Renal vascular injuries following nephron-sparing surgery and their endovascular management

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ABSTRACT

Introduction: This study aims to describe renal vascular injuries following nephron-sparing surgery and the efficacy of transcatheter embolisation in management of these complications.

Methods: A retrospective review was performed on 96 patients who underwent nephron-sparing surgery from 2001 to 2005. Selective angiography was performed on all patients referred for significant postoperative haematuria and internal bleeding, followed by embolisation where indicated. Patient presentation, type of vascular injury, embolisation technique and treatment outcome were reviewed in each case. Efficacy of embolisation in preservation of renal function was assessed.

Results: Seven arterial lesions were identified in four patients (three male and one female; age range 47-70 years). Three patients developed pseudoaneurysms (mean size 2.1 cm, range 1.5-3 cm). One patient revealed four separate areas of active contrast extravasations. All patients were successfully treated with coil embolisation with complete symptomatic relief within one to three days. Renal function was preserved in all patients over a follow-up period of 90 days.

Conclusion: Renal arterial injuries, especially pseudoaneurysms, are an important though uncommon cause of haematuria following nephron-sparing surgery. Coil embolisation is an effective treatment for management of these iatrogenic injuries.

Keywords: endovascular embolisation, nephron-sparing surgery, renal pseudoaneurysms, renal vascular injuries

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INTRODUCTION

Renal cell carcinoma accounts for approximately 3% of adult malignancies and the incidence of this tumour appears to be increasing.[1] Widespread prevalence of cross-sectional imaging has resulted in increased detection of small renal masses.[2,3] In most cases of large renal tumours, radical nephrectomy is the treatment of choice. Partial nephrectomy or nephron-sparing surgery (NSS) was initially performed in patients with essential indications to preserve renal parenchyma. It is now considered a safe and effective treatment with its elective role extending to involve patients with normal contra lateral kidney.[4,5]

NSS is now offered as a standard surgical approach in all patients with tumours 4 cm or smaller in a setting of a normal contra lateral kidney. A recent multicentre study suggests expansion of its role in tumours up to 7 cm in diameter.[6] Recognised vascular complications following NSS include pseudoaneurysms, arteriovenous fistulae, and haemorrhage from vascular injuries.[7] These reported complications are similar whether open or laparoscopical surgery is performed.[8-10] We report our experience of vascular complications following NSS, their management and outcome.

METHODS

A retrospective review of NSS was performed over a period of 46 months (between 2001 and 2005). Institutional review board approval was not required for this retrospective study. The parameters assessed in each patient included preoperative renal lesions, date of operation, surgical technique used including operative details, clinical presentation following surgery, vascular injury, embolisation technique used, and its outcome including its overall effect on renal function. As per our institutional criteria, the primary indication for NSS in each patient was an incidentally detected small renal mass (< 4 cm) or in patients in whom preservation of renal function was essential.

Ultrasonography (US) and/or computed tomography (CT) were performed in all cases with significant postoperative haematuria. Patients with suspicion of vascular lesion on imaging were referred for angiography. Those patients with positive findings on angiography were treated with embolisation at the same session. All patients were followed-up for a period of 90 days following endovascular treatment to assess for complications and clinical outcome. Follow-up included clinical, laboratory and imaging assessments.

Following access through the right femoral artery, abdominal aortogram was performed followed by selective renal arteriogram on the affected side. This was done to determine vascular anatomy, assess for accessory renal arteries, exclude main renal artery lesions, evaluate contralateral renal arteries, and exclude possibility of vascular injury other than renal vascular injury. All patients with positive angiographic findings were treated with transcatheter embolisation at the same session.

Catheterisation of the ipsilateral renal artery was done using selective catheters, depending on the configuration of renal artery in each patient and operator preference. After identifying site and type of injury, super selective catheterisation was performed in each patient. Microcatheter access using coaxial system was necessary to approach the site of injury in three patients. Coils were placed to exclude the lesion from the circulation without compromising blood supply to the rest of the kidney. This was considered important since NSS was initially performed to preserve renal function. Coils were used for each successful embolisation. Completion angiogram was performed one and five minutes afterwards to assess the angiographical outcome of the procedure. The amount of normal parenchymal loss was estimated on images post-embolisation and no objective method was used for its confirmation.

Clinical success was based on both subjective and objective criteria. Subjective assessment for successful outcome was based on alleviation of symptoms. Objective outcome was based on regular follow-up with urine microscopic analysis, serum creatinine levels and US/CT imaging findings. Procedure-related complications were documented according to Society of Interventional Radiology Clinical Practice Guidelines.[11]

Fig. 1a Selective angiogram shows a large pseudoaneurysm in the mid-portion of the right kidney.

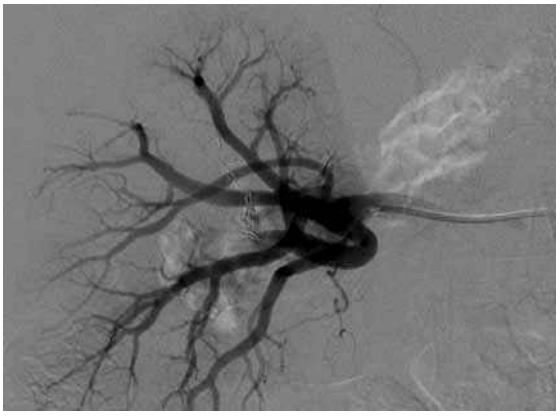

Fig. 1b Post-embolisation angiogram of the patient shows a complete exclusion of the pseudoaneurysm.

Fig. 2a Selective angiogram shows multiple areas of contrast extravasation in the mid and lower pole of the left kidney.

Fig. 2b Angiogram shows a successful result following coil embolisation at multiple sites with no further bleeding points identified.

Table I. Angiographical findings and endovascular treatment in patients with arterial injuries following nephron-sparing surgery.

Patient	Side of lesion	Vascular lesion	Embolisation agent	Outcome
1	Right	Pseudoaneurysm	Coils	Successful
2	Left	Pseudoaneurysm with arterio-venous fistula formation	Coils	Successful
3	Right	Pseudoaneurysm	NBCA Coils	Unsuccessful Successful*
4	Left	Extravasations	Coils	Successful

* Second session of treatment with desired result achieved after treatment with coils.

Table II. Serum creatinine levels before surgery, prior to embolisation and one month following embolisation (normal < 110 μmol/L).

Patient	Serum creatinine levels (μmol/L)		
	Pre-surgical	Peri-embolisation	Post-embolisation
1	100	123	94
2	71	102	95
3	89	144	103
4	101	126	95

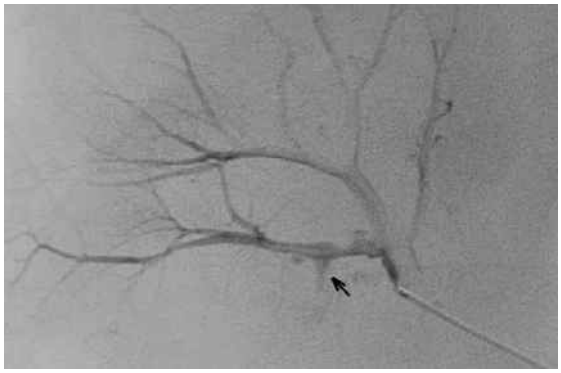

Fig. 3 Selective angiogram from a microcatheter four days following glue (NBCA) embolisation shows a contrast filling the feeding artery (arrow) supplying the pseudoaneurysm, which opacified on delayed images. Embolisation with coils was successful.

RESULTS

Of the 96 patients who underwent NSS between 2001 and 2005, four patients (4.1%) presented with vascular lesions for which embolisation was indicated. Three men and one woman whose age ranged between 47 and 70 years comprised this group of patients. All four patients had a small renal mass (< 4 cm) lying either in a polar or an exophytic location. None of the lesions involved the collecting system. The average operative blood loss was 200–300 ml, and the average time of operation was about 150 minutes. All the operations were done using an open approach with none of them undergoing laparoscopical resection. Haematuria was of new-onset in the postoperative period in three patients, while one patient presented with progressively worsening haematuria following surgery. Two patients presented with additional significant ipsilateral flank pain. The time of presentation varied between 10 and 28 days (mean 18.5 days) following surgery.

Seven arterial injuries were identified in four patients (Table I). Three patients presented with pseudoaneurysms (Figs. 1a & b). The average size of the pseudoaneurysm was 2.1 cm (range 1.5–3 cm). One of the pseudoaneurysms was associated with a concomitant arteriovenous fistula. One patient showed active extravasations of contrast at multiple points (n = 4) along the resection margin (Figs. 2a & b). All patients were treated by coil embolisation. One patient was initially treated with a mixture of n-butylcyanoacrylate (NBCA) mixed with iodised oil in a ratio of 1:3 (total 1 ml) to complete stasis. There was recurrence of haematuria after four days of treatment. Repeat angiogram showed revascularisation of the artery supplying the pseudoaneurysm (Fig. 3). Successful repeat embolisation was performed using coils.

Haematuria stopped within 1–3 days in all patients after successful coil embolisation with no recurrence of symptoms. No procedure-related complication was observed. Serum creatinine levels were elevated from the pre-surgical baseline levels at the time of presentation of vascular injury in all patients. They gradually returned to their baseline levels over the follow-up period. No acute deterioration of renal function was seen in the immediate post-embolisation period (Table II).

DISCUSSION

The role of NSS has expanded with indications for elective surgery continuing to evolve.[5] With an increase in incidentally-detected small renal tumours, NSS is likely to play an increasingly important role in the management of these lesions.[3] Disease-free survival rates are similar between partial and radical nephrectomy in these patients.[12] NSS is a more complex operation compared to total nephrectomy with unique complications such as arteriovenous fistulae and haemorrhage.[13,14] Iatrogenic injuries following other renal interventions, such as renal biopsy, are well documented.[15,16] Early detection and embolisation is important in treating these life-threatening injuries with reported success rates of 100%. The incidence of bleeding after NSS is 0%–4.3%.[7] Renal arterial injuries, especially pseudoaneurysms, contribute minimally to this figure.[15] We identified major vascular injuries in 4.1% of our study group. The major vascular injury was pseudoaneurysm formation with one patient revealing multiple areas of contrast extravasations along the resection margin. Pseudoaneurysm formation can be life-threatening and is an important treatable cause of gross haematuria in these patients. In our group of patients, the average onset of frank haematuria following surgery was 18.5 days. Three patients presented with sudden onset while one patient presented with increasing haematuria following surgery. This suggests these patients may have a sub-acute presentation rather than in the immediate postoperative period.

In our experience, coils alone are highly effective in embolising these lesions. Additional embolisation agents are not required, provided good catheter position is achieved next to the lesion. In one patient, we initially used NBCA mixed with iodised oil for embolisation of the pseudoaneurysm. After a brief period of improvement, patient presented with another episode of significant haematuria four days later, secondary to revascularisation of the embolised artery. Repeat embolisation was performed with coils with successful outcome. Coils proved to be a more effective and durable embolising agent, compared to NBCA, in the patient.

There was an elevation in serum creatinine levels in all our patients prior to embolisation, presumably due to poor renal function related to vascular injury. There was no further increase in serum creatinine levels post-embolisation. All our patients preserved their renal function with serum creatinine levels returning to presurgical baseline levels over the follow-up period. This demonstrates the safety and efficacy of transcatheter embolisation in management of these patients.

There are certain drawbacks in our study. The sample size of our patient group is small. Also, the study is a retrospective review of patients. However, our aim is to highlight the presence of these injuries so that a potentially treatable vascular complication following the surgery is not overlooked. A larger study will certainly be useful in estimating the true prevalence and spectrum of these injuries. In conclusion, renal arterial injuries are an uncommon cause of haematuria following NSS for which a high index of suspicion should be maintained. These injuries can be effectively treated with transcatheter embolisation.

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