Incidental renal stones in potential live kidney donors: prevalence, assessment and donation, including role of *ex vivo* ureteroscopy

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What's known on the subject? and What does the study add?

- Previously, donors with asymptomatic stones found incidentally on CT were not considered ideal donor candidates because of the presumed risk of morbidity to both the donor and recipient. Increasingly, studies show that these risks are low.
- This study aims to evaluate the long-term safety of using *ex vivo* ureteroscopy to remove the stones from the donor kidney on the bench before donation. Outcomes so far suggest that this technique can safely render a kidney stone-free before transplantation. This has led to 20 more transplants in our institution than would otherwise be possible.

Objectives

- To evaluate the prevalence of asymptomatic renal stones in our potential donor population.
- To assess the safety and success of *ex vivo* ureteroscopy (ExURS) to remove stones from explanted donor kidneys before transplantation.

Patients and Methods

- We conducted a retrospective analysis of 377 computed tomography (CT) angiograms of potential kidney donors between October 2004 and May 2007 to assess the prevalence of asymptomatic renal stones in our donor population.
- Between October 2005 and October 2011, kidneys from suitable donors underwent ExURS. Stones were removed using basket extraction or were fragmented with holmium laser on bench before transplantation.
- Immediate and long-term complications of the transplanted recipients were recorded.
- Donors were followed with yearly ultrasonography of the remaining kidney in addition to standard follow-up protocol.

Results

- Review of 377 CT angiograms between October 2004 to May 2007 showed a 5% prevalence of asymptomatic renal stones.
- Out of 55 potential donors (19 identified between October 2004 to May 2007 and a further 36 identified since May 2007), 20 donors with stones proceeded to donation, with stone size ranging from 2 to 12 mm.
- Of the patients, 17 proceeded to ExURS. Stones were removed in 10 patients; five with basket retrieval, four with laser fragmentation and one with both laser fragmentation and basket retrieval.
- There were no early or late allograft stone-related complications and no evidence of stones on follow-up imaging at a mean (range) of 10 (1–24) months.
- There has been no reported stone recurrence in any of the donors to date and no stone on ultrasonography of eight donors with >1-year follow-up (mean 26 months, range 12–49 months).

Conclusions

- Asymptomatic renal stones are present in 5% of our donors.
- ExURS can be safely used to remove stones in these kidneys before transplantation, without the risk of subjecting the donor to an additional stone-removing procedure.
- Continued long-term follow-up of donors and recipients is still required to ensure the safety of this approach.

Keywords

living donor nephrectomy, kidney stones, ex vivo uteroscopy, renal transplantation

Introduction

Renal transplantation offers the best long-term treatment for patients with end-stage renal failure [1]. There are over 37 800 patients in the UK with end-stage renal failure and 6800 on the transplant waiting list. A total of 1772 cadaveric kidney transplants were performed in 2011 compared with 1009 living kidney transplants [2]. Living kidney donation offers patients with end-stage renal failure improved long-term function and the attractive option of a planned and pre-emptive transplant.

Previously, donors with a history of renal stones or presence of stones discovered incidentally on screening were not considered ideal donor candidates because of the presumed risk of donor morbidity from possible stone formation in the solitary remaining kidney and potential recipient morbidity from obstruction attributable to a 'donor-gifted' stone. However, owing to a shortage of organs, many transplant centres are reviewing this and other donor exclusion criteria. A handful of studies report the use of donor kidneys with stones *in situ* and suggest the risk of recurrence and morbidity is low, but not insignificant [3]. The British Transplant Society guidelines, updated in 2011, state that in the absence of a significant metabolic abnormality, potential donors with a limited history of previous small calcium stones, or a small renal calculus on imaging, should be considered as potential kidney donors [1], but full counselling of donor and recipient is required, along with access to appropriate long-term donor follow-up [1].

Our institution considers donors with incidental kidney stones to be 'extended criteria' donors and we explore all avenues for other suitable non-stone bearing donors. Potential donors are highly motivated and aware that there may not be other opportunities for the recipient to undergo living donor transplantation. Such 'extended criteria' donors and their recipient require a full understanding of possible risks and the steps required to minimize these.

In the present study, we examine the incidence of asymptomatic stones in our potential donor population. A sub-group of these patients who fulfilled our unit's selection criteria donated either a stone-bearing or non-stone bearing kidney. After the appointment of a Consultant Transplant Urological Surgeon in 2006, *ex vivo* ureteroscopy (ExURS) was performed where appropriate to remove stone(s) before transplantation. This technique has been described in the USA, with good short-term outcomes reported [4]. In the present study we examine the safety and long-term morbidity of donor and recipient patients after living donation of kidneys with stones.

Methods

Initial Assessment

Potential kidney donor evaluation involved a detailed assessment with particular attention to age, blood group, body mass index, renal function, previous surgery and cardio-respiratory status. A urological history eliciting any previous history of UTIs, symptoms consistent with renal colic or family history of renal stones was sought. All potential donors had renal function measured by isotopic EDTA-GFR. Suitable potential donors then proceeded to CT renal angiography to assess renal vascular anatomy, including an initial non-contrast phase to detect renal stones and vascular calcification. Generic living donor exclusion criteria were followed as per current UK British Transplant Society Living Donor Guidelines [1].

Retrospective Analysis of Donor CT Scans

A retrospective review was undertaken of CT renal angiograms of all potential donors between October 2004 and May 2007, during which period all CT scans were performed at our centre. Data on patient demographics and comorbidities were routinely collected prospectively by a consultant nurse. The CT renal angiograms were reported contemporaneously by two consultant uroradiologists.

Assessment of Potential Donors with Asymptomatic Stones

From May 2007 onwards, potential donors with asymptomatic stones were accepted from other centres, with CT renal angiogram performed at the originating centre and re-reviewed by our own uroradiologists. All potential donors found to have asymptomatic stones had a DMSA scan to exclude renal scars and assess split renal function. They also underwent a screening for metabolic abnormalities associated with stones. This included analysis of serum electrolytes including calcium, albumin, bicarbonate, urate, parathyroid hormone (in selected patients), urine culture and two 24-h urine collections to assess urinary electrolyte excretion (Table 1). The results of these investigations were recorded in a prospective database.

Bilateral stones, stones secondary to infection or to an uncorrectable metabolic abnormality, were considered contraindications to donation (Table 2). All avenues were explored to find other non-stone-bearing potential living donors. Donors with an incidental stone require long-term follow-up including access to emergency urology care. Lack of access to such follow-up was considered a contraindication to donation.

Donor Consent

Consent for kidney donation is a process that develops over a number of visits before the proposed operation date. At each stage a number of individuals are involved whose key function is to act as the donor advocate; these include the donor nurse specialist, nephrologist and donor surgeon. The donor can withdraw from the assessment process at any stage. A final recommendation to proceed is reached by consensus across the multidisciplinary team. The final decision is made by the patient in consultation with the surgeon and after discussion of the lifetime risks and how these may be minimized. The donor's understanding and acceptance of the risks is tested by an independent assessor from the Human Tissue Authority who gives the final approval to proceed based on their considered opinion of whether the potential donor has fully understood the relevant risks and benefits.

Table 1 Metabolic stone screening.

Blood/Urine test	Metabolic abnormality/variable analysed
Blood serum levels	Calcium
	Albumin
	Urate
	Potassium
	Bicarbonate
	Creatinine
	Parathyroid Hormone
Urine	
Dipstick	early morning sample – pH
	leucocytes, nitrites, protein, blood
2 × 24-h collections	Volume
	Calcium, oxalate, citrate, urate, creatinine, magnesium, phosphate, sodium, potassium, cystine

Table 2 Contraindications to kidney donation.

Contraindications to kidney donation
Bilateral stones
Infection stones
Uncorrectable metabolic abnormality (e.g. cystinuria)
Lack of access to emergency urology expertise after donation

Ex Vivo Ureteroscopy Technique

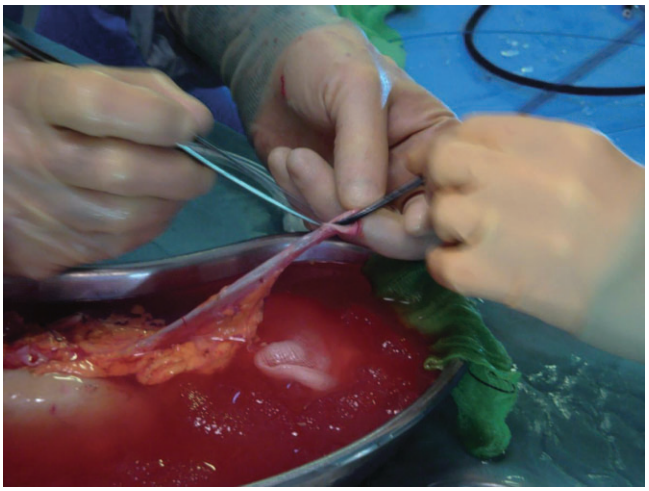
In those who proceeded to donation, donor nephrectomy was performed using a trans-peritoneal hand-assisted laparoscopic technique [5]. In all but one case, the kidney with the calculus was used for donation, leaving the donor with a solitary stone-free kidney (Table 3). The explanted donor kidney was transferred to the pre-prepared back-table or 'bench', immersed in ice-slush and perfused via the renal artery/arteries with 4 °C Marshall's hypertonic citrate solution. The ureter was spatulated and a flexible-tip Sensor™ (Boston Scientific, Hemel Hempstead, UK) guidewire was passed into the ureter to the renal pelvis. A 7.5-F flexible ureteroscope was passed over the guidewire using 4 °C saline irrigation at low pressure (Fig. 1). All calyces were inspected systematically and the stone(s) identified were removed with either zero-tip basket extraction or holmium laser fragmentation. The kidney was

Table 3 Stone characteristics for the 20 patients who proceeded to kidney donation.*

Case	No. of stones	Size of stones, mm	Location	Technique
1	1	1	Right, LP	Donor-gifted stone
2	1	2	Right, LP	Donor-gifted stone
3	1	1	Right, LP	Left kidney donated
4	1	1	Right, UP	Failed exURS, donor-gifted stone
5	1	4	Left, UP	No stones seen, probable parenchymal calcification on CT
6	1	1	Left, IP	Laser
7	1	4	Right, LP	Laser
8	2	2,2	Right, IP	Laser
9	1	3	Left, IP	Zero basket
10	1	7	Left, LP	Zero basket
11	2	2,2	Left, IP	Zero basket
12	1	2.3	Left, IP	No stones seen, donor-gifted stone
13	1	2	Left, LP	No stones seen, not in collecting system on CT
14	1	12	Left, LP	Laser + basket
15	1	<2	Left, UP	No stones seen, not in collecting system on CT
16	1	3	Left, UP	No stones seen, donor-gifted stone
17	1	2	Left, LP	Zero basket
18	1	3	Left, UP	Submucosal calcification left *in situ*
19	1	3	Right, LP	Zero basket
20	1	4	Right, LP	Zero basket

**Stone-bearing kidney used for donation in all cases except case 3. ExURS started with case 4.*
UP, upper pole; IP, interpolar; LP, lower pole.

Fig. 1 Ex vivo ureteroscopy.



kept in ice-slush during the procedure, allowing the kidney to be rotated to aid the location of stones. The procedure took 10–45 min in all cases. This did not add to the cold ischaemia time as the donor and recipient surgeries were performed sequentially rather than in parallel.

Transplantation of the donor kidney was performed using a standard extraperitoneal technique with vascular anastomoses to the external iliac vein and iliac artery and an extravesical ureteroneocystostomy (modified Lich Gregoir). A 7-F 16-cm transplant ureteric JJ stent was placed and removed 6 weeks after transplantation. All recipients had a urethral catheter for 5 days. The immunosuppressive regime was with basiliximab at induction, and triple therapy maintenance with mycophenolate mofetil, prednisolone and ciclosporin/tacrolimus. In paediatric recipients, basiliximab was omitted.

Donor Follow-Up

On discharge, all patients were given details of an appropriate point of contact for advice both within and outside of normal working hours. Donors also had direct line access to a living donor nurse and were reviewed 6 weeks after surgery to assess recovery and to check renal function. Surveillance of the solitary kidney continues with annual renal tract ultrasonography planned for life (Table 4).

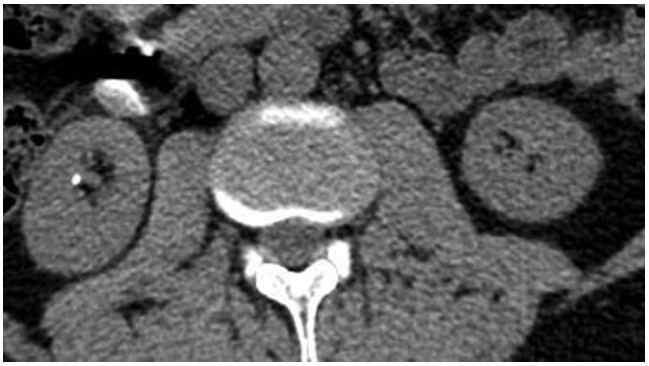
Recipient Follow-Up

Recipients were initially seen three times a week in the transplant clinic. Attendance frequency decreased according to progress and time from transplantation. Ultrasonography of the transplanted kidney was performed in the immediate postoperative period. Repeat imaging with either ultrasonography or non-contrast CT was performed during follow-up only when clinically indicated (Table 4).

Table 4 Follow-up scheme for kidney donors and transplant recipients.

Donor (with history of stone)	Recipient (where donor history of stone)
Advanced emergency access	Advanced emergency access
6 weeks follow-up appointment • Serum creatinine concentration	Transplant clinic • Initially three times per week
Yearly surveillance • Renal tract ultrasonography • Mid-stream urine, blood pressure, serum creatinine concentration	Removal of ureteric stent at 6 weeks Ultrasonography at 7 weeks Yearly surveillance • Renal tract ultrasonography (or CT plain abdominal film of kidney, ureter and bladder, where clinically indicated)

Fig. 2 Computed tomography scan demonstrating a small 3-mm stone in the stone-bearing kidney.



Results

Retrospective Analysis of Donor CT Scans

Between October 2004 and May 2007, 377 potential donors had CT assessment at our centre. Nineteen (5%) were found to have asymptomatic renal stones on CT. These stones ranged in size from 1 to 8.5 mm.

Assessment of Potential Donors with Asymptomatic Stones

A further 36 potential donors with incidental finding of stones on CT were identified between May 2007 and October 2011. These included patients who had their initial assessment and CT at other hospitals and were referred to our centre for evaluation of their stone(s). Thus, a total of 55 patients were identified with asymptomatic renal stone(s) found on CT (Fig. 2).

From the above 55 patients, 20 progressed to donation (Fig. 3) and 21 withdrew for non-stone-related donor and

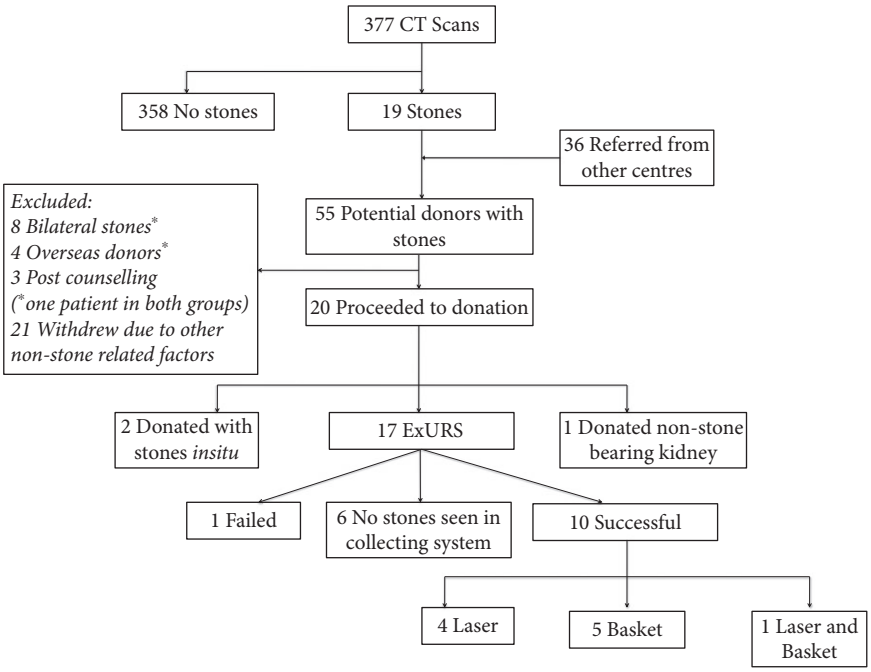


Fig. 3 Outcome of donor assessment, evaluation and ExURS.

recipient factors; however, eight patients were excluded owing to bilateral stones, a further three were excluded because they were overseas donors without appropriate access to specialist urology follow-up in their country of origin and three withdrew after counselling because of their perceived risk of donation in the presence of stone disease.

Metabolic screening confirmed abnormalities in 12 patients; six had isolated hypercalciuria (range 8–12 mmol/L), two had mildly raised urate levels, two had low citrate levels, one had both hypercalciuria and high serum urate, and one had low urine volumes (<1 L/24 h). Metabolic abnormalities were corrected by lifestyle advice and bendrofluazide in two patients. The median (range) donor age at time of donation was 45 (22–67) years, with a 1:1 male-to-female ratio. The median (range) recipient age at the time of transplantation was 39 (1–66) years. We had five paediatric transplant recipients, who were aged 1–15 years.

Stone size ranged from 1 to 12 mm (Table 3). Two donor kidneys with stones <2 mm were transplanted with the stone *in situ*. The recipients of these kidneys have had no graft dysfunction as a result of the 'donor-gifted stones'. One donor donated his non-stone-bearing kidney to his son, leaving a 1-mm lower pole stone in his solitary remaining kidney. The largest stone (12 mm) belonged to a patient who donated his kidney to his 5-year-old daughter who was running out of dialysis access. Two donors had more than one small calculus. A total of 17 donor kidneys proceeded to ExURS.

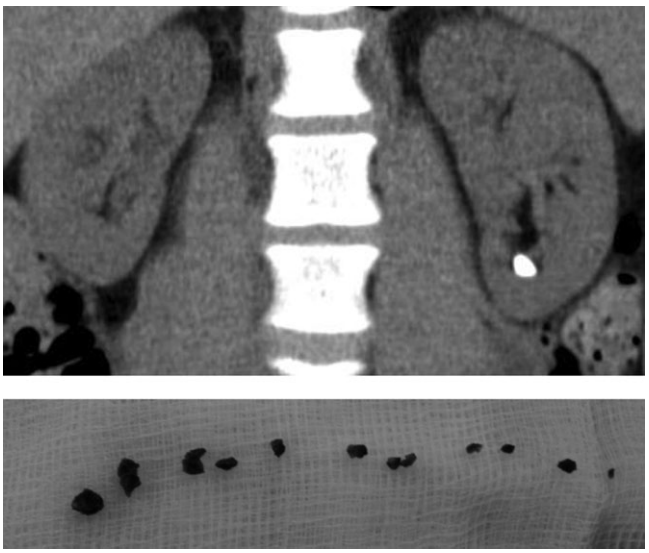
Ex Vivo Ureteroscopy

In the first case performed, ureteroscopy failed as a result of a narrow ureter that would not accept the ureteroscope and therefore the kidney was transplanted with a 1-mm stone *in situ*. In the second case, the kidney was thoroughly inspected and found to be stone-free, suggesting possible asymptomatic passage of the stone in the time period between donor CT assessment and surgery. This led to a change in protocol and a non-contrast CT was introduced on the day before donation. Despite this, five further kidneys were found to have no stone in the collecting system of the kidney at ExURS.

In 10 ExURS procedures, stone removal was successful (Fig. 3). In four cases we used holmium laser for fragmentation of the stone and in five cases we used basket extraction of the stone. In the kidney with the 12-mm stone, the stone was fragmented with holmium laser and the fragments removed with a basket (Fig. 4). Two donor kidneys had more than one stone; one kidney had two 2-mm stones fragmented successfully with holmium laser and another had two 2-mm stones removed with basket.

There were no immediate stone-related or allograft complications seen. The stone in the recipient where ExURS failed remained stable on CT scan at 49 months follow-up. In the two kidneys transplanted with stones *in situ*, no stones were seen on imaging (US/CT) in the transplanted kidney of the recipient at 21 and 55 months follow-up.

Fig. 4 Preoperative non-contrast CT of kidneys demonstrating 1.2-cm stone in lower pole of left kidney. Post-ExURS collection of stone fragments removed from donor kidney before transplantation.



Donor Follow-Up

No stones were seen on imaging (either ultrasonography or CT) at a mean (range) follow-up of 26 (12–49) months in eight donors with >1-year follow-up. The donor who had a 1-mm right lower pole stone left in his solitary right kidney (after donating the left kidney), had no stone-related complication but he moved overseas and was lost to follow-up.

Recipient Follow-Up

No new stone formation was seen in the recipient kidney on ultrasonography at 37-month follow-up. Seven of the 10 recipient kidneys who had ExURS with basket and/or laser fragmentation of stone had follow-up imaging (either ultrasonography or CT) at a mean (range) of 10 (1–24) months, with no evidence of stones.

The preoperative donor imaging of six patients, where no stones were seen in the collecting system of the kidney on ExURS, were re-reviewed by the same consultant uroradiologist. Only two of the six scans showed convincing stones in the collecting system; one had ultrasonography at 12 weeks showing no stone and the other was seen to have submucosal stones on ExURS which were left *in situ* and has not had any follow-up imaging to date.

Four of the scans reported preoperatively as having stones could represent calcification outside the collecting system. Two of these four recipients had CT scans (at 39 months and 3 weeks after transplantion) which revealed the presence of calcification unchanged in size from preoperative imaging. The other two have had no clinical indication for CT but ultrasonography at follow-up (at 3 weeks and 3 months after transplantation) revealed no stones. No stone-related complications or stone recurrence to our knowledge has occurred in either the donors or recipients to date.

Biochemical analysis of basket-retrieved stones showed that they were calcium oxalate (1/7), calcium phosphate (1/7) or a mixture of calcium oxalate and calcium phosphate stones (5/7).

Discussion

Traditionally, nephrolithiasis was considered a contraindication to living kidney donation because of the potential risk of stone recurrence in the donor and consequent risks of obstruction, sepsis and loss of the remaining solitary kidney, but attitudes are changing [6]. In the present study we have shown that the prevalence of asymptomatic stone carriers in potential donors (5%) is similar to that found in other studies which report a prevalence of up to 10% [7–9]. The detection of small asymptomatic stones may reflect the increasing use of CT over other imaging methods previously used in living kidney donor evaluation, such as IVU and interventional angiography; therefore, it is probable that kidneys with small stones may have been used inadvertently in living donation in the pre-CT era.

Although a 50% lifetime recurrence of stone formation has been reported in symptomatic stone formers [10,11], the natural history of asymptomatic stone carriers is uncertain [9]. Burgher et al. [12] reported on one of the largest studies on asymptomatic stone formers. In 300 male patients with asymptomatic stones discovered incidentally on imaging for other disease processes, 77% experienced disease progression with 26% requiring surgical intervention at a mean of 3.26 years. This population may not, however, be representative of a healthy donor population as they may have had underlying comorbidities for which the initial investigations were performed. Longitudinal follow-up of our patients and similar cohorts will provide insight into the natural history of asymptomatic stone carriers and in particular what factors are important for stone progression.

Lack of understanding of the natural progression of asymptomatic stone carriers has implications for how we counsel and consent a donor with a stone before donation to ensure they understand and accept the uncertain long-term risks of stone formation in the remaining solitary kidney. We advocate a multi-stage process of consent to allow potential donors sufficient time and opportunity to consider the risks of donation in the

presence of stone disease. In the present series, three potential donors withdrew after counselling and we believe that this underscores the value of our consent process.

Once the decision to proceed with transplantation has been made, there are four possible options: stone(s) can be removed before transplantation, or at the time of transplantation e.g. with ExURS, donation of the stone-bearing kidney can take place without stone removal, or the non-stone-bearing kidney can be used for transplantation. Early in the present series, we performed one transplant where a right-sided non-stone-bearing kidney was donated to the patient's 1-year-old son. The father was left with a solitary kidney with a 1-mm stone in the right lower pole. Unfortunately, both the donor and recipient moved to the USA and have been lost to follow-up. Vasdev et al. [13] reported two cases where small stones were purposely left in the donor after extensive counselling, with the non-stone-bearing kidney used for donation, and although they comment on 6-year recipient follow-up, no donor outcome was provided. Kim et al. [14] report on five subjects who donated the non-stone-bearing left kidney and whose remaining right kidney had single intraparenchymal <2 mm calcification. All five donors were successfully contacted and reported no symptoms of stone disease at a median follow-up time of 5.3 years.

We now use the stone-bearing kidney for donation in preference to the non-stone-bearing kidney because of the potential risk to the donor of obstruction from a stone in a solitary remaining kidney. In particular, we feel it is more likely that an otherwise healthy donor would be lost to follow-up than transplant recipients who are closely followed up by protocol. We have had one other donor who, since donating her stone-bearing kidney, has moved overseas and has been lost to follow-up.

We feel the best option where potential donors with stones wish to donate is nephrectomy of the stone-bearing kidney with ExURS using a flexible ureteroscope. We accept that a small number of 'donor-gifted' stones will be transplanted in the event of ExURS failure, (3/17 in this series). By removing the stone(s) at the time of transplantation, the donor avoids the risks of an additional stone-removing procedure which is not indicated in the general population for small asymptomatic <5 mm stones [15].

We have not had any medium- to long-term stone-related complications to date. There are potential risks of ExURS, including failure to remove the stone and damage to the kidney and ureter. In our first case, we failed to insert the ureteroscope into the ureter as the ureter was too narrow. Subsequently, the technique was adapted to incorporate the use of more than one guidewire as needed to aid insertion of the flexible ureteroscope. Potential bleeding from trauma to the renal pelvis is not immediately obvious in an *ex vivo* setting and extra care must be taken, particularly when using the laser.

In our centre, the majority of living donor–recipient pair operations occur sequentially (i.e. the donor nephrectomy followed by the recipient transplant). This approach did not lead to an increase in cold ischaemia time, but if implantation surgery occurs in parallel, the benefits of the ExURS technique must be balanced against the possibility of a moderate prolongation of cold ischaemia time. The learning curve was short and, after two cases, the procedure could be performed by an experienced endourologist with ease; the diagnostic ureteroscopy can be performed in around 10 min with laser fragmentation/basket retrieval adding a further 20–30 min procedural time. A zero-tip nitinol basket is suitable for small stones appropriately positioned and holmium laser fragmentation can be used for stones >3 mm with stone fragments removed with the basket as needed. In the second case in this series, no stone was seen after systematic inspection of each individual calyx. This led to a change in protocol and a limited non-contrast CT was introduced to ensure the stone had not passed between the time of the evaluation CT and donation. Despite this, no stones were seen in five further cases after systematic inspection of all calyces. We speculate that parenchymal calcification adjacent to the collecting system could be mistaken for stones on CT. The CT scans were subsequently re-reviewed and four of the six kidneys were deemed to have equivocal imaging that could represent calcification outside the collecting system.

Two donor kidneys had more than one stone, successfully treated with basket removal or laser fragmentation. Recently, we were challenged with one case where there was no other suitable donor and a paediatric recipient who could not wait for a deceased donor kidney. A laser was used on a 1.2-cm lower pole stone and the fragments removed using multiple passes of the basket. These cases show that ExURS in donor kidneys with multiple small stones or larger stones is technically feasible. As data regarding this are currently sparse, it should only be considered when no other donor options exist. Furthermore, where larger stones are attempted, one should be prepared to perform open nephrolithotomy or pyelolithotomy as necessary (in the event of ExURS failure) and the additional risks associated with this considered. The Amsterdam Forum guidelines set the threshold stone size at <1.5 cm, beyond which donation should not be considered [16].

Schade et al. [17] recently published their expanded series of 23 cases of ExURS, based on their original description of the technique, using a semi-rigid ureteroscope in the majority of the cases and a flexible ureteroscope in a selected few. In four kidneys, stones weren't seen; and 17

out of 19 were successfully cleared of stones with either basket or laser fragmentation. Vasdev et al. [13] report three cases of ureteroscopic removal of small stones (range 3–5 mm) from donor kidneys with a basket. In two cases, the stone was removed ureteroscopically after the kidney was revascularized in the recipient before the ureterovesical anastomosis. There were no procedure-related complications and no stones were seen in both donors and recipients at 64-month follow-up. Trivedi et al. [18] also reported success with ExURS technique in one living donor using a pneumatic lithotriptor to a 5-mm stone. Recently Mosimann et al. [19] reported the loss of a transplant kidney on reperfusion owing to acute ischaemia after ExURS from an intimal flap in the renal artery at the hilum adjacent to the renal pelvis, where rigid ureteroscopy and mechanical stone fragmentation was used. They believe, as we do, that use of a flexible ureteroscope is safer in ExURS.

By contrast, Devasia et al. [20] report alternate approaches including use of nephrotomy for removal of a 15-mm stone at time of transplantation, fragmentation of a 12-mm upper pole calculus using ESWL before donation with only a 4-mm residual fragment at time of donation, and three cases of small (3–4 mm) donor stones in which no treatment was performed and the stones left in the kidney that was transplanted. This latter approach of 'donor-gifted stones' has been adopted, with stone size ranging from 2 to 6 mm in five cases reported by Martin et al. [21], 13 by Ho and Chow [22] and 10 by Kim et al. [14].

In the present study, in three of five kidneys transplanted with small (<3 mm) 'donor-gifted' stones, no stone was seen on follow-up imaging. The rate of spontaneous passage of small (<4 mm) 'donor-gifted' stones in transplanted kidneys appears to be similar to that of other studies 38–60% [20,22]. The anatomy of the transplanted ureter, which is shorter and without the narrowing as the native ureters cross the pelvic brim, may account for these relatively high spontaneous stone passage rates.

Kim et al. [14] also report in their series a further patient who was transplanted with a kidney containing a 9-mm stone, but this patient presented with obstruction 3 months after transplantation, requiring urgent percutaneous nephrostomy to relieve obstruction. Because of this risk of obstruction with the 'donor-gifted stone' approach, a threshold of transplanting kidneys with <4 mm *in situ* may need to be considered.

Furthermore, should stone complications occur, access to the transplant ureter is more difficult because of the location of the transplant neo-ureteric orifice [23]. In paediatric recipients, there is also limited scope to perform minimally invasive stone removal. ExURS with a flexible ureteroscope appears a safe technique with no side effects found so far and the experience gained in removing small stones has allowed the confidence to perform the removal of larger stones.

The present findings have a number of important implications for clinical practice. They suggest that asymptomatic stones should not be considered an absolute contraindication to living kidney donation. The donor and recipient should be counselled extensively regarding the risks of donation and, where possible, aim to use the stone-bearing kidney for donation. Through this extended criteria programme, 20 additional live donor kidney transplants were performed; representing an additional 5% of the total number of transplants performed during this period at our institution. Whilst long-term data are awaited, the short- to medium-term outcomes are encouraging. The development of minimally invasive stone management strategies and the increasing pressure on the donor pool has led to transplant units considering donors with incidental CT-detected stones. These donors should be referred to a specialist centre with joint transplant and urological services for further evaluation and assessment. ExURS with a flexible ureteroscope can be readily performed with a short learning curve by a competent endourologist. Further experience is required to decide if small stones (<4 mm) can be left *in situ* and whether ExURS is appropriate for large (>1 cm) stones.

In the absence of an alternative suitable live donor, the present study supports using potential living donors with incidental renal stones where there is no uncorrectable metabolic abnormality. ExURS with a flexible ureteroscope is a safe technique that can render the transplant kidney stone-free and can be performed without subjecting the donor to risks of an extra stone-removing procedure. The consideration of these donors with stones has led to 20 (~5%) more transplants in our institution than would otherwise have been possible.

Conflict of Interest

None declared.

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Abbreviation: ExURS, *ex vivo ureteroscopy*.