



Concomitant Aortic Wrapping (AW) in patients undergoing Aortic Valve Replacement (AVR) with coexistent mild to moderate ascending aortic dilatation

Ahmed H. Lamloum¹, M. ElZayadi², Ibrahim Abdelkader³, Mahmoud M. Elwakeel⁴, Gehad M. Mahmoud⁵.

¹ Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, Egypt

² Department of Cardiothoracic Surgery, Faculty of Medicine, Fayoum University, Egypt

³ Cardiothoracic Specialist at Nasser National Institute and Sultan Qaboos University

⁴ Department of Anesthesiology, Faculty of Medicine, Cairo University, Egypt

⁵ Department of Cardiothoracic Surgery, Faculty of Medicine, Beni Suef University, Egypt

*Corresponding author: Ahmed Hamdy Lamloum, E-Mail: www.alamloumcts@gmail.com

ABSTRACT:

Background: Many aortic diameter reduction techniques have been suggested for patients with dilated ascending aorta. However, the most effective technique with the least surgical hazards is not yet determined.

1243

Aim of work: In this study, we investigated the post-operative impact of wrapping the ascending aorta using a fashioned vascular prosthesis on the diameter of different parts of the aorta, from the aortic root up to the proximal arch.

Patient and Methods: This study included 62 patients with ascending aortic diameters of 4.5-5 cm who underwent AW and AVR at Cairo University, Fayoum University, and Beniseuf University Hospitals. Data on perioperative multi-level aortic diameters, short- and mid-term morbidity, and mortality were gathered in the period between January 2016 and June 2021.

Results: Throughout the hospital stay and the follow-up period (11.30 + 13.11 months), there were no deaths, post-operative infection, or need for re-operation among our patients. Re-exploration was needed in one patient for significant postoperative hemoglobin drop. Follow-up imaging revealed a statistically significant reduction in the diameters of the different parts of the ascending aorta and the proximal arch (P value < 0.05).

Conclusion: Ascending aortic wrapping during AVR effectively reduces dilated aortic diameter and the risk of reoperation for aneurysms or dissections.

DOI Number: 10.48047/nq.2021.19.3.NQ21043

NeuroQuantology 2021; 19(3): 1243-1249

INREODUCTION:

Coexistent dilated aortopathy affects up to 15 percent of patients indicated for aortic valve replacement¹⁻² and, if left untreated, may lead to fatal aortic dissection or rupture³⁻⁵.

While there is universal consensus that a dilated ascending aorta greater than 5 cm is a candidate for aortic replacement⁶⁻⁷, a moderately (between 4.5-5 cm) dilated aorta remains a contentious subject⁸.



Taking the danger of ascending aortic replacement into consideration, several surgeons recommended the "wait and see" approach. Still, many surgeons advise early surgical intervention when there is a damaged aortic valve and associated potentially dangerous consequences⁹⁻¹⁰.

In cases undergoing AVR, external wrapping to reinforce the wall of the dilated aorta may be a better alternative to aortoplasty procedures or ascending aortic replacement surgeries, as it involves shorter pump and cardiac ischemia times, as well as reduced hypothermia. However, data regarding its outcome is not yet sufficient¹¹⁻¹².

We sought to investigate the effectiveness of this simple strategy in managing moderately dilated ascending aortas along with AVR, analyzing our results over short and mid-term postoperative follow-up periods.

MATERIALS AND METHODS

Study design:

Between January 2016 and June 2021, information on 62 patients who underwent Aortic valve replacement along with aortic wrapping for moderately dilated ascending aorta were gathered from Kasr Al-Ainy, Fayoum University Hospitals and Beniseuf University Hospitals.

Definitions:

Moderately dilated ascending aorta was defined as Ascending aortic diameter ranging between 4.5 to 5 cm on computed tomography (C.T chest)¹³.

Early mortality was defined as death within 30 days of surgery¹⁴.

Sudden Cardiac death was defined as death due to a cardiovascular cause that occurs within one hour of the onset of symptoms¹⁵.

Exclusion criteria:

Patients with severely dilated aorta; more than 5 cm in diameter on C.T chest¹³, patients with collagen disease such as Marfan syndrome and patients with ischemic heart disease mandating Coronary artery bypass graft (CABG).

Ethical approval:

This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving

humans¹⁶The obligation to acquire informed consent from individual patients has been omitted due to the routine need for chest imaging in candidates for AVR and the retrospective nature of data collecting.

Methodology:

Perioperative data including echocardiographic reports, heart computed tomography (CT) imaging, and all operative records were collected from the database and through retrospective review of medical records. The aortic diameter was measured at the level of the sinuses of Valsalva, the Sino tubular (ST) junction, the mid-ascending aorta, and the proximal arch. Serial 6 months-spaced C.T or echocardiographic reviews were the cornerstone postoperative follow-up imaging techniques. Interpretations of CT examinations were provided by a cardiothoracic radiology specialist and all echocardiographic Aortic measurements were made using the true short axis projection acquired from the double oblique views,

Anesthesia Technique:

All patients underwent cardiac catheterization preoperatively, to exclude associated coronary artery disease. Anesthesia induction started using 5 ug/kg fentanyl, 5 mg Midazolam, titration dose of propofol, 1244 Atracurium 0.5 mg/kg. After intubation, median sternotomy, cannulation of the aorta and vena cava and starting the CP bypass, aortic cross clamp was applied and selective cardioplegia of 0.5 to 1 Liter of cold cardioplegia solution was given at the left and right coronary ostium, at a ratio of 2:1 respectively to arrest the heart. Then retrograde cardioplegia is given through a cannula in the coronary sinus at a rate of 200cc every 10 minutes to all patients.

Surgical Technique:

A conventional median sternotomy incision was used to access the aorta and aortic valve. After heparinization and the start of cardiopulmonary bypass through aorto-common atrial cannulation, the pulmonary artery became decompressed, facilitating the complete dissection of the ascending aorta from the level of the Sino tubular junction (STJ) to the origin of the brachiocephalic artery (BCA), separating it from the pulmonary artery, and releasing the posterior pericardial reflection. The

The aorta was cross-clamped, and cardiac arrest was achieved by administration of a combined antegrade

and retrograde cold blood-based cardioplegic solution at moderate hypothermia (range 28 to 32°C). After the aortotomy incision, antegrade selective cardioplegia can be initiated. Either a mechanical or bioprosthetic aortic valve was implanted in the supra-annular position.

A 32–36 mm straight Dacron® vascular prosthesis (DuPont Pharmaceuticals, Wilmington, DE, USA) was cut longitudinally and positioned around the dilated portion of the ascending aorta shortly after aortic de-clamping. Two continuous 3–0 Prolene sutures were then used to approximate the prosthesis's edges. These sutures were tied in the middle of the wrap and ran from the prosthesis's proximal and distal ends aiming to reduce aortic diameter below 3.5- 4 cm in its maximal diameter. The greater curvature between the ST junction and the innominate artery's origin was used to measure the vascular graft's length, and the maximal diameter of the dilated aorta was used to estimate its diameter.

Sometimes, wrapping was done after weaning of the bypass and heparin reversal. However, maintaining systolic arterial pressure below 80 mmHg through prober CPB flow is preferred to prevent the dislocation of the wrap, the proximal and distal ends of the prosthesis were sutured to the surface of the aorta using several 5–0 Prolene stitches.

Statistical analysis:

Sampling method:

A convenient sample size (62 patients) was properly calculated from a total patient population of 75 cases. This size was adopted using the Medcalc 19program by setting an alpha error of 5%, 95% confidence level, and

80% power sample (Equations are described by Machin D et al.; 2009¹⁷).

Data analysis:

Continuous data were expressed as mean and standard deviation or median with the interquartilerange and categorical data as percentages. All statistical analyses were performed with SPSS version 22.0 (SPSS, Inc., Chicago, IL,USA). All statistical analyses were done with the help of a departmental statistician.

Outcomes:

We primarily figured out deaths and incidence of aortic events following the operation including dissection, rupture, reopening and sudden cardiac deaths to assess safety of the wrapping technique.

Then, over the mean follow-up (11.30 + 13.11 months) we focused on changes in aortic diameter at each individual level using serial echocardiographic and C.T imaging to assess efficacy of the wrapping technique to lower aortic diameter down to normal levels and to prevent further dilatation, dissection and rupture.

1245

RESULTS: [Data presented as mean± SD, mean (interquartile range), or n (%)]

Demographic and pre-operative variables; Table 1

62 candidates with a mean age of 37.33 + 8.89 at the time of surgery (AVR along with aortic wrapping) were involved in this study, including 35 males (56.45%), 15 patients (24.19%) with bicuspid aortic valves, and 27 (43.55%) hypertensive patients. Aortic valve stenosis was the predominant functional lesion in 42 patients (67.74%). The mean preoperative mid-ascending aortic diameter was 4.64 ± 0.38 mm (Table 1).

Variable	ValueP value
Age	37.33 + 8.89
Sex	
Male	35 (56.45%) P = 0.1525
Female	27 (43.55%)
Aortic phenotype	
Bicuspid	15 (24.19%) P < 0.0001
Tricuspid	47 (75.81%)



Hypertension	27 (43.55%) P = 0.1525
Aortic valve lesion	
Stenotic	42 (67.47%) P = 0.0001
Regurgitant	20 (32.26%)

Intraoperative variables; Table 2

Biological prostheses were used in only 4 (6.45%) females in the childbearing period, while mechanical prostheses in intra-supra-annular positions were used in the remaining 58 (93.55%) patients. The mean size of the prosthetic aortic valve was 22.2 ±1.8 mm. We exclusively used fashioned Dacron tubes as the wrapping material. The mean aortic cross-clamping time (ACC time) was 83.0±26.6 min, and the mean cardiopulmonary bypass time (CPB time) was 115.4±34.3 min.

Variable	Value	P value
Prosthesis type		
Mechanical valve	58 (93.55%)	P < 0.0001
Biological valve	4 (6.45%)	
Mean prosthesis size	22.2 ±1.8 mm	
ACC time	83.0±26.6 min	
CPB time	115.4±34.3 min	

1246

Postoperative variables; Tables3

Early outcomes; within 30 days after surgery:

We reported no early mortality, no surgical infection, only one case needed re-opening for surgical bleeding and only one case needed prolonged care in the Intensive Care Unit (ICU).

Follow-up Aortic diameters changes:

Within 30 days after surgery, diameters of the ascending aorta wrapped with the Dacron grafts showed dramatic reduction from 44.7 ± 2.6 to 33.6 ± 3.9 mm (p < 0.001). Throughout the follow-up duration (11.30 + 13.11 months), different parts of the aorta proximal and distal to the wrapping site showed significant remodeling and downsizing;

- The diameters of the sinuses of Valsalva declined considerably from 37.9 ± 4.9 mm before surgery to 33.3 ± 26.1 mm after aortic wrapping (p < 0.001).
- Statistically significant reduction of the STJ size from 33.2 ± 4.7 mm to 30.6 ± 4.4 mm was also observed (P = 0.02).
- Distally, the aortic arch's maximal diameter decreased from 34.7 ± 4.3 mm before surgery to 32.6 ± 4.1 mm after aortic wrapping (p = 0.03).

It is important to note that the observed aorta remodeling proximal and distal to the wrapping was independent of aortic valve disease.

Table 3; Early outcomes

Variable	Value
----------	-------



In-hospital mortality	Zero (No early mortality)
In-hospital morbidity	
Prolonged ICU stay > 7days	1 (1.61%); pneumonia.
Reopening for bleeding	1 (1.61%)
Surgical infection	Zero (no wound infection, no infective endocarditis)

Table 4; Changes in Aortic diameters

Part of Aorta	Preoperative diameter	Postoperative diameter	P value
Ascending tubular aorta	37.9 ± 4.9 mm	33.3 ± 26.1 mm	p < 0.001
Sinuses of Valsalva	37.9 ± 4.9	33.3 ± 26.1	p < 0.001
Sino-tubular junction	33.2 ± 4.7	30.6 ± 4.4	P = 0.02
Proximal Aortic Arch	34.7 ± 4.3	32.6 ± 4.1	p = 0.03

1247

DISCUSSION:

Ascending aortic replacement is the known standard surgical intervention for pathologically dilated aorta and despite advances in cardiac surgeries, it still of considerable morbidity and mortality approaching 20% in some records¹⁸⁻¹⁹.

It is thus always preferable to substitute a less invasive and more physiological treatment for AAR, particularly in high-risk instances or in patients having surgery for other heart diseases.

Aortic wrapping (AW), which was first introduced for abdominal aortic aneurysms by Robicsek²⁰, is a simple time-saving method that reduces aorta diameter rapidly to normal size. However, the outcome remains uncertain. In this study we investigated the safety and efficacy of AW in moderately dilated ascending aorta along with AVR.

We found no in-hospital late cardiac deaths among our patients and through the total follow-up period, and we

reported marked aortic diameter reduction at different levels, including supra-avalvular level (from 37.9 ± 4.9 mm before surgery to 33.3 ± 26.1 mm, P < 0.001), Sino-tubular junction (from 33.2 ± 4.7 mm to 30.6 ± 4.4 mm, P = 0.02), and proximal aortic arch (d from 34.7 ± 4.3 mm to 32.6 ± 4.1 mm, P = 0.03) after aortic wrapping.

In 2012, park JY and colleagues reported no postoperative deaths nor in-hospital deaths. They also observed marked reduction ascending aortic diameter from 46.4±4.3 mm to 33.0±3.5 mm (p<0.05) throughout the follow-up period (15.4±5.2 months)²¹. This coincides well with our findings.

Some papers reported need for reoperation during the follow-up duration in 1.7% to 2.1 % of their cases which remains low and acceptable⁸⁻²². None of our patients needed reoperation for aortic dilatation.

In 2014, Plonek et.al. In their systematic review found that AW prevented progressive aortic root enlargement



when the external prosthesis was secured by proximal and distal fixation²³. This copes well with our results.

Regarding prostheses displacement and aortic wall erosion, we reported no cases with such complication. In contrary, Bauer and colleagues²⁴ and Akgun and colleagues²⁵ presented 4 patients with dislocation of the external wrapping graft with progressive root dilatation besides Two cases of progressive dilatation that mandated reintervention reported by Cohen and colleagues²⁶.

This may be different fixation techniques used in these studies, proper vascular graft prostheses fashioning and fixation are the key points to prevent such serious problem that we did not face among our cases.

CONCLUSION:

In this study, we demonstrated that aortic wrapping along with aortic valve replacement for moderately dilated aortas is associated with no early hazards and proved to be effective in preventing progressive pathological aortic root dilatation and protecting against re-operation for aneurysmal rupture or aortic wall dissection.

REFERENCES:

1. Carrel T, von Segesser L, Jenni R, et al. Dealing with dilated ascending aorta during aortic valve replacement: advantages of conservative surgical approach. *Eur J Cardiothorac Surg* 1991;5:137-143.
2. González-Santos JM, Arnáiz-García ME. Wrapping of the ascending aorta revisited-is there any role left for conservative treatment of ascending aortic aneurysm? *J Thorac Dis*. 2017 May;9(Suppl 6):S488-S497.
3. Ergin MA, Spielvogel D, Apaydin A, Lansman SL, McCullough JN, Galla JD, Griepp RB. Surgical treatment of the dilated ascending aorta: when and how? *Ann Thorac Surg*. 1999;67:1834–1839.
4. Robicsek F, Cook JW, Reames MK Sr, Skipper ER. Size reduction ascending aortoplasty: is it dead or alive? *J Thorac Cardiovasc Surg*. 2004;128:562–570.
5. Ang KL, Raheel F, Bajaj A, Sosnowski A, Galiñanes M. Early impact of aortic wrapping on patients undergoing aortic valve replacement with mild to moderate ascending aorta dilatation. *J Cardiothorac Surg*. 2010 Aug 6;5:58.

6. Lee SH, Kim JB, Kim DH, Jung SH, Choo SJ, Chung CH, et al. Management of dilated ascending aorta during aortic valve replacement: valve replacement alone versus aorta wrapping versus aorta replacement. *J Thorac Cardiovasc Surg* 2013;146:802–809.
7. Erbel R, Aboyans V, Boileau C, Bossone E, Bartolomeo RD, Eggebrecht H, et al. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). 2014 ESC guidelines on the diagnosis and treatment of aortic diseases: document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. *Eur Heart J* 2014;35:2873–2926.
8. Kim HH, Lee S, Lee SH, Chang BC, Youn YN, Yoo KJ, Joo HC. Concomitant Wrapping of a Moderately Dilated Ascending Aorta during Aortic Valve Replacement: Postoperative Remodeling of a Distinctive Aorta. *Yonsei Med J*. 2020 Jan;61(1):40-47.
9. Zierer A, Melby SJ, Lubahn J, et al. Elective surgery for thoracic aortic aneurysms: late functional status and quality of life. *Ann Thorac Surg* 2006;82:573-8. 10.1016/j.athoracsur.2006.03.042.
10. Williams JB, Peterson ED, Zhao Y, et al. Contemporary results for proximal aortic replacement in North America. *J Am Coll Cardiol* 2012;60:1156-62. 10.1016/j.jacc.2012.06.023.
11. Gill M, Dunning J. Is reduction aortoplasty (with or without external wrap) an acceptable alternative to replacement of the dilated ascending aorta? *Interact Cardiovasc Thorac Surg* 2009;9:693-7
12. Laux, M., Ostovar, R., Braun, C., Hartrumpf, M., Claus, T. H., Schröter, F., & Albes, J. M.. Wrapping in ascending aortic aneurysms as an alternative for replacement: Is it beneficial? *The Thoracic and Cardiovascular Surgeon*, 68(04), 2019;322–327.
13. Zhu P, Zhou P, Xiao L, Ohene BE, Bian XM, Jiang X. Surgical treatment of mild to moderately dilated ascending aorta in bicuspid aortic valve aortopathy: the art of safety and simplicity. *Journal of Cardiothoracic Surgery*. 2020;15(1).
14. Shrimel MG, Bickler SW, Alkire BC, et al. Global burden of surgical disease: an estimation from the provider perspective. *Lancet Glob Health*. 2015;3:S8–S9.
15. Hayashi M, Shimizu W, Albert CM. The spectrum of epidemiology underlying sudden cardiac death. *Circ Res*. 2015 Jun 05;116(12):1887-906.

16. World Medical Association. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects. *JAMA*. 2013;310(20):2191–2194.
17. Machin, David & Campbell, Michael & Tan, Say & Tan, Sze-Huey. (2009). *Sample Size Tables for Clinical Studies*, Third Edition.
18. Zierer A, Melby SJ, Lubahn JG, Sicard GA, Damiano RJ Jr, Moon MR. Elective surgery for thoracic aortic aneurysms: late functional status and quality of life. *Ann Thorac Surg* 2006; 82:573-8.
19. Kari FA, Doll KN, Hemmer W, Liebrich M, Sievers H, Richardt D, et al. Survival and freedom from aortic valve-related reoperation after valve-sparing aortic root replacement in 1015 patients. *Interactive Cardiovascular and Thoracic Surgery* [Internet]. 2015 Dec 30;22(4):431–8.
20. Robicsek F. A new method to treat fusiform aneurysms of the ascending aorta associated with aortic valve disease: an alternative to radical resection. *Ann Thorac Surg* 1982;34:92-4.
21. Park JY, Shin J, Chung JW, Kim JS, Chee HK, Song M. Short-term outcomes of aortic wrapping for mild to moderate ascending aorta dilatation in patients undergoing cardiac surgery. *The Korean Journal of Thoracic and Cardiovascular Surgery* [Internet]. 2012 Jun 7;45(3):148–54.
22. Park JY, Shin J, Chung JW, Kim JS, Chee HK, Song M. Short-term outcomes of aortic wrapping for mild to moderate ascending aorta dilatation in patients undergoing cardiac surgery. *The Korean Journal of Thoracic and Cardiovascular Surgery* [Internet]. 2012 Jun 7;45(3):148–54.
23. Plonek T. A meta-analysis and systematic review of wrapping of the ascending aorta. *J Card Surg*. 2014; 29:809–815.
24. Bauer M, Grauhan O, Hetzer R. Dislocated wrap after previous reduction aortoplasty causes erosion of the ascending aorta. *Ann Thorac Surg*. 2003 Feb;75(2):583-4.
25. Akgün S, Atalan N, Fazlıoğulları O, Kunt AT, Başaran C, Arsan S. Aortic root aneurysm after Off-Pump reduction Aortoplasty. *The Annals of Thoracic Surgery* [Internet]. 2010 Nov 1;90(5):e69–70.
26. Cohen O, Odum J, De La Zerda D, Ukatu C, Vyas RM, Vyas N, et al. Long-Term experience of girdling the ascending aorta with dacron mesh as definitive treatment for aneurysmal dilation. *The Annals of Thoracic Surgery* [Internet]. 2007 Feb 1;83(2):S780–4.