. **Results:** The diameters of the ascending aorta wrapped with the Dacron graft were significantly reduced within a month after surgery from  $46.4 \pm 4.3$  mm to  $33.0 \pm 3.5$  mm ( $p < 0.05$ ). There was no early mortality or major surgical complication. During the mean follow-up period of  $15.4 \pm 5.2$  months, there was only one late death caused by septic multiorgan failure. **Conclusion:** Dacron wrapping of the ascending aorta offers excellent results with very low mortality and morbidity, and it can be regarded as a safe and effective method for the treatment of moderately dilated ascending aorta in selected patients.

Key words: 1. Aorta, surgery  
2. Aortic aneurysm

### INTRODUCTION

Ascending aortic aneurysm is generally treated by resection and replacement of the aneurysm. Replacement of the ascending aorta is the most frequently performed procedure for thoracic aortic aneurysm [1]. However, this operation is still associated with substantial perioperative mortality and morbidity [2,3]. Moreover, the management of mild to moderate dilatation of the ascending aorta of less than 5 cm is contro-

versial. In these cases, some surgeons favour a “watch and wait” approach, until surgery is indicated. A less radical operation than graft replacement, such as reduction aortoplasty with excision of the aneurismal wall and external wrapping of the ascending aorta, was reported by Robicsek in 1982 [4] as one of the treatments for dilatation of the ascending aorta. This procedure is generally advocated for combined concomitant cardiac surgery. However, there is little information on the natural history of the remaining aorta following such

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**Table 1.** Main preoperative characteristics of all 90 patients

Variable	Value
Age (yr)	58.7±13
Sex	
Male	49
Female	41
Former cardiac surgery	
Aortic valve replacement	3
Symptom	
Dyspnea	20
Angina	7
Dizziness	5
Risk factors	
Hypertension	21
Diabetes	6
COPD	4
Creatine ≥2.0	3
Ejection fraction ≤40%	7
Concomitant heart disease	
Ischemic heart disease	12
Mitral valve insufficiency	8
Aortic valve stenosis	68
Aortic valve insufficiency	10
Aortic valve type	
Bicuspid aortic valve	45
Tricuspid aortic valve	45

COPD, chronic obstructive pulmonary disease.

procedures. The purpose of this study was to report on the short-term outcomes and clinical experience of the wrapping of the ascending aorta in patients with mild to moderately dilated ascending aortic aneurysm who required concomitant cardiac surgery.

## MATERIALS AND METHODS

### 1) Patients

This study involved a retrospective review of the medical records, surgical notes, echocardiograms, cardiac computed tomography (CT), and outpatient record of all patients undergoing Dacron wrapping of the ascending aorta combined with another cardiac procedure at our institution.

From March 2008 to January 2011, 90 consecutive patients underwent treatment of ascending aortic aneurysm with the Dacron wrapping technique during a concomitant procedure. Patients with documented ascending aortic dilatation of 3.5 to

**Table 2.** Concomitant surgeries performed

Type of surgery	No. of patients
AVP	62
AVP+CABG	8
AVP+MVP	13
AVP+MVPZ+CABG	2
AVR	2
CABG	3
Total	90

AVP, aortic valvuloplasty; CABG, coronary artery bypass graft; MVP, mitral valvuloplasty; AVR, aortic valve replacement.

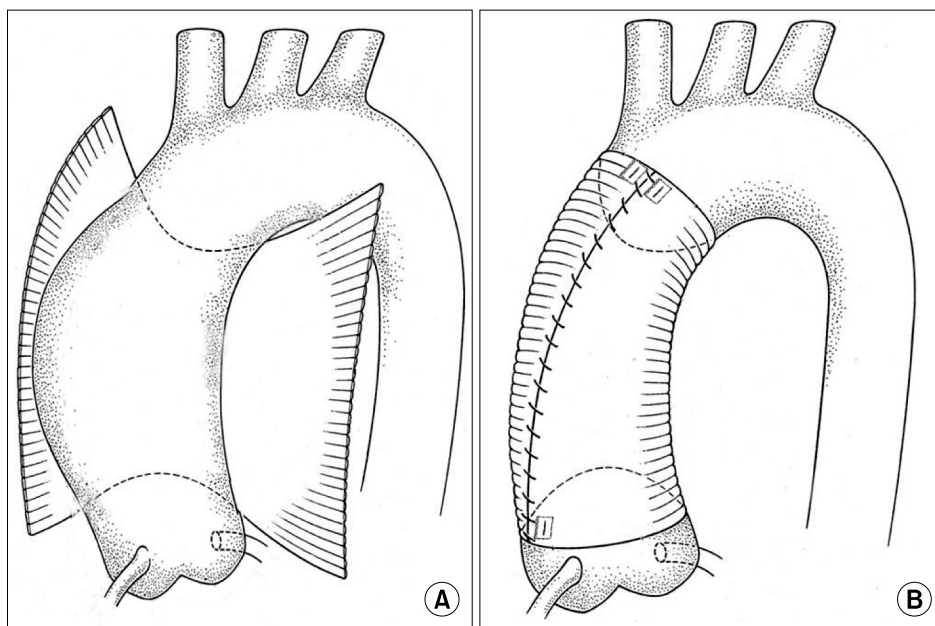
5.5 cm on CT were identified as part of their pre-operative cardiac surgery workup. The diameters of the coronary sinus, sinotubular junction, tubular portion, and proximal arch were measured on the CT image.

In these patients, the wrapping of the ascending aorta was performed as described below as an additional procedure to other cardiac operations. All the patients included in this study underwent a CT scan during their routine follow-up within four weeks after surgery. Likewise, the diameters of the four portions of the aorta previously described were compared with the diameters measured before surgery.

There were 49 male and 41 female patients. The mean age at operation was 58.7±13 years (range, 24 to 81 years), and the mean body weight was 54±10.5 kg (range, 41 to 79 kg). Three patients received aortic-valve replacement due to aortic stenosis, 20 complained of dyspnoea due to congestive heart failure, seven complained of angina, five complained of dizziness, and the others were asymptomatic. Detailed characteristics of the patients are described in Table 1. The primary cardiac surgical procedures were coronary artery bypass grafting (CABG) in 3, aortic valve replacement in 2, and aortic valvuloplasty in 85 patients (isolated in 62 and combined with CABG or mitral valvuloplasty in 23) (Table 2).

### 2) Surgical technique

The heart and the ascending aorta were exposed through the usual median sternotomy. Except for the two patients who underwent only CABG, the planned open-heart surgery was performed after a cardiopulmonary bypass (CPB) by employing the usual method. Following the initiation of cardiopulmonary bypass, the ascending aorta was freed from its



**Fig. 1.** Wrapping of the ascending aorta with the Dacron graft. The graft is pulled below the aorta (A) and oversewn with a continuous suture (B).

pericardial reflection proximally from the sinotubular junction (STJ) and as far up to the origin of the innominate arterial trunk. After completing the main procedure of cardiac surgery under general CPB, just before coming off CPB, a Dacron graft of 25 to 35 mm diameter was cut longitudinally and passed around the ascending aorta to cover the entire length from the STJ to the innominate artery (Fig. 1). The ascending aorta was reduced to the diameter of the Dacron graft by approximating the edges of the Dacron with a continuous 3/0 Prolene suture. In most of the cases, wrapping was completed while increasing the body temperature to reduce the size of the ascending aorta to a diameter less than 35 mm. The size and length of the Dacron graft were decided based on the results of the intraoperative measurement of the ascending aorta from the STJ to the right innominate artery. When the saphenous vein graft was anastomosed to the aorta in the patients who had undergone CABG, the region starting from the point immediately above the anastomosed point was wrapped.

### 3) Follow-up

The incidences of late mortality, adverse clinical events, and dilatation of the ascending aorta during the follow-up period were investigated. The follow-up period was  $15.4 \pm 5.2$  months (range, 10 to 28 months). We evaluated the diameter of the ascending aorta using cardiac CT at three points: be-

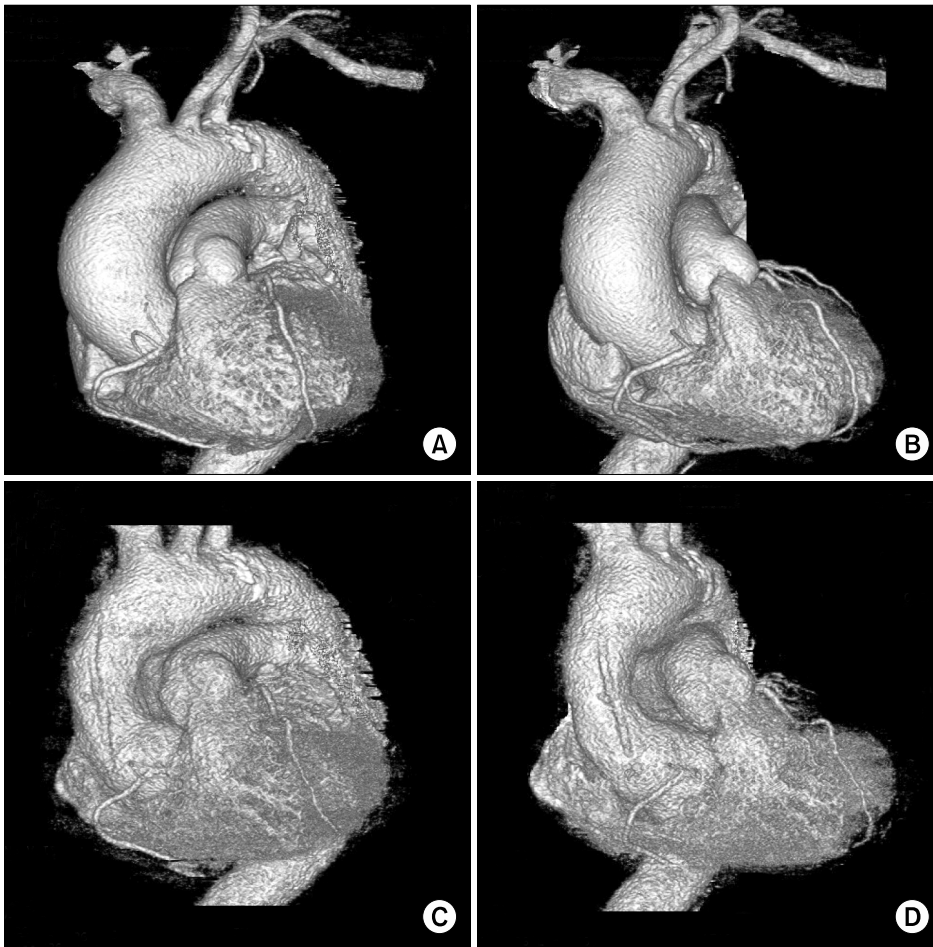
fore surgery, within a month postoperatively, and 12 months postoperatively (Fig. 2).

### 4) Statistical analysis

All continuous data and results were expressed as the mean  $\pm$  standard deviation and the significance of the differences between the preoperative and postoperative data was assessed by one-way analysis of variance. A value of *p* less than 0.05 was considered statistically significant.

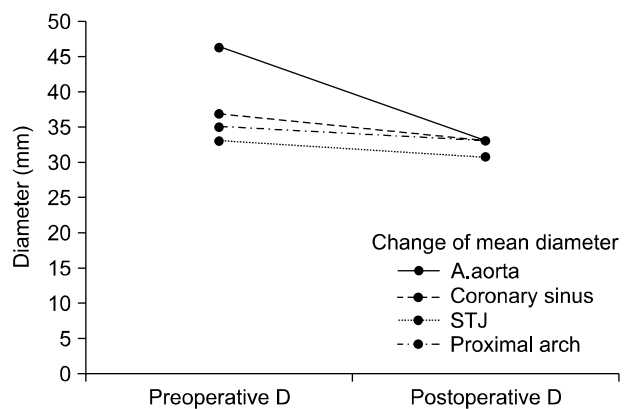
## RESULTS

There were no perioperative or early postoperative deaths and no bleeding complications requiring exploration. For one patient with a 30% preoperative ejection fraction, intra-aortic balloon insertion was performed because cardiopulmonary bypass weaning was difficult to perform. In this patient, the intra-aortic balloon pump was removed without any particular complications at postoperative day 2, and then the patient was discharged. No other major surgical complication was observed. There was only one late mortality (1.1%) as a result of septic multiple-organ failure at the second postoperative year. No other late complications occurred. CT was performed on all 90 patients both before surgery and within four weeks after surgery. External wrapping of the ascending



**Fig. 2.** Preoperative computed tomographic scan (A, B). Postoperative computed tomographic scan (C, D) of the same patient showing a decrease in the diameter of the ascending aorta.

aorta resulted in a significant reduction of the ascending aorta in all patients. The maximal diameter of the ascending aorta significantly decreased from preoperative  $46.4 \pm 4.3$  mm to postoperative  $33.0 \pm 3.5$  mm ( $p=0.01$ ). Interestingly, the diameter of the coronary sinuses were also significantly reduced from  $36.9 \pm 4.2$  mm before surgery to  $33.3 \pm 5.1$  mm after the aortic wrapping ( $p=0.001$ ). The STJ size also significantly decreased from preoperative  $33.1 \pm 4.8$  mm to postoperative  $30.8 \pm 4.6$  mm ( $p=0.02$ ). The changes in the dimensions of the aorta distal to the wrapping also significantly decreased from preoperative  $35.1 \pm 3.5$  mm to postoperative  $33.1 \pm 3.2$  mm ( $p=0.01$ ) (Fig. 3). The number of patients who showed a significant decrease in the diameter, insignificant decrease in the diameter, and increase in the diameter are presented by region in Table 3. In addition, 78 (86.7%) of the 90 patients underwent CT at postoperative 12 months; the maximal diameter of the ascending aorta was  $33.1 \pm 2.5$  mm ( $p=0.34$ ), while



**Fig. 3.** Mean values of the dimensions. A.aorta, ascending aorta tubular portion; STJ, sinotubular junction; Proximal arch, proximal aortic arch; D, diameter.

that of the coronary sinuses was  $33.5 \pm 2.1$  mm ( $p=0.42$ ), and the STJ size was  $33.4 \pm 3.3$  mm ( $p=0.44$ ). Compared to the diame-

**Table 3.** The number of patients according to the degree of change in each region of the ascending aorta (within post-operative 4 weeks)

Portion of ascending aorta	Significant decrease	No change	Increase
Tubular portion	90	0	0
Coronary sinus	86	4	0
Sinotubular junction	85	5	0
Portion distal to the wrapping	86	4	0

ter measured on early postoperative CT, no significant difference was observed and there were no findings that suggested redilatation.

## DISCUSSION

Even in the current time of advanced surgical procedures and alternative endovascular techniques for the treatment of aortic pathologies, ascending aortic aneurysms remain a challenging problem for every cardiac surgeon. Although graft replacement for an ascending aortic aneurysm is now performed relatively safely and remains the accepted surgical procedure, we cannot ignore the hospital mortality rates of 4.5% to 20% and the morbidity related to such extended operations [2,3]. A more physiological technique that is safe, effective, and causes less injury would be an attractive option. Of the surgical procedures that have been devised toward this end, reduction aortoplasty, which was first described by Robicsek [4], is the least radical. This technique consists of decreasing the aortic diameter by excising the oval segment of the ascending aorta after longitudinal aortotomy followed by placing a well-tailored Dacron vascular graft around the aorta. This surgical procedure is meaningful in that it is simple and easy to perform, and above all, it can preserve the endothelial lining. Since the introduction of this procedure, many surgeons have reported indications for reduction of aortoplasty and its surgical outcomes. In particular, in a meta-analysis of the surgical outcomes of a total of 716 patients from 13 studies on reduction aortoplasty, Gill and Dunning [5] reported that only 25 (3%) of the 716 patients had to undergo redilatation during follow-up, and the others had good postoperative outcomes.

In addition, Gill and Dunning [5] presented a recommendation on which patients are suitable for reduction aortoplasty. In light of these previous studies, we prepared a set of guidelines for the wrapping of the ascending aorta.

First, the size of the ascending aorta should be 4 cm or more and 6 cm or less. In this hospital, CT was performed on every patient who underwent cardiac surgery, and wrapping was performed if the diameter of the ascending aorta was 4.0 cm or more. Coady et al. [6] reported that the aortic size should be less than 6 cm to avoid late redilatation. Second, the intraoperative reduction of the aorta should be less than 35 mm. After follow-up, at a mean of 40 months following reduction aortoplasty in patients with a bicuspid aortic valve, Bauer et al. [7] reported that significant redilatation did not occur in the patient group whose ascending aorta had a maximal diameter of 35 mm or less, but occurred in the patient group whose ascending aorta had a maximal diameter of 40 mm or more. Third, the aneurysm should be limited to the ascending aorta. Fourth, patients with connective-tissue diseases, including Marfan’s syndrome, or acute or chronic dissection should be excluded. Lastly, wrapping of the ascending aorta is ideal for patients who have multiple co-morbidities and for whom a prolonged operative time would significantly increase their mortality risk.

Surgeons have diversified the surgical procedures for reduction aortoplasty [8]. When reduction aortoplasty was first introduced by Robicsek [4], the procedure consisted of excising the ascending aorta into an oval shape, and then external wrapping with a Dacron graft was performed depending on the situation. Since then, surgeons have tended to perform external wrapping to prevent redilatation, and as a result, the aortic-clamp time decreased. In South Korea, a good surgical outcome was reported after using the suture plication technique without excising the ascending aorta, according to the method described by Baek et al. [8], in 14 patients. In addition, Ang et al. [9] reported 14 cases of good surgical outcomes that only had Dacron wrapping performed, without aortic excision, in patients who underwent aortic-valve replacement. In this study, we chose the surgical procedure that would reduce the diameter of the ascending aorta by only the wrapping of the ascending aorta, without excision of the ascending aorta.

Wrapping alone does not require the opening of the aorta or the extension of the aortic cross-clamp time. It can be performed relatively quickly within 5 to 10 minutes, and it is safe, with no significant morbidity or mortality. Moreover, reduction aortoplasty without external wrapping could not prevent the recurrence of redilatation, but recurrence can be prevented if external wrapping is also performed [4,7].

The optimum surgical timing for dilatation of the ascending aorta remains under debate. It is unknown whether a mild to moderately dilated ascending aorta would cause problems later for a patient. We aimed to ascertain the benefits of the wrapping procedure that is performed concomitantly with CABG or open-heart surgery in patients who require CABG or open-heart surgery, rather than the benefits of only performing the wrapping procedure.

In this study, the diameter of the ascending aorta for which wrapping was performed was significantly decreased, and redilatation was not found in the CT that was performed within one year after operation. This indicates that without aortic dissection, wrapping alone is sufficient to decrease the diameter of the dilated aorta.

Additionally, it should be noted that the diameter of the ascending aorta can decrease in the dilated site as well as in the regions proximal and distal to the aortic-wrapping site. Although the follow-up period was short, the reduction in the diameter at different aortic sites was statistically significant. This suggested that correcting the dimensions of a dilated ascending aorta at an early stage, and before irreversible anatomical changes occur, results in the rapid reverse remodeling of the rest of the aorta, and is probably due to the restoration of normal blood flow hemodynamics. This reversibility enables the prevention of future dilatation of the remaining aorta through early intervention in a mild to moderately dilated ascending aorta [9].

Although operative complications did not occur in this study, other studies on the wrapping of the aorta have reported complications. Neri et al. [10] reported on two patients who developed false aneurysm of the ascending aorta 7 and 11 years, respectively, after wrapping. Histologic examination of the aortic wall underlying the reinforcement cuff revealed extensive wall degeneration [10]. Bauer et al. [11] reported a case wherein after reduction aortoplasty, the dislocated wrap

caused erosion of the ascending aorta. However, this type of complication is very rare.

This study has the following limitations: no control group was used, and the follow-up period was too short to allow the identification and explanation of possible complications, such as redilatation of the ascending aorta, which may occur during the long-term follow-up period. Thus, a prospective randomized study with long-term follow-up and a bigger population sample is required to ascertain the safety and benefits of wrapping the ascending aorta.

## CONCLUSION

The results of this study indirectly suggest that the wrapping procedure was associated with the early reversed remodeling of the remaining proximal and distal aorta. Although a long-term study on a larger sample population is needed to confirm the benefits of this procedure, if the procedure is performed well on eligible patients, it can prove to be a safe and simple surgical method. Moreover, it can also decrease postoperative mortality and morbidity, and can serve as an alternative for conventional graft replacement.

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