Acute Femoral Neuropathy Following Renal Transplantation: A Retrospective, Multicenter Study in China


ABSTRACT

Background. We investigated the relationship between the mode and duration of iliac artery anastomosis and acute femoral neuropathy (AFN).

Methods. A retrospective analysis was performed for 83 AFN cases from 6 transplantation centers in China. The incidence and nature of dysfunction of AFN were classified based upon the duration of iliac arterial anastomosis. No prisoners were used, and no organs from prisoners were used to obtain the data.

Results. The incidence of AFN was 3.6% (53/1,449) in internal iliac anastomosis (group 1), 3.1% (11/346) in external iliac anastomosis (group 2) \((P > 0.05\) vs. group 1), and was 54.2% (19/35) in internal iliac ligation with external iliac anastomosis (group 3 \(P < 0.01\) vs. groups 1 and 2). In group 1, the duration of the arterial anastomosis was \(\leq 20\) minutes in 1 case (1.9%), and \(>20\) minutes in 52 cases (98.1%). In group 2, the duration of arterial anastomosis was \(\leq 20\) minutes in 1 case (9.0%) and \(>20\) minutes in 10 cases (91%). In group 3, the duration of the arterial anastomosis was \(>20\) minutes in all cases; 20 cases showed injury to the iliolumbar or deep iliac circumflex artery.

Conclusion. The incidence of AFN was associated with the selection of iliac arteries, the duration of the arterial anastomosis, and an injury to the iliolumbar or deep iliac circumflex artery.

We have discovered 83 cases of acute femoral neuropathy (AFN) among 1,830 renal transplantation cases performed at 6 renal transplantation centers in Chongqing, Beijing, Guangdong, Lanzhou, and Shandong between December 1988 and February 2009. Based on the anatomic sites of the renal artery and the femoral nerve reconstructed using 64-slice computed tomography (CT) scan, we determined AFN incidences among an internal iliac artery anastomosis group (group 1), an external iliac artery anastomosis group (group 2), and an internal iliac artery ligation plus external iliac artery anastomosis group (group 3). We analyzed the incidence of AFN at various times after arterial anastomosis and classified femoral neuropathy in these groups. Our results indicated that AFN after transplantation was not rare. The incidence was relatively high in group 3. Sensory and motor disturbance of the femoral nerve were manifest, and functional recovery slow. The duration of blood flow occlusion related proportionally to the incidence of AFN. Based on these findings, we conclude that: interruption the mode of renal allograft artery anastomosis and the duration of iliac artery blood flow occlusion were important factors for AFN. AFN is related to injuries to the iliolumbar and deep iliac circumflex arteries that supply the femoral nerve. Whenever possible, an abnormal internal iliac artery should be preserved during the operation. To anastomose the renal allograft artery and external iliac artery within 20 minutes may lower the incidence of AFN. The combination of medications possibly with acupuncture and massage may promote AFN recovery.

AFN subsequent to renal transplantation is a rare condition. Since Vaziri et al reported AFN subsequent to renal transplantation, there have been few case reports.1,2 How-
ever, the precise cause of AFN remains unknown. Over recent years, we have performed a retrospective analysis of 83 cases of AFN among 1,830 renal transplantation cases performed between December 1988 and February 2009 at 6 renal transplantation centers in China.\textsuperscript{3–8} The present study sought to determine the incidence of AFN in relation to the mode and duration of iliac artery anastomosis and AFN.

PATIENTS AND METHODS

Patients

We included 1,830 renal transplantation cases at 6 Chinese renal transplantation centers between December 1988 and February 2009. There were a total of 83 AFN cases (4.5%; Table 1), including 60 males and 23 females of overall age range of 28 to 64 years (mean = 38 years). AFN occurred at 3 to 7 days (mean = 4 days) after renal transplantation. All patients had undergone 3 to 6 months of hemodialysis prior to renal transplantation; none developed AFN before renal transplantation. There were 518 patients who underwent first renal transplantation. Among the other 312 patients, a second graft informed consent for renal transplantation and difficulty with leg-lifting; 2) ground activity limitations of walking difficulty and inability to stretch the leg at 7 days after operation; 3) sensory disturbance as revealed by skin puncture tests; and 4) femoral nerve injury documented by electromyogram.

Statistical Analysis

The differences in AFN incidence were analyzed by chi-square tests using SPSS 11.0. A value of $P < .05$ was deemed statistically significant.

RESULTS

The Mode and Duration of Iliac Artery Anastomosis and the Incidence of AFN

Incidence of AFN. There were 53 AFN cases in group 1 (3.6%), 11 AFN cases in group 2 (3.1%; $P > .05$ vs. group 1), and 19 AFN cases in group 3 (54.2%; $P < .001$ vs. group 1 and 2). Table 2 shows the incidence of AFN and the duration of the iliac arterial anastomosis.

Statistical analysis indicated that the incidence of AFN was significantly greater when the duration of iliac arterial anastomosis was $\geq 40$ minutes versus $< 40$ minutes ($P < .05$ for group 1 and 2; $P < .01$ for groups 3).

A duration of iliac artery anastomosis of $\leq 20$ was safe relatively dangerous when $\geq 30$, and extremely dangerous when $\geq 40$ (Figure 1). That is, the duration of iliac artery anastomosis was related proportionately to the risk of AFN. In particular, AFN occurred in about 50% patients who underwent anastomosis of the renal artery and external iliac artery ($P < .05$; Figure 1).

Arterial Injury and AFN. Reconstruction of the renal artery was performed in 20 patients with AFN. Iliolumbar arterial injury was observed in 1 group 1 patient, 4 in group 2, and 10 in group 3. Injury to both the iliolumbar and deep iliac circumflex arteries was noted in 5 group 3 patients (Figure 2). Thus injuries to the iliolumbar and deep iliac circumflex arteries are important factors for AFN. (Figure 2).

Classification of Femoral Nerve Dysfunction

Sensory disturbances of the lower limb on the affected side were present in 72 of 83 AFN cases including numbness and hypesthesia; 4 subjects showed motor disturbances such as iliac and knee joint flexion/extension dysfunction and weakness of quadriceps muscle of thigh; 7 patients showed both sensory and motor disturbances. Table 3 reveals sensory disturbances to be common among group 1 and 2, with sensory and motor disturbances in group 3. The incidence of motor disturbances was significantly greater in group 3 than the other groups ($P < .01$).
After renal transplantation, all patients took cyclosporine A (6 mg/kg/d) or FK506 (1.5 mg/mg/d) mycophenolate mofetil (MMF; 1.5–2.0 g/d) + prednisone (20–30 mg/d). Femoral neuropathy was treated by acupuncture of Weizhong, Futu, Feishi, Xuehai, or Zuwuli, massage and medications, as well as by hyperbaric oxygen when necessary. Of the 83 AFN cases, 78 subjects (93.9%) showed complete recovery of sensory and motor functions; the other 5 had mild sequelae that did not affect their quality of life.

Follow-Up

Of the 83 AFN cases, sensory and motor functions recovered completely in 39 cases within 1 month; 23 cases, within 3 months; 12 cases, in 6 months; 1 case, 8 months, and 3, 12 months. In 1 case, mild atrophy of the quadriceps muscle occurred within the first postoperative year, but did not influence limb movement. In the other 4 cases, mild numbness of the medial and lateral aspects of the thigh persisted for 18 months after surgery.

DISCUSSION

Relationship Between the Mode and Duration of Iliac Artery Anastomosis and AFN

After renal transplantation, multiple factors lead to AFN, such as the use of self-retaining retractors, renal allograft hematoma, intraoperative or postoperative hypotension, and prolonged exposure of the iliac fossa to ice. Whether AFN after renal transplantation relates to an ischemic injury to the femoral nerve is still controversial. Over recent years, we have observed intriguing phenomena through the use of 64-slice CT scan visualization of renal allograft vessels. The incidence of AFN was higher after internal iliac artery ligation and external iliac artery anastomosis than after a simple internal or external iliac artery anastomosis \(P < .001\). This observation may be related to injuries to the iliolumbar and deep iliac circumflex arteries. Following renal allograft artery to internal or external iliac artery anastomosis, femoral nerve dysfunction is mainly characterized by a sensory disturbance, but the incidence of motor disturbances differs insignificantly from that of sensory disturbances. However, in cases with an atherosclerotic internal iliac artery with its ligation, and external iliac artery anastomosis to renal allograft vessels, the risk of both sensory plus motor disturbances AFN is increased significantly compared with the other 2 groups \(P < .01\). The incidence of AFN is related proportionally to the duration of renal allograft artery to iliac artery anastomosis. During renal transplantation, the duration of iliac artery anastomosis was safe when \(\leq 20\), relatively dangerous when \(21–29\), and extremely dangerous when \(\geq 30\) minutes (Table 2). In particular, AFN occurred in 36% to 47% patients who underwent an anastomosis of the renal allograft artery to the external iliac artery \(P < .05\). These observations suggested that injuries to the iliolumbar and deep iliac circumflex arteries are important factors for AFN. The incidence of AFN related significantly to the mode and duration of anastomosis. In 5 cases the sensory and motor functions of the affected thigh did not recover after more than 1 year, suggesting a more severe, prolonged ischemia from disruption of the blood supply to the femoral nerve causing axonal loss and a slow, incomplete recovery as observed in previous studies.

Prevention and Treatment of AFN

Of the multiple factors that influence AFN after renal transplantation, surgical factors play a pivotal role. We suggest these measures to prevent and treat AFN. For patients with diabetes or persistent hypertension, preoperative ultrasonography and CT scan should be performed to determine the pathology of the internal and external iliac arteries. When internal iliac artery atherosclerosis is confirmed, ligation of the internal iliac artery should be avoided whenever possible; an anastomosis of the renal allograft artery to the external iliac artery should be the end-to-side. If atherosclerosis is confirmed in both the internal and the external iliac arteries, the surgeons should avoid excessive dissection of the vasaervosum of the external iliac artery.

Table 2. Incidence of Acute Femoral Neuropathy and Duration of Iliac Arterial Anastomosis

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>≤20 (%)</th>
<th>21–29 (%)</th>
<th>30–39 (%)</th>
<th>≥40 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>53</td>
<td>1 (1.9)</td>
<td>15 (28.3)</td>
<td>17 (32.1)</td>
<td>20 (37.7)</td>
</tr>
<tr>
<td>II</td>
<td>11</td>
<td>1 (9.0)</td>
<td>3 (27.3)</td>
<td>3 (27.3)</td>
<td>4 (36.4)</td>
</tr>
<tr>
<td>III</td>
<td>19</td>
<td>0 (0)</td>
<td>2 (15.8)</td>
<td>7 (36.8)</td>
<td>9 (47.3)</td>
</tr>
</tbody>
</table>

Fig 1. Mode and duration of vascular anastomosis and acute femoral neuropathy.
when performing the external iliac artery anastomosis to prevent disruption of the collateral circulation to the femoral nerve. The lumbar plexus has a rich anatomic supply from the inferior mesenteric and vesical arteries, whereas the middle and distal portions of the femoral nerve depend primarily on the integrity of the internal or external iliac artery for their blood supply. With an anastomosis of the renal artery of the graft to the internal, external, or common iliac artery, the possibility of significant localized “steal” exists. A proximal end-end anastomosis of the renal artery to the internal iliac artery can shunt blood away from the vasanervosum. Therefore, the internal iliac artery should be isolated as far from its origin as possible, to avoid injury to the iliolumbar artery; the bladder should be isolated as near to its lateral and superior aspects as possible so as to avoid injuring vesicle arteries. The duration of the arterial anastomosis should be 20 minutes. Self-retaining retractors may not be placed too deeply or stretched too widely; they may injure the lateral femoral cutaneous nerve. Thorough hemostasis and careful ligation of lymphatic ducts in the iliac fossa are also crucial to prevent AFN. During the operation, ice water in the iliac fossa must be removed in a timely manner to reduce cold injury to the femoral nerve.

Medical treatments include neurotrophic and blood circulation-promoting drugs, including vitamin B12 (0.5 mg, intramuscularly, daily) vitamin B1 (100 mg, intramuscularly, daily), mecobalamin (0.5 μg, intramuscularly, daily), and Danshen injection (20 mL in 500 ml of 5% glucose solution, volume of distribution, daily). The drugs are administered for a course of 14 days. Hyperbaric oxygen treatment may also be considered, for it may accelerate motor functional recovery.

Early physical therapy and functional exercise may promote functional recovery of the affected limb, preventing quadriceps muscle atrophy. The patients are instructed to perform passive exercise, such as knee joint extension and hip joint flexion for 20 minutes, twice daily, when they are confined to bed. The frequency of exercise depends on the patient’s physical status. During exercise, the region of the renal allograft should be protected: overexercise must be avoided.

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REFERENCES