The effect on systolic hypertension after repair of coarctation of the aorta in adults
K Ergüne?, H Ya?a, U Yetkin, B Pamuk, B Lafç?, C Özbek, A Gürbüz

Citation

Abstract
Background: The purpose of this retrospective study is to determine the effect of repair on systolic hypertension and the results of repair of aortic coarctation in adults.

Methods: Eight adults patients underwent aortic coarctation surgical repair between March 1990 and October 2007. Mean age of the patients 28.5±8.59 years (range, 18 to 41 years). There were 6 men and 2 women patients. Mean systolic blood pressure was 160.63±12.37 mmHg (range, 145 to 180 mmHg). All patients were receiving two or three antihypertensive drugs preoperatively. Mean peak systolic gradient across the coarctation was 62.5±11.65 mmHg (range, 40 to 80 mmHg). Surgical treatment were performed with bypass graft between proximal and distal descendan aorta in four patients, bypass graft from the left subclavian artery to the descending aorta in three patients, patch aortaoplasty in one patient. In none of the patients there was hospital mortality or late morbidity and mortality.

Results: Mean follow-up was 8.06±4.95 years (range, 1 to 17 years). There were no deaths. At the last follow-up, only two patient was normotensive without receiving any hypertensive medication. The other 6 patients were normotensive with one antihypertensive drug. Recoarctation hasn't been noticed in follow-up of the patients.

Conclusion: Surgical repair of aortic coarctation in the adult has low-risk, and it is an effective method in decreasing the sistolic hypertension and lessens requirement of antihypertensive medications and clinical symptoms.

INTRODUCTION
Coarctation of the aorta is seen (appeared) in the rate 0.2 to 0.6% after birth, and it constituted 6 to 8% of congenital heart diseases. Coarctation of aorta is often associated with congenital heart diseases as patent ductus arteriosus, ventricular septal defect, bicuspid aortic valve, and mitral valve anormalities. The first successful repair of coarctation of the aorta was performed by Crafoord in 1944. If coarctation of aorta those are seen in adult patients hasn't been repaired, the patients die before the age of 50 from hypertension and associated complications as aortica dissection, myocardial infarction, congestive heart failure, and bacterial endocarditis. Well and colleagues demonstrated that systolic hypertension is decreased with surgical repair of coarctation of the aorta in adult.

In this study, we analysed our surgical repair results in 8 patients. In follow-up, systolic hypertension and clinical findings decreased in these patients.

PATIENTS AND METHODS
Between March 1990 and October 2006, eight adult patients underwent surgical repair of aortic coarctation in our institution. The mean age of patients were 28.5±8.59 years (range, 18 to 41 years) and there were 6 men and two women patients. All patients were receiving two or three antihypertensive drugs before aorta coarctation has been diagnosed. All patients had hypertension before they hadn't aorta coarctation repair and the mean systolic blood pressure was 160.63±12.37 mmHg (range, 145 to 180 mmHg). The patients had antihypertensive medications with the combination of two or three antihypertensive drugs which were angiotensin-converting enzyme inhibitors, β-blockers,calcium-channel antagonists, and diuretics(Table I).
The effect on systolic hypertension after repair of coarctation of the aorta in adults

Figure 1
Table 1: Preoperative and postoperative medication and systolic blood pressure measurements

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Sex</th>
<th>Age</th>
<th>Time of operation</th>
<th>Preoperative systolic BP (mmHg)</th>
<th>Preoperative medication</th>
<th>Postoperative systolic BP (mmHg)</th>
<th>Preoperative medication</th>
<th>Systolic BP at follow-up</th>
<th>Medication at follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>23</td>
<td>09/13/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>23</td>
<td>10/29/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>23</td>
<td>11/10/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>23</td>
<td>12/01/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>23</td>
<td>10/30/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>23</td>
<td>11/30/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>23</td>
<td>09/30/1990</td>
<td>160</td>
<td>e, c</td>
<td>120</td>
<td>c</td>
<td>120</td>
<td>c</td>
</tr>
</tbody>
</table>

Abbreviations: a=angiotensin-converting enzyme inhibitors; b=ß-adrenergic blockers; c=calcium-antagonists; d=diuretics; e=isosorbid-5 mononitrat.

According to frequency order, the most common symptoms were headache, asthenia, intermittent claudication, dyspnea and vertigo. 8 patients had notching of the ribs in the chest roentgenograms. Three patients had atrial fibrillation on the electrocardiogram. All patients had been performed angiography, and echocardiography preoperatively.

Three patients had in New York Heart Association class I symptoms, 2 patients had class II symptoms, and 3 patient had class III symptoms preoperatively according to New York Heart Association classification (Table II).

Figure 2
Table 2: Preoperative and postoperative NYHA class, associated CVD and type of operation

<table>
<thead>
<tr>
<th>Patient No</th>
<th>Preoperative NYHA Class</th>
<th>Associated CVD</th>
<th>Type of operation</th>
<th>Postoperative NYHA Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Class I</td>
<td>PDA</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>2</td>
<td>Class II</td>
<td>PDA</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>3</td>
<td>Class III</td>
<td>PDA</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>4</td>
<td>Class III</td>
<td>MVR</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>5</td>
<td>Class III</td>
<td>MI</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>6</td>
<td>Class III</td>
<td>MI</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>7</td>
<td>Class III</td>
<td>MI</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>8</td>
<td>Class III</td>
<td>MI</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
<tr>
<td>9</td>
<td>Class III</td>
<td>MI</td>
<td>PDA-Igmon+Patch aortoplast</td>
<td>Class I</td>
</tr>
</tbody>
</table>

Abbreviations: PGB=prosthetic graft bypass; MVR=mitral valve replacement; PDA=patent ductus arteriosus; MI=mitral valve insufficiency; MS=mitral valve stenosis; AS=aortic valve stenosis ;CVD=cardiovascular disease

In echocardiograms there were left ventricular hipertrophy in 3 patients. Preoperative angiographic examination revealed anatomy of the coarctation and collateral circulation (Figure 1).

Figure 3
Figure 1: Preoperative angiographic image of a severe coarctation of the aorta in a 23 years old patient.

There were extensive collateral circulation and long segment coarctation (n=4), extensive collateral circulation (n=3), and extensive collateral circulation and calcification of the aortic wall (n=1) on the angiographic examination. Mean peak systolic gradient across the aortic coarctation was 62.5±11.6 mmHg (range, 50 to 80 mmHg). Femoral pulses were weak or absent with palpation, but they were positive in Doppler examination.

4 patients (50%) had associated cardiac diseases. There were patent ductus arteriosus in one patient, mitral valve stenosis and regurgitation and tricuspid valve insufficient in one patient, subvalvular aortic stenosis and ventricular septal defect in one patient, and mitral stenosis in one patient in addition to aortic coarctation (Table II).

Repair of coarctation of the aorta carried out with a left posterolateral thoracotomy through fourth intercostal space. Hemodynamic monitoring was performed with right radial artery canullation for arterial pressure and pulmonary artery catheter. Endotracheal entubation was performed with a
double lumen tube to permit deflation of the left lung for obtaining a good surgical exposure. A collagen-impregnated woven polyester dacron tube graft (14 to 16 mm) or patch angioplasty with Gore-Tex were used in the coarctation repair. Perioperative pressure measurements were made in all patients following the coarctation repair. Surgical treatment were performed with bypass graft between proximal and distal descendan aorta in four patients, bypass graft from the left subclavian artery to the descending aorta in three patients (Figure 2), patch aortaoplasty in one patient.

Figure 4
Figure 2: Postoperative angiogram of the same patient in figure 1 that shows subclavian artery to descending aorta bypass graft.

Surgical repair was performed simultaneously in two patients. The repair of aortaic coarctation and patent ductus arteriosus ligation were performed simultaneously with a left thoracotomy in one patient. Mitral valve replacement, tricuspid De Vega annuloplasti and repair of aortic coarctation were performed simultaneously in other patient owing to mitral valve insuffiency and stenosis, tricuspit insuffiency and aortaic coarctation.

Follow-up of all patients was achieved with a hospital office visit or by telephone interview. The patients were evaluated by clinical examination, electrocardiograms, chest roentgenograms, and transthoracic echocardiographic examinations.

RESULTS
None of the patients had operative and postoperative mortality. There was no complications like bleeding, spinal cord ischemia, left phrenic or recurrent laryngeal nerve damage, chylothorax, pleural effusion, pneumothorax, and wound infection in the postoperative period.

Atrial fibrillation went on despite medical treatment postoperatively in the two patients who had atrial fibrillation preoperatively. In the patients who had symptoms like headache, asthenia, intermittant claudication, dyspnea, and vertigo preoperatively improved significantly postoperatively.

6 patients (75%) had NYHA class I and two (25%) patients class II symptoms postoperatively (Table II).

Seven (87.5%) patients had paradoxical hypertension in the early postoperative period, which was controlled with sodium nitroprusside and nitrate infusion.

Postoperatively mean systolic blood pressure was 126.87±10.99 mmHg. Mean follow-up was 7.06±4.95 years (range, 1 to 16 years). At the last follow-up, mean systolic blood pressure was 121.25±8.34 mmHg. At the last follow-up, two patients (25%) were normotensive without the need for antihypertensive medication.

Six patients (75%) needed fewer numbers of antihypertensive drugs. Those patients needed antihypertensive drugs, such as angiotensin-converting enzyme inhibitors, ß-adrenergic blockers, calcium-antagonists, and diuretics for the control of blood pressure (Table I). The normotensive patients who underwent exercise testing had normal blood pressure responses.

After aorta coarctation operation two patients had no pressure gradient between upper and lower extremities at rest, whereas six patients had a mild gradient of less than 20 mmHg.

In a period between one and six months after the repair, two patients were operated for associated cardiac diseases. Mitral
valve replacement was performed in one patient because of mitral valve insufficiency. Ventricular septal defect patch repair and subaortic membra resection were performed in other patient owing to subaortic stenosis and ventricular septal defect.

The average stay in the intensive care unit was 1.37± 0.52 days (range, 1 to 2 days). The average postoperative period in the hospital was 5.75±1.28 days (range, 4 to 8 days). At follow-up, left ventricular hypertrophy regressed in the three patients who had left ventricular hypertrophy preoperatively. In follow-up, all patients are alive and active.

**DISCUSSION**

Although the descending thoracic aorta coarctation generally is seen in childhood period, it can be seen with or without associated intracardiac disease in the adult period. As Camphell explained If aorta coarctation untreated, 50% of patients die by the age of 30 years, 75% at 46 years, and 90% at 58 years.5

The goal of surgical treatment in the patients who had coarctation of the aorta is to decrease left ventricular afterload, to increase efficacy of antihypertensive medication after operation, to improve symptoms, and to obtain long-term survey.

Some authors have reported that to achieve of control of the systolic hypertension and decreased of need antihypertensive medication after surgical repair of coarctation of the aorta.6,7,8,9

The surgical approaches of coarctation of the aorta include resection and end-to-end anastomosis, end-to-end conduit interposition, left subclavian artery to descending thoracic aorta conduit interposition, end patch aortaoplasty. Further, intraluminal balloon angioplasty and stent placement can be used in these patients.

Repair of coarctation of the aorta in the adults represent technical difficulties because of long segment coarctation, large collateral circulation, relatively immobile aorta, and aortic calcification. In these patients end-to-end conduit interposition or left subclavian artery to descending thoracic aorta conduit interposition should be prefered.

We used end-to-end conduit interposition between proximal and distal descending aorta in 50% of patients, and end-to-side conduit interposition between left subclavian and descending aorta in 37.5% of patients.

Some authors had emphasized that between subclavian artery and descending aorta prosthetic bypass is as effective as others type of repair.6,7,9,10

We found no any difference in results on the basis of the type of repair in our operated patients.

Hehrlein and associates, Carvalho and associates had emphasized to become higher rate of false aneurysm seen after patch graft aortaoplasty.11,12 Although correction of aortic coactation can be performed with the percutaneous balloon aortaoplasty and stent graft in the well selected cases we had no further reports for their long-term outcome.13

We hadn't found suitable the balloon dilatation for our patients because they had mostly complex forms of coarctation of the aorta.

Hypertension that is seen after and before operation in the adult patients who had coarctation of the aorta has a significant role in the morbidity and mortality. A lot of factors are effective in the presentation of hypertension after coarctation repair.

These factors are anatomic aortacic alterations, structural wall alteration of thoracic and peripheral vessels, poor compliance of the arterial tree, altered renin-angiotensin system, sodium and water retantion, and neural reflex.14,15,16

Some studies had emphasized that prevalence of hypertension after coarctation repair is between 12% and 50%.6,7,17,18

In our patients, a mean time follow-up was 8.06±4.95 years, two of 8 patients had normal blood pressure without receiving any antihypertensive medication, and 6 patients had normal blood pressure with fewer numbers of antihypertensive drugs.

All patients were performed a treadmill excercise test in follow-up. Six patients who had normotension at rest showed a hypertensive response to exercise despite the absence of a pressure gradient at the prosthesis.

Alejandro and associates showed that hypertensive response to exercise tests occured if a residual gradient was presented at the prosthesis.8,10

We did not find any correlation between residual gradient and late hypertension.

Bouchart and associates did not found a relation between
residual gradient and late hypertension like our study.

Exercise test is mandatory to administer effective antihypertensive treatment after coarctation repair.

We found congenital heart defects as subvalvular aorta stenosis, ventricular septal defect, patent ductus arteriosus, and mitral and tricuspid valve abnormalities in some of our patients simillary to other studies. Operations for congenital heart defect were performed in two patient simultaneously and in two patients during follow-up period. Most of our patients were in NYHA class I postoperatively and patients showed significant improvement according to preoperative NYHA class.

In conclusion, surgical repair of the aortacic coarctation in adult patients can be performed safely and it is a necessary method to give in the fewer number antihypertensive drug, to be done more effective medical treatment of hypertension, and to decrease clinical symptoms.

CORRESPONDENCE TO
Dr.Kazim Ergüneş 2040-1Sokak, Selçuk-1 No:2, Daire51, Mavişehir. 35540 Karşıyaka-IZMIR TURKEY Tel: +90232-244444 Fax: +90232-2434848 E-mail: ufuk_yetkin@yahoo.fr & kazimergunes@yahoo.com

References
2. Abbott ME. Coarctation of the aorta of the adult type. A statistical study and historical retrospective of 200 recorded cases with autopsy of stenosis or obliteration of the descending arch in subjects above the age of 2 years. Am Heart J 1928;3:574-618
The effect on systolic hypertension after repair of coarctation of the aorta in adults

Author Information
Kazım Ergüne?, M.D.
Specialist, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Haydar Ya?a, M.D.
Specialist, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Üfük Yetkin, M.D.
Deputy Chief, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Bülent Pamuk, M.D.
Assistant, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Banu Lafç?, M.D.
Specialist, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Cengiz Özbek, M.D.
Deputy Chief, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital

Ali Gürbüz, M.D.
Clinic Chief, Department of Cardiovascular Surgery, İzmir Atatürk Training and Research Hospital