Surgical treatment of aortoiliac aneurysms in renal transplant patients

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Purpose: The purpose of this study was to report our experience of surgical treatment of aortoiliac aneurysms in kidney transplant patients, to describe technical problems of this surgery, to evaluate its long-term outcome, and to discuss the place of endovascular repair.

Methods: Eighteen patients who had undergone renal transplantation 3 months to 23 years earlier (mean: 6 years) were operated on for an aortoiliac aneurysm. In 15 patients (83%), no protective measure of the kidney was used. In seven patients, the reconstruction remained proximal to the renal artery whereas in 11 patients it required the reattachment of the artery to the prosthesis.

Results: There was no mortality after the operation. A moderate increase of blood creatinine occurred in all patients but by the end of the tenth postoperative day, all patients had regained renal function identical to the preoperative state. In the long-term follow-up, nine late deaths occurred, mainly due to myocardial infarct (N = 7), and chronic rejection led to hemodialysis in three patients. Six patients are alive with a functioning transplant. The follow-up ranges from 5 to 30 years.

Conclusion: Open repair of aortoiliac aneurysms can be safely undertaken in renal transplant recipients without protection of the transplanted kidney. In the long-term follow-up, these patients are exposed to complications of general arteriosclerosis and to rejection of their transplanted kidney. Aortic aneurysms following kidney transplantation are likely to become more frequent in the future due to extension of renal transplantation to older and severely arteriosclerotic patients. (J Vasc Surg 2008;48:291-5.)

An increase in the number of renal transplant recipients who will require surgical repair of aortoiliac aneurysms is foreseeable. First, these patients often have accelerated arteriosclerosis because of prolonged hemodialysis and other risk factors (tobacco, arterial hypertension, diabetes, metabolic disturbances due to chronic renal insufficiency), and arterial lesions may progressively worsen despite renal transplantation. Second, the expansion of renal transplantation to older and arteriosclerotic patients and the increasing rate of long-term successes result in survival of more recipients in later decades of life.

Until now, publications dealing with aortoiliac aneurysms repair in renal transplant patients reported either isolated cases or small series of patients. This article reports personal experience with 18 patients who were successfully operated on.

PATIENTS AND METHODS

Eighteen patients were operated on for abdominal aortoiliac aneurysm after renal transplantation from January 1973 to December 2005. Indications of aneurysm repair were the same as for nontransplant patients. These patients were referred to us from several transplant centers all over France, a majority coming from the Department of Nephrology at Necker Hospital in Paris.

All these patients were men. They were between 27 and 63 years of age (mean: 47). They had undergone renal transplantation 3 months to 23 years before (mean: 6 years). The nature of their nephropathy is shown in Table I. Fifteen had received a cadaver kidney; three a kidney from a living related donor. Eleven patients had normal transplant function at the time the aneurysm was diagnosed (mean blood creatinine: 112.8 ± 11.4 μmol/L). Seven patients had impaired renal function due to stable chronic rejection (mean blood creatinine: 203.3 ± 33.2 μmol/L).

All these patients were heavy smokers. Thirteen had arterial hypertension (72%). Two were diabetic (11%). Associated arteriosclerotic lesions in other areas were found in 14 of these patients (78%): seven had coronary artery disease with previous myocardial infarct in two, three had transient cerebral ischemic attacks before (two cases) or after (one case) the transplantation, with spontaneous regression of the deficits, and four had arteriosclerotic arteries of lower limbs.

The aneurysm was discovered under various circumstances. In eight symptom-free patients, it was diagnosed by duplex ultrasound that is routine in the periodical follow-up of transplant patients. In four patients, intermittent claudication of the lower limbs occurred and prompted vascular investigations. In two patients, a pulsatile abdominal mass was felt on routine follow-up examination. In two patients, the aneurysm was recognized in the pretransplant study; at that time it was considered too small to justify any treatment, but it increased precociously after transplantation. In one patient, an embolus from the aneurysmal sac migrated in the common iliac artery opposite the transplanted kidney, and in one other an acute thrombosis of the external iliac...
Table 1. Nature of the nephropathy in 18 transplant patients

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Cases</th>
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<tbody>
<tr>
<td>Nephroangiosclerosis</td>
<td>3</td>
</tr>
<tr>
<td>Chronic glomerulonephritis</td>
<td>3</td>
</tr>
<tr>
<td>Chronic interstitial nephritis</td>
<td>2</td>
</tr>
<tr>
<td>Segmental and focal glomerulosclerosis</td>
<td>2</td>
</tr>
<tr>
<td>Membranous glomerulonephritis</td>
<td>3</td>
</tr>
<tr>
<td>Polycystic kidney disease</td>
<td>1</td>
</tr>
<tr>
<td>IgA nephropathy</td>
<td>1</td>
</tr>
<tr>
<td>Nephromephritis</td>
<td>1</td>
</tr>
<tr>
<td>Goodpasture’s syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Not determined</td>
<td>1</td>
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</tbody>
</table>

below the transplant occurred; critical limb ischemia resulted in both patients who required emergency surgery.

The site and extent of the aneurysm were assessed by aortography (Seldinger’s technique) in the first seven operated patients and by intra-arterial digital angiography in eleven. Fourteen patients were also examined by ultrasonic echography before angiography and four by computed tomography.

The aneurysm involved the site of the anastomosis of the transplant artery in 11 cases; the reattachment of this artery to the prosthesis was required in all these patients. In the seven remaining patients, the aneurysm remained far from the implantation of the transplant artery.

The features of aortic repair are summarized in Table II. In two patients, the inferior mesenteric artery was reattached to the aortic prosthesis. In two, a transplant biopsy was performed during the aortic operation. In one, a bilateral amination of native kidneys was associated to the aortic repair. The arterial occlusion time between aortic clamping and revascularization of the transplant ranged from 25 to 50 minutes (mean: 38 minutes).

In the first patient of the series, who was operated on in 1973, protection of the transplant was afforded by general hypothermia. In two recent patients, selective hypothermia of the transplant was performed by perfusion of cold (4°C) Ringer’s lactate through the common iliac artery, because of especially difficult anatomical and repair conditions with bulky aneurysms involving the iliac implantation of transplant artery. In fifteen patients (83%), no protection of the transplanted kidney was used during aortic reconstruction.

Intraoperative and postoperative care included standard intravenous fluid therapy, blood loss replacement, usual monitoring of renal function, and cardiovascular condition and administration of broad-spectrum antibiotics. Intravenous administration of heparin was routine before aortic clamping (dose of 1.5 mg/kg). During the period of vascular clamping, intravenous furosemide (dose 20 mg) and continuous infusion of dopamine (doses of 3 to 8 μg/kg/minute) were administered; both drugs were given during the first 6 to 24 postoperative hours, depending on urinary output. Evolution of transplant function was assessed by daily measurements of blood creatinine. Immunosuppressive treatment was administered intravenously until intestinal transit reappeared; it was then resumed orally.

Postoperative digital angiography was performed in eleven patients. This investigation was not performed in the seven patients with impaired renal function to avoid further deterioration of transplant function. The latter patients had only periodic ultrasonic echography. Observation periods ranged from 1 to 30 years. No patient was lost to follow-up.

RESULTS

Mortality. No patients in the series died while hospitalized after their operations.

During the long-term follow-up, nine late deaths occurred: seven from myocardial infarct between 7 months and 8 years after the operation (mean: 4.2), one from a cerebral hemorrhage after 5 months, and one from diffuse peritoneal metastases of a bladder tumor 1 year after the aortic repair.

Morbidity. In one patient, embolic occlusion of the left common femoral artery by an aortic clot occurred at the end of the operation and was treated successfully with embolectomy. In another patient, occlusion of the aortic prosthesis occurred 4 hours after the operation and was treated by immediate thrombectomy without damage to transplant function. In a third patient, abdominal wound dehiscence led to incisional hernia that was repaired secondarily. All other patients had uneventful postoperative courses.

Renal function. As mentioned above, 11 patients had normal transplant function and seven had moderate impairment of transplant function before the operations. During the operation, urine excretion stopped in each case during the period of vascular clamping and resumed after restoration of normal circulation to the transplant. In each patient, adequate urine output was restored by the end of the operation and remained satisfactory during the whole postoperative course.

Early postoperative renal function is summarized on Fig 1 according to the preoperative level of transplant function. After operation, increase in mean blood creatinine value occurred in both groups of patients. The maximum increase occurred on the third postoperative day in patients with normal transplant function and on the first postoperative day in the remaining patients. By the end of the 10th postoperative day, all patients had regained renal function identical to the preoperative state.

Table 2. Features of aortic aneurysm repair

<table>
<thead>
<tr>
<th>Type of prosthesis</th>
<th>Number of cases</th>
<th>Reimplantation of transplant artery into prosthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight aortic tube</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Aorta to both common iliac</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Aorta to right external iliac left common iliac</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Aorta to both external iliac</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Aorta to both common femoral</td>
<td>1</td>
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Protection of the kidney transplant during aortic repair remains a matter of general concern in published cases since aortic clamping has been postulated to entail renal warm ischemia.

In fact, I demonstrated that the transplanted kidney is not completely ischemic during aortic clamping. It remains perfused, albeit at a low pressure, by the retrograde flow from the lumbar, inferior mesenteric and both iliac arteries while the aorta is clamped. Aortic cross-clamping entails dampening of the arterial flow to the transplant and lowering of its perfusion pressure, but this flow ensures sufficient perfusion of the kidney since measurements of aortic back pressure after supra-aneurysmal cross-clamping showed that this pressure was always greater than 35 mm Hg in my experience of elective cure of abdominal aortic aneurysms in non transplant patients. As early as 1956, Morris et al had shown experimentally that kidneys perfused at an arterial pressure of only 25 mm Hg remain viable. Later, progress in the surgical treatment of thoracoabdominal aneurysms, which represent a comparable situation, provided supportive evidence that kidneys perfused at low pressure can tolerate significant periods of proximal aortic occlusion.

Total ischemia of the kidney occurs only when its artery is clamped during its reattachment. However, my experience with surgery of stenoses of the kidney transplant artery and with acute thrombosis of the renal artery showed that the kidney tolerates periods of total arterial occlusion of up to 50 minutes, which greatly exceeds the time required for performing an arterial anastomosis.

Taking into account these data and the experience of my first five patients, I devised a technique for the treatment of these aneurysms. In the light of its good results, this technique became a standard and was applied to all patients of the series thereafter. It is similar to the conventional technique except for the sequence of surgical steps and avoids the use of protective measures for the transplant, thus greatly simplifying the operation. The first step is the supra-aneurysmal transverse section of the aorta between two clamps followed by the end-to-end anastomosis of the prosthesis with the aorta. In difficult cases, transsection of the left renal vein facilitates proximal aortic exposure. The second step is the revascularization of the transplant either by anastomosis of the ipsilateral limb of the prosthesis with the iliac axis proximal to the transplant artery or by reattachment of the latter artery to the corresponding prosthetic limb. The length of the prosthesis depends on the extent of the aneurysm and on the presence of severe atherosclerotic lesions of the iliac arteries. The third step is the management of the aneurysmal sac and the revascularization of the opposite limb.

In my opinion, the indications for adjunctive renal protection measures in these operations include unusually difficult surgical anatomy, especially when the transplant artery originates from a large iliac artery aneurysm. Renal protection is also recommendable when the transplant function is impaired, particularly when the blood creatinine value exceeds 250 μmol/L, for fear of irreversible renal

In the long-term follow-up, severe chronic rejection led to hemodialysis in three patients, 1 to 3 years after aortic repair. At present time, six patients are alive with a functioning kidney. The follow-up ranges from 5 to 30 years.

Atherosclerotic lesions. Atherosclerotic lesions worsened in other territories in 15 long-term survivors (83%). Besides coronary artery lesions, which were responsible of seven late deaths by myocardial infarct as mentioned above, carotid lesions increased in two patients, one suffering from massive hemiplegia, and the other from transient brachial monoparesis. Six patients complained of intermittent claudication of lower limbs that did not justify endovascular or surgical treatment.

Results of reconstruction. Eleven patients underwent postoperative digital angiography up to 14 years after their operations. In one patient, a tight stenosis of the origin of both common iliac arteries developed 14 years after aortic aneurysm repair by a straight tubular prosthesis. In this patient, a new prosthesis was inserted between the aortic tube and both common iliac arteries; his transplant function is normal with 30 years follow-up. In all other patients, reconstruction was satisfactory (Fig 2, A and B).

In patients who did not undergo angiography, periodic Doppler investigations suggest adequate repair.

DISCUSSION

Surgical management of aortic aneurysms after renal transplantation is frequently reported, but important series of this complication are rare. To the best of my knowledge, the present series is the largest reported up to now.

![Image](image_url)
failure due to aortic clamping. Several methods of protection have been described: in situ renal perfusion with a pump oxygenator by cannulation of femoral vessels, in situ renal perfusion with cold (4°C) Ringer’s lactate through the common iliac artery, temporary shunt from the aorta to the iliac or femoral artery, temporary subclavian-femoral or axillofemoral shunt, and general hypothermia. Among these methods, selective hypothermia of the transplant by in situ perfusion with cold (4°C) Ringer’s lactate through the common iliac artery combined with application of sterile ice around the kidney seems preferable because this method is the easiest and does not excessively extend the operative time.

The study of postoperative renal function showed a transient increase of blood creatinine which regressed in a few days and by the 10th postoperative day renal function had regained its preoperative level in all patients. Thus, it appears that the kidney does not suffer permanent damage during aortoiliac reconstruction and that aortic aneurysmectomy without protective measures does not carry excessive risks to the transplant provided an adequate surgical procedure is used. In the long-term follow-up, these patients are exposed to the occurrence of late irreversible transplant rejection requiring hemodialysis.

These patients are also threatened by atherosclerosis complications especially myocardial infarct.

During the last decade, endovascular repair of abdominal aortic aneurysm has become a recognized alternative to open repair in many patients. In patients with kidney transplants, a review of the literature shows that endovascular repair has been applied in 14 cases. In all these patients, the aneurysm remained far from the anastomosis of the kidney artery and did not involve it. In one patient with a ruptured aneurysm, emergency endovascular repair was performed. In three patients, an aortomonoiiliac prosthesis was used with occlusion of the contralateral common iliac artery completed by a cross-over femoral by-pass. In the other patients, straight aortic tubes or bifurcated prostheses (aorta to both common iliac arteries) were used.

There were no mortality and no unfavorable repercussion on renal function in any of these patients. Endovascular repair offers the advantage of a less invasive treatment since laparotomy is avoided, which reduces the duration of hospital stay. Absence of aortic clamping avoids important arterial flow disturbances in the transplanted kidney, thus minimizing the ischemic damage to the kidney. However, endovascular repair is not always possible, depending on anatomical conditions. For that reason, preoperative assess-

Fig 2. A, Preoperative angiography of a patient with aortoiliac aneurysm after renal transplantation. Note the complete obstruction of the external iliac artery below the implantation of the renal artery. B, Postoperative angiography after reconstruction by aorta to both common femoral prosthesis with reattachment of the transplant artery.
ment of the aortoiliac anatomy must be pursued cautiously. Furthermore, in severely arteriosclerotic patients, the possibility of embolization of the transplanted kidney or damage to the iliac artery must be kept in mind. Also, contrast agents are used during the procedure and patients with compromised renal function are at increased risk for contrast-related nephropathy. Both iodinated contrast and gadolinium have been shown to be nephrotoxic.23,24 For that reason, contrast doses should be kept as low as possible and associated with adequate intravenous hydration and diuretics to maintain a satisfactory urinary output.

Indications of endovascular repair depend mainly on the extent of the aneurysm. This technique can be applied only to patients in whom the aneurysm does not involve the anatomosis of the renal artery to the iliac axis and when other anatomical conditions are favorable. It may also be useful when the transplant function is compromised by chronic rejection because the impairment of renal blood flow during the procedure is of limited duration. At the present time, in this selected type of patients, endovascular repair seems preferable.

CONCLUSIONS

Open repair remains an important resource in the treatment of aortoiliac aneurysms in kidney transplant patients since it can be applied in every case whatever the site and extent of the aneurysm. The absence of kidney protective measures simplifies the operation and reduces its duration. My experience shows that this absence has no harmful effect on the transplant. Endovascular repair has now a place in highly selected cases, especially when anatomical conditions are favorable, when the aneurysm remains far from the implantation of the transplant artery and when the transplant function is impaired by chronic rejection. Surgery of aortoiliac aneurysms is likely to become more common in renal transplant patients due to the extension of renal transplantation to older and high-risk arteriosclerotic patients.

AUTHOR CONTRIBUTIONS

Conception and design: ML
Analysis and interpretation: ML
Data collection: ML
Writing the article: ML
Critical revision of the article: ML
Final approval of the article: ML
Statistical analysis: ML
Obtained funding: Not applicable
Overall responsibility: ML

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