The Surgical Management of Renovascular Hypertension in Children and Young Adults

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Objectives: to assess the outcome and durability of operative revascularisation in young patients with renovascular hypertension.

Design: retrospective study.

Method: the records of all young patients (under 25 years) operated on for renovascular hypertension at St Mary's Hospital 1988–1998 were reviewed. We assessed the aetiology of hypertension, operations performed, effect of treatment on blood pressure, renal function and requirement for antihypertensive medication during follow-up.

Results: ten patients were identified who had been considered for surgery, of median age 16 years (22 months to 22 years). Fibromuscular dysplasia was present in five patients, mid-aortic syndrome (MAS) in four and neurofibromatosis in one. Operations performed were aortorenal bypass (three), aorto–aortic bypass + renal bypass (three), splenorenal bypass (one) and autotransplantation (one). Of the three patients treated by balloon angioplasty, only one had a successful result. One patient with MAS is currently awaiting surgery.

Over a median follow-up of 24 months (8–144), seven patients are normotensive off all antihypertensive medication. Of two patients on reduced doses of medication, one (splenorenal bypass) required surgical repair of a late (9 years) coeliac stenosis.

Conclusions: The surgical treatment of renovascular hypertension in carefully selected young patients gives durable results. Blood pressure is well controlled long-term, and the need for antihypertensive medication is removed altogether in the majority of patients.

Key Words: Renovascular hypertension; Young patient; Surgery.

Introduction

Although the majority of young people presenting with severe hypertension have renal parenchymal disease as the underlying aetiology, renovascular problems account for up to 20% of these patients referred to specialist centres.1 Within this sub-group of patients, a further distinction can be drawn between those who have vascular disease amenable to intervention (only 20 of 54 cases reported by Deal et al.) and those who do not.2 Thus it is a fairly select cohort of young patients with renovascular hypertension who can be considered for surgical revascularisation.

There has been considerable debate about when to intervene in these patients. A balance has to be drawn between allowance for patient growth and development of renal parenchymal loss/end-organ damage. However, the surgical literature indicates that, with appropriate patient selection, excellent results can be obtained. Over the years, the exact nature of procedure and conduit have changed as experience has demonstrated the shortcomings of certain techniques (for example the use of saphenous-vein grafts and splenorenal bypass).3

We have reviewed our experience in the field of vascular and endovascular surgery for renovascular hypertension in young patients (under 25 years of age) over the past 10 years.

Materials and Methods

Between 1988 and 1998, 10 young people were referred to our unit for consideration of surgical management of renovascular hypertension. There were five males and five females of median age 16 years (range: 22 months to 22 years). The mode of presentation was: asymptomatic hypertension in five patients (detected...
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of operation (GC, 9 h) and operative traction-related left kidney ischaemia (MM).

Three patients underwent percutaneous transluminal balloon dilatation, in two cases for isolated renal-artery stenosis and in one hypertensive infant with mid-aortic syndrome (MAS) it was hoped that balloon dilatation could “buy some time” prior to definitive surgical intervention. Only one of these interventions was successful. One failed acutely and emergency surgical revascularisation was necessary (Fig. 2). The MAS patient had a poor result and had operative treatment subsequently.

One of the patients in this series, an 8-year-old girl with MAS associated with renal- and visceral-artery-origin stenoses (Fig. 3) is currently well controlled on medication and, in the absence of end-organ damage, surgical intervention is being delayed to allow for growth to occur.

Over a median follow-up of 24 months (range: 8 months to 12 years) seven patients are normotensive on no antihypertensive medication (including the one successful balloon dilatation), one patient is normotensive on a reduced dose of antihypertensive medication and one patient (who had a splenoral bypass nine years previously) re-presented with recurrent hypertension due to the development of a coeliac-artery-origin stenosis. This was treated by operative patch angioplasty with a good result.

The median time from surgery to the complete cessation of antihypertensive agents was 6 months (range: 0–23 months).

Discussion

So-called fibromuscular dysplasia (FMD) and the “mid-aortic syndrome” (MAS) are the two commonest causes of surgically-remediable hypertension in the young patient. Often multiple stenoses exist simultaneously, affecting distal branch and intrarenal arteries as well as the main renal artery stenoses. Extreme care is required to ensure that surgery is only undertaken in appropriate cases. Patients with FMD, ostial and proximal lesions are best treated surgically. The “ideal” lesion for balloon dilatation is a short, isolated, non-ostial stenosis. The surgical treatment of MAS is less dependent on the anatomy of the lesion(s) and more dictated by the relative urgency of the operation.

The timing of surgical (and endovascular) intervention is important. Our perception is that the absolute indications for surgery include poor blood-pressure control on high doses of antihypertensive agents, evidence of end-organ damage (left-ventricular

Results

Patient details, the operations performed, pre- and postoperative blood pressure and creatinine levels and follow-up data are shown in Table 1. Renal function was well preserved in all nine cases. In two (GC and MM) there was a transient rise in creatinine in the early postoperative period which returned to normal within two days. This was attributed to the duration

at routine medical checks, severe headache in three, hypertensive encephalopathy presenting as fits in one and intermittent claudication in one. The underlying cause of the hypertension was “fibromuscular dysplasia” in five patients (angiographic diagnosis), mid-aortic syndrome in four and renal artery stenosis in association with neurofibromatosis in one (Fig. 1). We did not include patients with arteritis or other acquired pathology: we wished to study patients with truly congenital lesions only. Evidence of end-organ damage was present in four at the time of referral (left ventricular hypertrophy in three and hypertensive retinopathy in one). All patients had undergone thorough assessment by the referring physician prior to surgery. This work-up included clinical examination with fundoscopy, serum biochemistry, peripheral plasma renin and catecholamine levels, electrocardiography and echocardiography, abdominal ultrasound scan and renal isotope scan. The isotope scans were performed with or without the use of angiotensin-converting enzyme inhibitor drugs according to the preference of the renal physician involved. All patients had pre-operative intra-arterial digital subtraction angiography including aortograms in two planes and selective renal and visceral views.

![Fig. 1. Left renal arteriogram showing the typical “funnel-shaped” stenosis associated with neurofibromatosis.](image-url)
Table 1. Vascular intervention for renovascular hypertension at St Mary's Hospital.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Sex</th>
<th>Diagnosis</th>
<th>Intervention</th>
<th>Pre:post BP</th>
<th>Prepost creatinine</th>
<th>Follow-up (months)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT</td>
<td>22</td>
<td>M</td>
<td>FMD</td>
<td>Renal autotransplantation</td>
<td>180/115:145/75</td>
<td>88:87</td>
<td>24</td>
<td>Normotensive</td>
</tr>
<tr>
<td>KB</td>
<td>19</td>
<td>M</td>
<td>FMD</td>
<td>Aortorenal LSV graft</td>
<td>185/110:120/75</td>
<td>84:93</td>
<td>30</td>
<td>Normotensive</td>
</tr>
<tr>
<td>ZR</td>
<td>21</td>
<td>F</td>
<td>MAS</td>
<td>Aorto-aortic dacron graft, LSV to R renal artery</td>
<td>130/90:125/75</td>
<td>69:83</td>
<td>60</td>
<td>Normotensive</td>
</tr>
<tr>
<td>KB</td>
<td>7</td>
<td>F</td>
<td>NFM</td>
<td>Aortorenal internal iliac artery graft</td>
<td>150/100:130/90</td>
<td>35:60</td>
<td>10</td>
<td>Normotensive</td>
</tr>
<tr>
<td>RC</td>
<td>19</td>
<td>F</td>
<td>MAS</td>
<td>Splenorenal bypass</td>
<td>130/105:120/80</td>
<td>60:77</td>
<td>120</td>
<td>Coeliac stenosis patched at 9 years</td>
</tr>
<tr>
<td>AA</td>
<td>3</td>
<td>F</td>
<td>FMD</td>
<td>PTA L renal artery</td>
<td>140/110:110/70</td>
<td>38:52</td>
<td>8</td>
<td>Normotensive</td>
</tr>
<tr>
<td>MM</td>
<td>22/12</td>
<td>M</td>
<td>MAS</td>
<td>Failed aortic PTA, aorto-aortic graft</td>
<td>160:100</td>
<td>60:65</td>
<td>5</td>
<td>Normotensive</td>
</tr>
<tr>
<td>TW</td>
<td>8</td>
<td>F</td>
<td>MAS</td>
<td>Medical management awaiting surgery</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>Normotensive</td>
</tr>
</tbody>
</table>

Key: FMD, fibromuscular dysplasia; MAS, mid-aortic syndrome; LSV, long saphenous vein; PTA, percutaneous transluminal angioplasty; NFM, neurofibromatosis; *: systolic blood pressure.
hypertrophy and hypertensive retinopathy) and evidence of a deterioration in renal function and loss of renal mass. Relative indications for surgery in this patient group are poor compliance with medications and that the patient has reached an age where only one definitive operation should be required (particularly applicable to MAS).

Data in the literature on the outcome of balloon dilatation are limited. In a review of reported cases, Tegtmeyer identified 25 renal artery angioplasties performed in children with FMD. Immediate success was seen in 92% and, over a median follow-up of 15 months, 18 patients remained normotensive and three required further intervention. The reported results for balloon dilatation in renal artery stenosis associated with neurofibromatosis are not as favourable. Of 12 patients identified by Tegtmeyer, only four reverted to normotension and two still required antihypertensive medication. However, in six cases balloon dilatation failed and surgery was necessary. The results of balloon dilatation in MAS patients are also discouraging. The exception to this experience is the report by Tyagi et al. from Delhi. The 92% immediate success rate is probably attributable to the underlying aetiology in their patients being arteritis rather than MAS.

The largest experience in the surgical management of paediatric renovascular hypertension comes from Stanley’s group, who have treated 57 patients (age range: 10 months to 18 years) over the last 30 years. As can be seen from Table 2, this group’s experience has yielded excellent results and these have been mirrored by those from smaller series from other centres including our own. In their keynote publication in 1995, Stanley and colleagues reviewed their complex experience and outline how this had led to an evolution of their surgical approach to these patients over the study period. Their view on balloon dilatation and intraoperative dilatation was that neither of these methods were appropriate. They stated that, in their opinion, FMD was a misnomer and that, in fact, renal artery stenosis in affected patients reflected an undergrowth of the affected segment of artery. This group also found that up to 20% of aortorenal vein grafts developed severe aneurysmal changes and so they have changed their practice to the use of internal iliac
Table 2. Results of published series on outcome of surgery for renovascular hypertension in young people (adapted from Stanley et al.).

<table>
<thead>
<tr>
<th>Institution</th>
<th>No. patients</th>
<th>Cured</th>
<th>Improved</th>
<th>Failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>57</td>
<td>79</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Cleveland</td>
<td>27</td>
<td>59</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>UCLA</td>
<td>26</td>
<td>84</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Vanderbilt</td>
<td>21</td>
<td>68</td>
<td>24</td>
<td>8</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>17</td>
<td>76</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Univ. California</td>
<td>14</td>
<td>86</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>St Mary’s</td>
<td>8</td>
<td>88</td>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>

artery autografts rather than vein grafts, a practice favoured by other authors. These conduits are far less prone to dilate over time. The incidence and clinical significance of vein-graft dilatation are not known, but, historically, it has been thought prudent to replace grafts that have been affected. For ostial lesions, Stanley et al. preferentially re-implant the renal artery either directly into the aorta or into a neighbouring branch artery.

Other forms of arterial reconstruction have largely fallen out of favour. Although offering an autogenous arterial conduit of reasonable length, from the experience of Novick et al. amongst others, the splenorenal bypass does not perform well in this group of patients. Commonly encountered technical problems include kinking and early thrombosis. Further, disease progression in the coeliac artery can compromise the long-term control of blood pressure, requiring secondary intervention. This was our experience in the one patient treated with splenorenal bypass at St Mary’s.

Whilst rarely performed, renal autotransplantation may be necessary. This approach has been recommended for patients with MAS who are too small for a definitive aortic operation but in whom renal function is in jeopardy. Combining balloon dilatation (as a temporising measure) with autotransplantation is therefore sometimes justified. Bench repair of intra-renal disease using short autogenous grafts can be combined with autotransplantation with good results in some authors’ experience. The durability of renal revascularisation in children appears to be excellent (Table 2). Reoperation can be necessary in some patients. Late graft stenosis is relatively rare but dilatation can occur in up to 20% of vein grafts. Interestingly, the development of stenoses in autogenous arterial grafts can be a feature of so-called fibromuscular dysplasia, indicating that although apparently normal at the time of the original renal arterial bypass procedure, these conduits can be pathologically affected by the same process that affects the renal arteries. Furthermore, patients can develop de novo renal artery stenoses which may or may not be amenable to surgical correction.

The surgical treatment of choice for patients with MAS is aortic patchplasty, together with grafts to the renal arteries as necessary. However, in the very young (and small) patient, a compromise is sometimes required in the form of aorto–aortic bypass grafting. Reoperation on such a patient is a formidable undertaking, and so allowing growth to occur prior to definitive surgery seems preferable. Clearly, a balance has to be struck between this approach and compromise to renal function and end-organs.

In conclusion, we have presented our recent experience with the surgical management of renovascular hypertension in young patients. Bearing in mind that these patients represent a relatively small sub-group of young people with hypertension, we believe that our results are encouraging and reflect those reported from other centres. With appropriate patient selection we can expect a durable result from surgery and the need for antihypertensive medication is removed altogether.

References

7. Chalmers RTA, Dhadwal A, Deal JE, Wolfe JHN. What are


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