Best evidence topic - Congenital

Does surgical correction of coarctation of the aorta in adults reduce established hypertension?

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Summary

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed was whether surgical correction of coarctation of the aorta in adults (≥ 16 years) results in reduction in established hypertension. Altogether 484 relevant papers were identified using the above search, 11 papers represented the best evidence to answer the question. The author, journal, date and country of publication, patient group studied, study type, relevant outcomes, results and study weaknesses were tabulated. We conclude that surgical repair of coarctation of the aorta in adult patients is superior to conservative management in the reduction of established hypertension, with one meta-analysis and several retrospective reviews reporting low morbidity and low risk of re-stenosis. The reduction in blood pressure postoperatively has been demonstrated consistently, with most patients reported as normotensive without medication and the remainder having reduced requirements for antihypertensive medications. In all the papers included here (except one), there was no early mortality and no procedure-related late mortality during mean follow-up ranging from 2 to 14 years. Thus, surgical correction of aortic coarctation is a relatively safe procedure.

Keywords: Coarctation of aorta; Cardiac surgery; Hypertension; Evidence based medicine

1. Introduction

A best evidence topic was constructed according to a structured protocol. This protocol is fully described in the ICVTS [1].

2. Clinical scenario

A 50-year-old man is referred to your clinic by the cardiologists. He has had severe hypertension (BP 210/96 mmHg) secondary to coarctation of the aorta. He has been prescribed an antihypertensive regimen including ACE inhibitor and calcium channel blocker. The cardiologist has just attended a national conference and heard about the practice of repair of coarctation of the aorta in adult patients and how this has been shown in some cases to reduce hypertension postoperatively. He asks whether this patient might benefit from surgical repair of his coarctation of aorta. You discuss it with your consultant who has read conflicting evidence regarding repair of coarctation in adults, specifically that it does not alter the natural history of disease in a patient with already established hypertension. He asks you to review the literature.

3. Three-part question

In adult patients with coarctation of the aorta is surgical repair or conservative management the best option in reducing established hypertension?

4. Search strategy


5. Search outcome

A total of 484 papers were produced by the above search out of which 50 papers relevant to the subject were found. Out of these, 11 papers were selected as representing the best evidence on this topic (Table 1).

6. Comments

Ten clinical studies were found in 646 patients (age > 16 years). The studies reviewed the operative outcomes in adult patients undergoing surgery for repair of aortic coarctation. In addition, a meta-analysis of 846 patients undergoing surgical or endovascular treatment for coarctation of the aorta was found.
### Table 1

**Best evidence papers**

<table>
<thead>
<tr>
<th>Author</th>
<th>Patient group</th>
<th>Outcome</th>
<th>Key results</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Almeida de Oliveira et al., (2003), Ann Thorac Surg, Brazil [2]</td>
<td>18 consecutive patients aged 18–61 undergoing extra-anatomic bypass grafting to repair coarctation of aortic arch</td>
<td>Mortality</td>
<td>4.0% total mortality in study group (99 patients). No mortality in extra-anatomic bypass grafting group</td>
<td>Authors conclude that the procedure of extra-anatomic bypass grafting for repair of coarctation of the aortic arch effectively controls arterial hypertension, does not result in recoarctation or repeat operations for graft related complications</td>
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<tr>
<td>Cohort study (level 2b)</td>
<td>81 patients aged 18–64 undergoing conventional repair of coarctation</td>
<td>Hypertension</td>
<td>Twelve of 18 patients in group one found to have normal systemic arterial blood pressure post surgical repair without medications</td>
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| Connolly et al., (2001), Circulation, USA [3] | 18 patients with coarctation of the aorta undergoing ascending to descending aortic bypass graft via the posterior pericardium | Postoperative morbidity | Reexploration for control of bleeding from an intercostal artery in one patient, transient atrial fibrillation in two patients, permanent pacemaker implantation in one patient | Indications for extra-anatomic bypass grafting in this series included:  
1. Coarctation or recoarctation and associated cardiac problems that required repair through median sternotomy  
2. Complex coarctation or recoarctation appears to be a safe flexible method particularly useful in adult patients when simultaneous intracardiac repair is required |
| Cohort study (level 2b) | 81 patients aged 18–64 undergoing conventional repair of coarctation | Systolic blood pressure | Decrease in systolic blood pressure demonstrated. 158 mmHg average preoperatively vs. 125 mmHg average postoperatively |  |
Group 1 endovascular therapy (16 reports)  
Group 2 surgical therapy (6 reports) | Restenosis | Significantly higher risk of restenosis after stenting compared with surgery (OR 6.0 ± CI 1.8, RR 5.5) and after angioplasty compared with surgery (OR 8.6 ± CI 2.2, RR 7.5) |  |
| Metaanalysis (level 1a) |  | Need for reintervention | Repeat interventions necessary in 0.3% of surgery patients. Dramatically higher risk of needing repeat interventions after stenting (OR 16.1 ± CI 2.8, RR 14) or angioplasty (OR 14.8 ± CI 2.7, RR 13) compared to surgery |  |
|  |  | Hypertension | Endovascular group: cure of hypertension in 18% to 88% (mean 61%) | Surgical complications which occurred were ‘minor’ (vasculitis, bleeding) while endovascular complications ‘major’ (dissection, traumatic aneurysm, stroke) |
Postoperative mean systolic pressure 128 ± 16 mmHg  
\(P < 0.001\) | Surgical repair of aortic coarctation in patients older than 50 years of age can reduce systolic hypertension and the need of antihypertensive medication |

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<td>McKellar et al., (2007), J Thorac Cardiovasc Surg, USA [6]</td>
<td>Cohort study (level 2b) 50 consecutive patients with congenital aortic coarctation or recurrent coarctation undergoing ascending-descending posterior pericardial aortic bypass</td>
<td>Hypertension</td>
<td>Preoperative systolic BP mean 158 ± 25 mmHg Postoperative systolic mean BP 123 ± 14 mmHg P &lt; 0.001</td>
<td>Upper extremity BP after coarctation repair significantly improved Authors conclude that the ascending-descending aortic bypass through a posterior pericardial window is a safe operation and is effective in relieving obstruction and improving hypertension</td>
</tr>
<tr>
<td>Bauer et al., (2001), Ann Thorac Surg, Germany [7]</td>
<td>Cohort study (level 2b) 15 patients undergoing primary surgical correction of coarctation</td>
<td>Hypertension</td>
<td>All had hypertension preoperatively despite combined antihypertensive medication</td>
<td>Authors conclude that the operation reduces systolic hypertension at rest Hypertension during exercise persisted, but authors report symptomatic improvement</td>
</tr>
<tr>
<td>Wells et al., (1997), Ann Thorac Surg, Germany [8]</td>
<td>Cohort study (level 2b) 26 consecutive patients undergoing repair of coarctation, mean age 32 ± 10 years, all patients had critical systolic hypertension</td>
<td>Morbidity</td>
<td>One patient had persistent left vocal cord paralysis, no other major complications</td>
<td>Authors report a minimal incidence of residual hypertension after operation in a group of patients among whom many failed drug therapy and remained hypertensive even with medications preoperatively. They recommend operation even for patients with mild preoperative hypertension</td>
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<td>Bouchart et al., (2000), Ann Thorac Surg, France [9]</td>
<td>Cohort study (level 2b) 35 adults, mean age 28.1 ± 5.7 years undergoing coarctation surgical repair between 1977 and 1997, all with preoperative hypertension</td>
<td>Hypertension</td>
<td>71% of patients normotensive at rest postoperatively, remaining 10 with significant improvement Decrease in SBP highly significant at early follow-up (P &lt; 0.0001), and late follow-up (P &lt; 0.0001)</td>
<td>No correlation found between residual gradient present in three patients and late hypertension. No relationship between perioperative hypertension and subsequent hypertension at late follow-up Authors conclude that surgical repair of aortic coarctation in patients older than 20 years of age reduces systolic hypertension</td>
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<td>Hashemzadeh et al., (2008), Asian Cardiovasc Thorac Ann, Iran [10]</td>
<td>Cohort study (level 2b) 38 adults (22 men); mean age, 25.6 ± 6.9 years (range 16–39 years) underwent coarctation repair between 1996 and 2006. 30 patients had preoperative hypertension (mean systolic pressure 158.3 ± 18.6 mmHg; range 140–200 mmHg), Follow-up 2–90 months (mean 37 ± 23 months)</td>
<td>Hypertension</td>
<td>Of the 30 patients with preoperative hypertension, 25 (83%) were normotensive at last follow-up. One was lost to follow-up. The mean systolic BP in the 29 hypertensive patients was 126.9 ± 14.7 mmHg (range 100–160 mmHg); (t = 6.7, df = 28, P = 0.000 compared to preoperative values). Mean diastolic BP (75 ± 13 mmHg) was also significantly reduced (t = 4.9, df = 28, P = 0.000) Need for antihypertensive medications 58% patients were still taking antihypertensive medication</td>
<td>Surgical repair of coarctation of the aorta in adults leads to regression of systolic hypertension and a decreased antihypertensive requirement</td>
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In a retrospective study by Almeida de Oliveira et al. [2], 18 patients underwent extra-anatomic bypass grafting to repair coarctation of the aortic arch, and a further 81 patients underwent conventional repair of aortic coarctation. It was shown that extra-anatomic repair improved mortality and that postoperatively, blood pressure was normal in 67% of this group without the need for medication. The authors concluded that the procedure of extra-anatomic bypass grafting for repair of coarctation of the aortic arch effectively controls arterial hypertension with an acceptable long-term survival.

Connolly et al. [3] reviewed 18 patients with coarctation of the aorta undergoing ascending to descending aortic bypass graft via the posterior pericardium with regard to postoperative morbidity, hypertension and left ventricular function. The found significant complications in four patients including reexploration for control of bleeding, transient atrial fibrillation and the need for a permanent pacemaker. They demonstrated a decrease in systolic blood pressure, however, found no overall change in left ventricular function. They comment that extra-anatomic bypass is particularly useful when simultaneous intracardiac repair is required.

Carr [4] performed a meta-analysis of 22 studies of the results of treatment for coarctation in the adult and adolescent population and compared endovascular therapy to surgical therapy with regard to morbidity, restenosis, requirement for re-intervention and hypertension. It concluded that primary stenting had the lowest risk of complications, with surgery having slightly higher risk and angioplasty significantly higher risk. Rates of restenosis and need for reintervention were significantly higher following both stenting and angioplasty when compared to surgery. A cure for hypertension was seen in 61% of the endovascular group compared to 64% of the surgery group. The author comments that surgical complications which occurred were minor (e.g. vasculitis, bleeding) while endovascular complications tended to be much more serious.

Aris et al. [5] demonstrated that hypertension was significantly reduced following surgical repair of aortic coarctation, as did McKellar et al. [6] and Bauer et al. [7]. Wells et al. [8] studied 26 patients with critical systolic hypertension undergoing repair of coarctation. They studied outcome in terms of morbidity, effect on blood pressure and the need for antihypertensive medications. They reported a complication of persisting left vocal cord paralysis in one patient and no other major complications. They found a significant decrease in postoperative systemic arterial pressure and showed that requirement for antihypertensive medications was reduced following repair.


Cohort study (level 2b)

Between 1974 and 2000, 404 patients underwent surgery for isolated aortic coarctation. Of 382 who were still alive, 273 patients aged 16–73 years underwent blood pressure measurement, ambulatory blood pressure measurement, and symptom-limited exercise testing. Follow-up was 1–27 years

Hypertension

63 (23%) patients had an increased ambulatory blood pressure and 26 (10%) patients had a blood pressure during exercise exceeding 2 S.D. of reference values. 117 (43%) patients had a normal blood pressure response. In the patient group without restenosis (n=245), independent risk factors for hypertension were repair with prosthetic material, male sex, a residual brachial-ankle blood pressure difference, and older age at follow-up

Sixty-seven (25%) patients were taking antihypertensive drugs, From 156 patients with hypertension, only 21 (13%) had a systolic brachial-ankle blood pressure difference of <20 mmHg, suggesting restenosis


Cohort study (level 2b)

84 patients between 16–54 years (mean 29 years) underwent surgery. Mean systolic blood pressure was 162 mmHg and mean diastolic blood pressure was 93 mmHg. Follow-up was 1–12 years (mean 5.2 years)

Hypertension

There was significant regression of hypertension (P<0.001) in all patients. At mean follow-up of 5.2 years, 31% patients were hypertensive

Surgical repair of coarctation of the aorta in adults leads to regression of systolic hypertension and a decreased requirement for antihypertensive medication

need for reintervention were significantly higher following both stenting and angioplasty when compared to surgery. A cure for hypertension was seen in 61% of the endovascular group compared to 64% of the surgery group. The author comments that surgical complications which occurred were minor (e.g. vasculitis, bleeding) while endovascular complications tended to be much more serious.

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They
recommend operation even for patients with mild systemic hypertension.

Bouchart et al. [9] retrospectively reviewed outcomes of coarctation surgical repair in 35 adults with preoperative hypertension. They found a highly significant decrease in systolic blood pressure at both early and late follow-up, with most patients now normotensive. They report evidence of a mild stenosis in the graft in one patient and describe six patients having developed significant aortic valve disease on long-term follow-up, four of whom had bicuspid aortic valve related to their coarctation. They conclude that a reduction in systolic hypertension is evident following surgical repair of coarctation in patients older than 20 years. Hashemzadeh et al. [10] demonstrated that surgical repair of aortic coarctation in adults leads to significant regression of systolic hypertension and a decrease in antihypertensive medication in a group of 30 hypertensive patients over a mean follow-up of 37 months. A similar study by Bhat and colleagues [11] in 84 patients made the same conclusion. On the contrary, Hager et al. [12] are the only study to have reported in 273 patients that the majority of patients are hypertensive at long-term follow-up after coarctation repair. They add that even in patients without restenosis, there is a substantial incidence of arterial hypertension and in these patients the independent risk factors for hypertension are repair with prosthetic material, male sex, residual brachial-ankle blood pressure difference and older age at follow-up.

7. Clinical bottom line

Surgical repair of coarctation of the aorta in adult patients is superior to conservative management in the reduction of established hypertension, with one meta-analysis and several retrospective reviews finding low morbidity and low risk of re-stenosis. It has been shown that 90% of patients with coarctation of aorta die by the age of 58 [13]. Only the study with the longest follow-up (up to 27 years) [12] reports a 5.1% overall mortality from all causes. In all the other reports included in this paper, there was no early mortality and no procedure-related late mortality during mean follow-up ranging from 2 to 14 years in these studies. Hence, with surgery, these patients have a much better chance of survival. The reduction in blood pressure post-operatively has been demonstrated consistently (except for Hager et al. [12]), with most patients reported as normotensive without medication and the remainder having reduced requirements for anti-hypertensive medications.

References


eComment: Surgical treatment of coarctation in adult patients yields better long-term results with regard to hypertension but carries a substantial risk

Authors: Christian Schreiber, German Heart Center Munich, Technical University Munich, 80636 Munich, Germany; Alfred Hager
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We have read with interest the recent contribution of Vohra et al. on whether surgical correction of any coarctation does not always resolve the inborn pathology [5]. Interestingly, our long-term survival data [2] compare to data published in 1970 [4] – Campbell even mentioned natural history of coarctation. In our mind there is an ongoing confusion between hypertension and restenosis. Hypertension is not necessarily linked to stenosis/restenosis. The pathophysicsology seems much more complex, i.e. impairment of elastic properties of the aorta – surgical correction of any coarctation does not always resolve the inborn pathology [5]. Nevertheless, if coarctation with a systolic blood pressure gradient $>20$ mmHg is present, it should be considered as the main reason for the existing arterial hypertension.

References

