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Short-Term Results of Ascending Aorta Wrapping: A Single Center Experience with 82 Consecutive Patients

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Abstract

Objectives: Moderate dilated ascending aorta can be treated with different procedures. One of them is wrapping of the ascending aorta which is considered less invasive and optional for high risk patients.

Methods: Between January 2014 and December 2017, 82 patients with a mean age of 64 ± 14 years underwent wrapping of the dilated ascending aorta. Mean EUROScore II was 3 ± 3.2%. Twelve patients (15%) were high risk with mean EUROScore II of 9.5 ± 3.1%. Concomitant procedures were aortic valve repair (n=21) and replacement (n=40), mitral- (n=14) and tricuspid valve (n=10) procedures as well as coronary artery bypass grafting (n=28). 68 (83%) were male.

Results: A 30-day mortality was 1% (n=1). Mean follow up time was 1.8 ± 1 years. We noticed seven (4.8%/pt-year) late deaths and one (0.7%/pt-year) neurological event (stroke) during follow up. There were no cases of reoperation. Follow up echocardiography revealed a mean ascending aorta diameter of 3.2 ± 0.2 cm. Kaplan-Meier estimate for survival was 96% at 1 year and 84% at 3 years. At latest follow up patients were in New York Heart Association class 1.6 ± 0.9 mean.

Conclusion: According to our short-term clinical outcome and echocardiography data a sufficient application of this procedure can directly reduce the diameter of the ascending aorta. Wrapping of the ascending aorta with Dacron prosthesis is a safe and effective method with good short-term clinical outcome. It is an option for high risk patients with dilated ascending aorta. However, a longer follow up period is necessary to underline our thesis.

Keywords: Wrapping; Dilated ascending aorta; PUS; CABG

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Introduction

Moderate dilatation of the ascending aorta is defined as an aortic diameter exceeding at least 50% of the norm for a given age and body size and can be treated with a variety of procedures [1,2]. The physiological diameter of the ascending aorta has been determined as <2.1 cm/m^2 and gains with increasing age [2]. The most famous patient who underwent a wrapping of his abdominal aneurysm with cellophane was Albert Einstein in 1948 who died in 1955 because of a rupture of aorta after declining are operation [3]. Currently, the wrapping procedure is considered controversial by many surgeons. On the other hand, several studies demonstrated that wrapping is a sufficient technique to reduce the ascending aorta diameter to normal, and it also may prevent the progressive dilatation of the ascending aorta with good follow up results [4-7]. In order to analyze the short-term and postoperative clinical results, we retrospectively examined 82 patients with dilated ascending aorta who underwent wrapping of the ascending aorta and concomitant cardiac procedures.

Material and Methods

Our study was approved by institutional ethics committee of University Hospital Frankfurt am Main, Germany. A total of 82 patients underwent wrapping of the ascending aorta between January 2014 and December 2017 in the University Hospital Frankfurt am Main. Their mean age was 64 ± 14 years. We also included patients with other concomitant heart operations like valve procedures and Coronary Artery Bypass Grafting (CABG). The decision of wrapping technique was made by senior surgeons according to the preoperative echocardiographic data and intraoperative situs. The preoperative patient demographics are listed in Table 1. The mean diameter of the ascending aorta in preoperative echocardiography was 4.5 ± 0.6 cm. The predominant etiology of dilated

Table 1: Preoperative patient demographics.

Baseline characteristics	
Patient number	82
Age, mean ± SD (years)	64 ± 14
Systemic hypertension, n (%)	34 (41 %)
Male, n (%)	68 (83%)
Aortic valve stenosis, n (%)	26 (32 %)
Aortic valve insufficiency, n (%)	34 (41 %)
Mitral valve stenosis, n (%)	1 (1 %)
Mitral valve insufficiency, n (%)	19 (23 %)
Tricuspid valve insufficiency, n (%)	16 (20 %)
Diabetes mellitus, n (%)	6 (7%)
COPD, n (%)	8 (10 %)
Cerebrovascular event, n (%)	4 (5 %)
Chronic renal failure, n (%)	14 (17 %)
CAD involvement, n (%)	33 (40 %)
Cardiac decompensation, n (%)	15 (18 %)
logisticeuroSCORE, (mean ± SD %)	3 ± 3.2
NYHA class, (mean ± SD)	3 ± 1
LVEF, mean ± SD (%)	60 ± 10
LVESD, mean ± SD (cm)	2.5 ± 4.5
LVEDD, mean ± SD (cm)	5.0 ± 1
AV Mean gradient, mean ± SD (mmHg)	36 ± 33
AV Max gradient, mean ± SD (mmHg)	53 ± 45
Aortic valve insufficiency, mean ± SD (°)	1.8 ± 1
Ascending aorta diameter, mean ± SD (cm)	4.5 ± 0.6

COPD: Chronic Obstructive Pulmonary Disease; CAD: Coronary Artery Disease; NYHA: New York Heart Association; LVEF: Left Ventricular Ejection Fraction; LVESD: Left Ventricular End-Systolic Diameter; LVEDD: Left Ventricular End-Diastolic Diameter

ascending aorta was systemic hypertension in 37 (45%) patients. 35 (43%) patients had a bicuspid and 47 (57%) a tricuspid aortic valve. The indication for an aortic valve replacement was insufficiency in 34 (41%) patients and degenerative stenosis in 26 (32%) patients. A combination was seen in 9 (11%) patients. All patients underwent preoperative and postoperative echocardiography.

Surgical technique

Senior surgeons performed all operations. In 50 patients the surgical approach was performed minimally invasive through the Partial Upper Sternotomy (PUS). In 32 patients who required CABG or a reoperation a full median sternotomy was the standard approach. Intraoperative transesophageal echocardiography was applied in all patients. For an optimal organ protection and to reduce the incidence of gaseous emboli, carbon dioxide was continuously insufflated into the operative field. Except in one case, all the procedures were carried out under cardiopulmonary bypass and cardioplegic arrest. First of all, a macroscopic intraoperative inspection of the ascending aorta was done. The ascending aorta was separated from the pulmonary artery and released from surrounding tissue. After this entire mobilization, the distal ascending aorta was cannulated, cardiopulmonary bypass was started and the aorta was clamped. The concomitant procedures such as CABG, valve replacements or repairs were first performed. During weaning from cardiopulmonary bypass the Dacron vascular prosthesis was prepared. A tongue shaped extension was created to

Figure 1: Dacron vascular prosthesis. The extended part of prosthesis at the proximal end adjusted tongue-shaped (to cover the noncoronary sinus) for a proper adaptation for the aortic root.

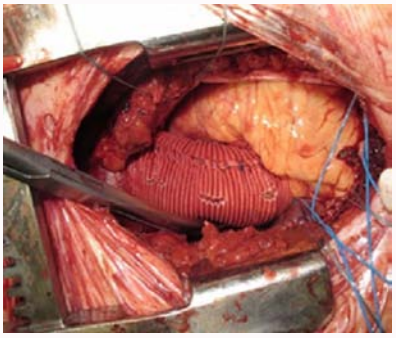

Figure 2: Final operative result. After a sufficient wrapping of the dilated ascending aorta. Along the prosthesis, arrangement of the double running suture and pores about 0.5 cm sized for an accurate adaptation of prosthesis with the surrounding tissue and a better systolic expansion.

cover the noncoronary sinus and the tube was split longitidinally (Figure 1). The aorta was wrapped usually during reperfusion with Dacron prosthesis (32 mm to 34 mm diameter). The tongue was fixed at the base of the noncoronary sinus. The split prosthesis was readapted anteriorly during a brief episode of lowered arterial pressure. Subsequently, the longitudinally incision of the prosthesis was sewn with a double running 4-0 polypropylene suture, and the proximal and distal ends were anchored to the surface (adventitia) of the aorta. For a better stabilization of the Dacron wrap stitches were taken through the adventitia. Additionally, to encourage in growing of the surrounding tissue and a better systolic expansion, small longitudinal cuts of about 0.5 cm were made using thermal cauterization before wrapping (Figure 2).

Statistical analysis

Descriptive statistics were utilized to present the demographic data. Categorical variables are expressed as percentages (%), and continuous variables are expressed as mean ± standard deviation. The survival curve is presented with the Kaplan–Meier method.

Results

Perioperative outcome

The operative and perioperative data are listed in Table 2. The aortic valve was repaired in 26 (32%) patients and replaced in 38 (46%) patients. The majority of patients underwent minimally invasive surgical access *via* partial upper sternotomy (61%). A conversion to full sternotomy was not needed in any patient. Mean cardiopulmonary bypass time was 146 ± 57 min. There were no operative deaths. The

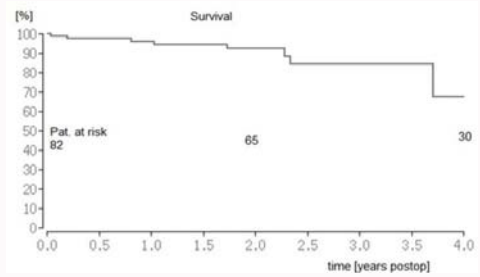

Figure 3: Kaplan-Meier curve for survival.

Table 2: Operative and perioperative results.

Operative and perioperative data	
Surgical Access	
Partial upper sternotomy, n (%)	50 (61 %)
Full median sternotomy, n (%)	32 (39 %)
Concomitant procedures	
Aortic valve repair, n (%)	26 (32 %)
Aortic valve replacement, n (%)	38 (46 %)
Mitral valve repair, n (%)	12 (15 %)
Mitral valve replacement, n (%)	12 (15 %)
Tricuspid valve repair, n (%)	2 (2 %)
Coronary artery bypass grafting, n (%)	24 (29 %)
Cardiopulmonary bypass time, mean ± SD (min)	146 ± 57
Cross clamp time, mean ± SD (min)	103 ± 43
Intensive care unit stay, mean ± SD (days)	4 ± 10
Ventilation time, mean ± SD (h)	25 ± 53
Blood loss postoperatively, mean ± SD (mL)	558 ± 469
Rethoracotomy, n (%)	4 (5 %)
Neurologic event (stroke), n (%)	1 (1 %)
Deep wound dehiscence, n (%)	1 (1 %)

in-hospital mortality was 1% (n=1). This patient with EUROScore II of 14% underwent CABG and wrapping of the ascending aorta and died of Multi Organ Failure (MOF) due to septicaemia at 15th pod. We observed one patient (1%) with perioperative neurological deficit (stroke). The mean ventilation time was 25 ± 53 h and the intensive care unit stay was 4 ± 10 days. Mean postoperative bleeding was 558 ± 469 ml. Four patients (5%) underwent re-thoracotomy: Three patients had hemodynamically relevant pericardial effusion (4%) and one had persistent bleeding complication after a pleural paracentesis (1%). Only one patient (1%) developed a deep wound dehiscence.

Follow-up

All patients were evaluated for their clinical status, quality of life, NYHA classification and occurrence of complications. All postoperative echocardiographic examinations were performed by two experienced examiners. Mean follow up time was 1.8 ± 1 year. At latest follow up 95% of the patients (n=70) were in New York Heart Association class I and II with 1.6 ± 0.9 mean in total. No case of reoperation was observed. Seven patients-with mean EUROScore II of 6 ± 3% at time of surgery-died during follow-up (4.8%/pt-year). We documented three cardiac related deaths: one sudden cardiac death, one a systole with Cardiopulmonary Resuscitation (CPR) and one due to heart failure. One patient died of brain hemorrhage

Table 3: Echocardiographic data.

ECHO-parameter	Preoperative	Postoperative	Follow-up
Ejection fraction mean ± SD (%)	60.4 ± 10	57 ± 10	63 ± 3
Asc. Aorta Diameter mean ± SD (cm)	4.5 ± 0.6	3.2 ± 0.5	3.2 ± 0.2
Aortic insufficiency mean ± SD (°)	2 ± 1	0.4 ± 0.5	0.2 ± 0.4
Aortic Valve maxPG mean ± SD (mmHg)	53 ± 46	30 ± 14	18 ± 10
Aortic Valve meanPG mean ± SD (mmHg)	36 ± 33	18 ± 9	13 ± 7
LVEDD mean ± SD (cm)	5 ± 0.9	5 ± 1.7	4.9 ± 0.5
LVESD mean ± SD (cm)	2.5 ± 4.5	2.7 ± 1.9	3.2 ± 0.7

LVEDD: Left Ventricular End-Diastolic Diameter; LVESD: Left Ventricular End-Systolic Diameter; Aortic Valve max/mean PG, maximal/mean pressure gradient

(he received oral anticoagulation because of atrial fibrillation), one suffered from end stage renal failure, one patient died of liver failure and one due to Multi Organ Failure (MOF). One neurological event (stroke) was observed during follow up (0.7%/pt-year). Two other patients developed dementia (1.4%/pt-year). We noticed one bleeding event due to gastrointestinal bleeding (0.7%/pt-year). Kaplan-Meier estimate for survival was 96% at 1 year and 84% at 3 years (Figure 3). Follow-up echocardiography exam revealed a mean ascending aorta diameter of 3.2 ± 0.2 cm. All echocardiographic data are listed in Table 3.

Discussion

Surgical intervention in ectasia or aneurysm of the ascending aorta has been advocate on the base of current diameter. Physiologically the size of ascending aorta is reciprocal related to the Body Surface Area (BSA) and the age of the patient [8]. The current general statement for surgical intervention in degenerative aneurysms is indicated in adults at a diameter of 55 mm except in Marfan's diseases or family anamnesis in which a lesser diameter is recommended [9]. It is already published that an untreated aortic aneurysm can result in rupture or dissection of the aorta [1,10-12]. In cases of moderate dilatation of the ascending aorta wrapping or graft replacement are additional surgical methods of choice [11]. Wrapping is known to be the less invasive method with shorter CPB times [11]. Several studies examined these two methods and showed different short- and long-term clinical outcomes. Carrel and colleagues report of an early (1.8% *vs.* 6.4% early mortality) and long-term survival benefit in patients undergoing wrapping compared to graft replacement (89.6% *vs.* 73.2% survival at 8 years) [13]. On the other hand Lee and coworkers report of a study showing no differences in short- (about 1.2% early mortality) and long-term mortality rates of patients undergoing wrapping in comparison to replacement of the ascending aorta [1]. Similar results were presented by Abe et al. with a 0% early mortality in a small cohort of 40 patients [11]. Plonek and colleagues presented a meta-analysis with patients undergoing wrapping alone or wrapping with resection aortoplasty with a lower in hospital mortality rate in the group with wrapping alone (0.4% *vs.* 2.0%) [6]. In our study population of 82 patients with 15% high risk cases the 30-day mortality was 1% which is comparable to other reports [1,6,11]. The short-term survival of our cohort is 96% at 1 year (Figure 3) and acceptable for a high risk study population that is containing in our study group. Our mean cardiopulmonary bypass time with 146 ± 57 min is also comparable with that of other studies [14]. The short-term follow-up echocardiography results of our study population showed stable diameter of ascending aorta with 3.2 ± 0.2 cm mean (Table 3).

Conclusion

Simple external support of the ascending aorta offers a good and less invasive solution for selected patients with moderate dilatation of the ascending aorta and may stop the progression of the disease due to reverse remodeling. By this technique the wall stress of the dilated aorta is reduced and also the risk of rupture. The wrapping procedure is useful as a concomitant procedure in cardiac operations without increasing mortality, especially in a high risk patient population.

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