Hybrid Laparoscopic Technique for Renal Artery Takayasu Arteritis

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Abstract  
Objective: To evaluate the feasibility of combined laparoscopic technique for different types of vascular reconstruction in the treatment of Takayasu renal artery stenosis.  
Design: Retrospective study of seven cases of renal artery stenosis caused by Takayasu arteritis (TA).  
Materials: Institutional practice and hospitalised patients. All these patients manifested renal arterial hypertension and failed to percutaneous transluminal angioplasty (PTA) treatment. Different types of revascularisation using hybrid laparoscopic technique were applied.  
Methods: Laparoscopic renal artery isolation and kidney mobilisation were first performed. Several types of vascular reconstruction were performed as two patients underwent autotransplantation, four patients aortorenal bypass and one splenorenal bypass. For bypass patients, hypogastric artery was harvested by laparoscopic approach while saphenous vein and spleen artery were dissected by conventional opening. Autotransplantation and arterial anastomosis were then performed through an open incision.  
Results: All procedures were performed successfully without major intraoperative complications. The total operative time was 191 (130–280) min while laparoscopic part was 62 (40–105) min. The mean blood loss was 261 (150–400) ml. Postoperative blood pressure returned to normal in five patients but two others required single-agent antihypertensive medication. Minor complications included lumbar artery injury and flank pain each in one case. The anastomosis was patent in all patients and no re-stenosis occurred during 6–40 months of follow-up.  
Conclusions: Hybrid laparoscopic techniques involving renal artery dissection and hypogastric artery harvesting are feasible in surgical treatment of Takayasu renal arteritis. This hybrid surgical technique provides an alternative approach to revascularise the renal circulation, especially for the patients of PTA treatment failure.  
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Significant renal artery stenosis may lead to refractory hypertension, increased risk of vascular events and impaired renal function. In Asian countries the most common cause of renal artery stenosis in young patients is Takayasu arteritis (TA). TA is a chronic vasculitis involving the aorta and the root of its major branches. The diagnosis of TA depends on the following criteria such as age no more than 40 years, decreased brachial artery pulse, Claudication of extremities and arteriographic abnormality. Surgical intervention of renal artery stenosis is necessary when renal arterial hypertension (RAH) could not be controlled by medications. Percutaneous transluminal angioplasty (PTA) with stenting provides a simple procedure with minimal invasion while it may fail in the case of severe artery narrowing and the long-term patency of stenting is not satisfactory. Surgical revascularisation is still the gold standard treatment of renal artery stenosis as a salvage method for failed endovascular procedures as well. Conventional renal revascularisation, either autotransplantation or bypass operation, is performed through an open approach. As it was first introduced in live donor nephrectomy involving renal pedicle and parenchyma dissection in 1995, laparoscopic technique has widely been accepted by transplant surgeons. In this study, we used hybrid laparoscopic technique including different types of renal revascularisation in treating TA with refractory RAH. The technical feasibility and efficiency of these hybrid laparoscopic techniques in reconstitution of renal circulation were evaluated.

Patients and Methods

Between March 2007 and August 2010, seven patients with renal artery stenosis were admitted to our department. Information on patients and preoperative data are summarised in Table 1. All patients had sustained hypertension that could not be well controlled by oral antihypertensive drugs. Computer tomography angiography (CTA) and digital subtraction angiography (DSA) in each patient confirmed that the stenosis was caused by TA disease. TA in every case was assessed as in a stable stage due to the normal erythrocyte sedimentation rate (ESR) and no requirement of steroids. Radiological studies revealed that three patients (cases 2, 3, 5) had bilateral stenosis with different severity. No immediate intervention was given for the mild side. The other four patients presented unilateral affected renal artery. Attempts of PTA as initial treatment failed in seven patients due to the severe lumen narrowing.

Renal artery reconstructive methods of seven patients included two autotransplantations, one aortorenal anastomosis, two aortorenal bypass with autogenous hypogastric artery, one aortorenal bypass with autogenous saphenous vein, and one splenorenal arterial bypass. In this study we combined laparoscopic dissection of renal pedicle, renal parenchyma and harvesting hypogastric artery with open procedure to complete renal revascularisation.

1. Laparoscopic dissection of renal pedicle (Fig. 1): All patients were placed in a lateral decubitus position with four ports in lumbar region. By mobilising posterior wall of kidney, renal artery was isolated and dissected to its stenotic part. Accessory renal artery and peripheral compensating artery were also dissected if existed. Renal parenchyma was then defatted for completed mobilisation.

2. Laparoscopic harvesting of hypogastric artery (Fig. 2): Two patients were placed in a supine position. Four ports were placed, with subsequent open incision passing three of them. Bifurcation of right common iliac artery was exposed after pelvic peritoneum incised. Hypogastric artery was isolated to its major branch. Hypogastric artery was clipped at proximal and distal sites of the stem for harvesting.

3. Autotransplantation: A Gibson incision ipsilateral to the affected side was made through which the mobilised kidney was taken out. The renal artery was end-to-end anastomosed to hypogastric artery while the renal vein was end-to-side anastomosed to external iliac vein. The accessory renal artery was preserved and conjoined with the main renal artery before anastomosis with the hypogastric artery. The ureter was transected and reimplanted to the bladder.

4. Aortorenal bypass (Fig. 2): A right subcostal, curved incision was made to expose the renal pedicle and aorta from the level of renal artery to inferior mesenteric artery. A suitable segment of infrarenal aorta was transversely clamped at both ends following systemic heparinisation. An aortic hole was made with aortic punches for end-to-side anastomosis. Subsequently,

### Table 1

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/sex</th>
<th>BMI</th>
<th>Estimated length of RAS in DSA (cm)</th>
<th>Pre-op BP (mmHg)</th>
<th>Pre-op rennin (decubitus) (µg/L/h)</th>
<th>Pre-op GFR in operative side (ml/min)</th>
<th>Preoperative sCr (µmol/L)</th>
<th>ESR (mm/H)</th>
<th>Number of BP medications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24/M</td>
<td>22.0</td>
<td>0.5/ostial</td>
<td>180/110</td>
<td>10.9</td>
<td>33.7</td>
<td>79.1</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>26/F</td>
<td>23.1</td>
<td>2.1/main RA</td>
<td>195/105</td>
<td>9.5</td>
<td>36.3</td>
<td>88.1</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>29/M</td>
<td>24.4</td>
<td>1.5/main RA</td>
<td>210/110</td>
<td>6.2</td>
<td>29.8</td>
<td>115</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>22/F</td>
<td>19.6</td>
<td>1.0/main RA</td>
<td>205/110</td>
<td>7.2</td>
<td>34.5</td>
<td>69.1</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>23/F</td>
<td>19.2</td>
<td>0.5/ostial</td>
<td>180/105</td>
<td>7.1</td>
<td>31.7</td>
<td>60.4</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>8/F</td>
<td>18.3</td>
<td>1.2/main RA</td>
<td>145/100</td>
<td>4.9</td>
<td>41.7</td>
<td>48.5</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>26/F</td>
<td>19.2</td>
<td>2.8/main RA</td>
<td>165/95</td>
<td>7.7</td>
<td>35.3</td>
<td>72.5</td>
<td>6</td>
<td>1</td>
</tr>
</tbody>
</table>

a bulldog clamp was placed on the graft and aortic clamp is released. The renal artery was finally transected distal to stenotic segment and anastomosed to the graft or the aorta directly.

5. Splenorenal arterial bypass: A left subcostal incision was made and spleen artery was freed and transected at the distal end. The renal artery was then transected and end-to-end anastomosed with spleen artery to allow the reconstitution of renal circulation.

For each patient, several indexes including the operation time, ischaemia time, the amount of blood loss, intra-/postoperation complications, bowel recovery time, discharge time and pre-/postoperative GFR levels during follow-up were monitored.

**Results**

All procedures were completed successfully with outcomes seen in Table 2. The mean total operative time was 191 (130–280) min, in which the laparoscopic part on average occupied 62 (40–105) min. The average blood loss was 261 (150–400) ml. Three patients had accessory renal artery and all seven patients had compensated minor arteries supplying renal parenchyma around the pedicle. These vessels were preserved during the laparoscopic dissection. The mean cold ischaemic time was 44 (16–110) min. The two patients undergoing autotransplantation had significantly longer cold ischaemic time compared to those who received bypass surgery.

One intraoperative complication as lumbar artery injury occurred in case 6 during open procedure and the injury was sutured with Prolene. No other complications such as major bleeding, aortic or vena caval injury, or visceral organs injury occurred. One patient complained of flank pain after the operation. The average recovery time of bowel movement duration was 2 days and the mean hospitalisation stay was 6 days.

Postoperative blood pressure of five patients returned to normal within 2 weeks. In two patients (cases 3 and 5), single-agent antihypertensive medication was still required after the operations. After surgery, a reduced level of serum rennin was observed in all seven patients. Anastomoses were assessed for patency in all patients with no haemodynamic abnormalities through colour Doppler ultrasound studies at discharge. CTA studies at 6 months revealed patency of renal artery with no re-stenosis occurred (Fig. 3). Patient no. 5 received PTA as treatment of the contralateral renal artery stenosis 8 months after the surgery and had a normal blood pressure thereafter. During 6–40 months of the follow-up, none of these patients had arterial occlusion, recurrence of hypertension or deterioration of renal function.

**Discussion**

TA is characterised by large-vessel vasculitis that mainly affects the aorta and its major branches. Renal artery stenosis is observed in 38–40% angiographically confirmed TA patients. In patients with renal artery occlusion,
complex branch stenosis or aneurysms, as well as failed PTA treatment, surgical revascularisation is absolutely indicated. Outcomes of surgical vascular reconstruction for TA disease have been proved to be safe and effective with the development of surgical equipment and technologies. Recently, minimal invasive techniques such as laparoscopic and robotic techniques have also been applied in surgical treatment of renal artery disease to potentially improve surgical outcomes.

One application of laparoscopy is the isolation of renal artery to expose the stenotic segment. Under the laparoscope, dissection becomes more precise and meticulous owing to enlarged visions. TA is usually accompanied with severe inflammation around aorta and renal pedicle. Compensating vessel or accessory artery is also common in TA patients in our series. These vessels bring technical difficulties to delicate dissection. Injury of compensating or accessory artery gives rise to parenchymal ischaemia in a segmental area and has negative influence on renal function. In addition, we advocate laparoscopic dissection through retroperitoneal approach considering following reasons: (1) Retroperitoneal approach provides direct access to renal artery. Inferior vena cava and aorta can be clearly exposed from operating side. (2) It avoids interference with visceral organs and decreases the risk of injury. (3) For the proximal stenosis, retroperitoneoscopic dissection can extend to the aorta in the left side or beneath the vena cava in the right side. For the distal stenotic site or a long stenotic segment, the dissection can be directed towards the renal hilum to expose segmental renal arteries. After completing laparoscopic isolation, clear exposure of stricture and non-stricture part promises subsequent transection. At the meantime, we isolated the whole kidney from perirenal fat laparoscopically. It facilitates mobilising the kidney and decreases anastomotic tension in subsequently open procedure.

Another laparoscopic application is to harvest hypogastric artery. It provides rapid access to internal iliac artery after incising the peritoneum. From the origin to its major branches, hypogastric artery is retrieved immediately after transecting several minor branches. This approach avoids a long incision for harvesting in open surgery and the whole procedure took less than 20 min in our study.

Bypass surgery and renal autotransplantation remain predominant ways for the treatment of renal artery stenosis. Aortorenal reconstruction without graft is considered when a short stenotic segment allows direct reimplantation. Because the remnant healthy renal artery in most cases are not long enough for direct anastomosis, splenorenal arterial bypass, hepatorenal arterial bypass or aortorenal bypass with autogenous graft are considered. Choice of graft is dependent on different situations. Hypogastric artery and saphenous vein are readily available in our study. The hypogastric artery has limited branches that clearly enlarged under laparoscope image. The advantage of choosing saphenous vein is its superficial position. In splenorenal bypass, harvesting procedure is avoided. It demands only one time of end-to-end anastomosis, while aortorenal bypass requires arterial anastomosis twice. Two transplantees did not receive splenorenal bypass in the left side due to the accessory arteries which were also affected by the aortitis. For the two younger

<table>
<thead>
<tr>
<th>Patient</th>
<th>Types of renal artery reconstruction (operation side)</th>
<th>Operative time (min)</th>
<th>Time of bowel movement/discharge (d)</th>
<th>Time on laparoscopic isolation (min)</th>
<th>Time on vessel harvesting (min)</th>
<th>Cold ischemic time (min)</th>
<th>Post-op GFR on operative side (3 months) (ml/min)</th>
<th>Post-op sCr(3 months) (mmol/L)</th>
<th>Complications Follow-up (mo)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aortorenal anastomosis (R)</td>
<td>130</td>
<td>20</td>
<td>40</td>
<td>20</td>
<td>20</td>
<td>63.2</td>
<td>72.5</td>
<td>1/5</td>
</tr>
<tr>
<td>2</td>
<td>Autotransplantation (L)</td>
<td>260</td>
<td>110</td>
<td>105</td>
<td>55</td>
<td>300</td>
<td>40.1</td>
<td>34.3</td>
<td>2/8</td>
</tr>
<tr>
<td>3</td>
<td>Aortorenal bypass with saphenous vein (R)</td>
<td>180</td>
<td>22</td>
<td>20</td>
<td>95</td>
<td>105</td>
<td>42.3</td>
<td>61.3</td>
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<td>Autotransplantation (L)</td>
<td>280</td>
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<td>45</td>
<td>105</td>
<td>42.3</td>
<td>61.3</td>
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</tr>
<tr>
<td>5</td>
<td>Splenorenal arterial bypass (L)</td>
<td>150</td>
<td>33</td>
<td>18</td>
<td>55</td>
<td>180</td>
<td>65.1</td>
<td>58.2</td>
<td>2/8</td>
</tr>
<tr>
<td>6</td>
<td>Aortorenal bypass with hypogastric artery (R)</td>
<td>170</td>
<td>14</td>
<td>14</td>
<td>55</td>
<td>180</td>
<td>50.6</td>
<td>47.9</td>
<td>1/5</td>
</tr>
<tr>
<td>7</td>
<td>Aortorenal bypass with hypogastric artery (R)</td>
<td>160</td>
<td>13</td>
<td>13</td>
<td>40</td>
<td>150</td>
<td>43.7</td>
<td>60.6</td>
<td>6</td>
</tr>
</tbody>
</table>

GFR: glomerular filtration rate, Cr: creatinine.
patients, we used the hypogastric artery instead of saphenous vein as the graft considering the patient’s age and the more favourable vessel condition. Saphenous vein is not suitable for children due to its small size and potential risk of aneurismal dilation.

In aortorenal bypass, we clamped target segment of aorta at both ends. Clamping time of infra-aorta is controlled within 30 min with systemic heparinisation. Warm ischaemic time of kidney should be limited to 20 min and cold ischaemic time to 35 min according to international collaborative review. These limitations for anastomosis are feasible for open surgery while they become quite challenging in a pure robotic or laparoscopic operation although the preliminary experience has been reported in the latest literature. To minimise renal ischaemic time in our series, aortorenal bypass started from anastomosis between aorta and graft to that between graft and transected renal artery.

One of the limitations of this study is the small sample size due to low incidence of renal artery stenosis caused by TA and wide application of PTA. Evaluation of long-term outcomes demands more cases with a variety of treatment approaches. Laparoscopic technique facilitates surgical procedure and brings low intra-/postoperative morbidities. However, this efficacy is based on abundant accumulation of laparoscopic skills as well as open experience for surgeons. Our initial experience is promising while optimisation of surgical treatment for renal artery stenosis is still awaited.

Conclusions

Hybrid laparoscopic technique involving renal artery dissection and hypogastric artery harvesting is feasible in surgical treatment of Takayasu renal arteritis. Aortorenal bypass as well as splenorenal bypass provide good efficiency for renal revascularisation. It may serve as a reference for further studies to evaluate its clinical significance.

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Conflict of Interest

None.

References