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Intraoperative indocyanine green fluorescence navigation in a robot-assisted partial nephrectomy for a large renal cell carcinoma in a horseshoe kidney

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SUMMARY

A man in his 60s was referred to the urology department with an incidental finding of large 75 mm mass within a horseshoe kidney. CT imaging highlighted the well-known aberrant arterial anatomy seen in horseshoe kidney which often causes significant surgical challenges. After careful preoperative planning, the mass was resected successfully during a robot-assisted partial nephrectomy. Intraoperatively, indocyanine green fluorescence navigation helped to confirm arteries supplying area of resection were appropriately clamped, allowing for safe resection of the mass. Histology revealed a chromophobe renal cell carcinoma with clear margins. The patient was discharged on day 4 postoperatively and continues to be cancer free on routine surveillance imaging.

BACKGROUND

Horseshoe kidney is the most common renal fusion anomaly, with an incidence of approximately 0.25%. These anomalies are often associated with several anatomic abnormalities, including the presence of aberrant and accessory blood vessels as well as fusion or anatomical variants of the urinary tract.¹ This aberrant anatomy increases operative complexity for management of suspicious renal masses in nephron sparing surgeries, as 89% of cases with renal masses in fusion abnormalities have been shown to have aberrant and accessory blood vessels.² The importance of nephron sparing surgery and challenges to ensure histological margins and cancer outcomes are not compromised is well appreciated.³ Partial nephrectomies in these cases are challenging, often requiring a heminephrectomy. To date, seven cases in a horseshoe kidney have been reported regarding management of renal masses with partial nephrectomy using robot-assisted techniques. We report the first case of a partial nephrectomy in a horseshoe kidney with the use of intraoperative indocyanine green (ICG) fluorescence navigation, highlighting the importance of preoperative planning and intraoperative techniques.

CASE PRESENTATION

During the management of an episode of acute cholecystitis, a man in his 60s had an incidental finding of a large left-sided renal mass in a newly identified horseshoe kidney. The patient was asymptomatic with no pain, no haematuria and no symptoms of paraneoplastic syndrome. A

quadruple phase CT confirmed a 75 mm solid enhancing lesion, with Hounsfield units of 33 on the non-contrast phase and 56 on the arterial phase. No signs of extracapsular extension, renal vein involvement nor local or distant metastasis. The patient's medical history included obesity with a body mass index of 41, hypertension, type 2 diabetes mellitus managed with diet and oral hypoglycaemic agents, and he was an ex-smoker. His preoperative creatinine was 84 µmol/L (60–110 µmol/L) and all other bloods were unremarkable.

INVESTIGATIONS

A dedicated arterial phase CT was completed to analyse the arterial supply of the kidney, and the operative approach was discussed in a urology unit meeting (figure 1). On review of the images, it was noted the potential challenges of the case included hilar control for resection, thought best achieved by clamping the single left renal artery, then assessing intraoperatively with ICG noting that both horseshoe kidneys and tumours can have multiple smaller accessory arterial supply. Should a partial nephrectomy need to be aborted and a heminephrectomy undertaken the isthmus was supplied by the right lower pole artery, an intraoperative decision would need to be made before resection of tumour, if the right lower pole artery should be exposed. It was also noted the isthmus was thick and in close proximity to the inferior mesenteric artery making a heminephrectomy challenging. The renal score was 10×. Size >7 cm, >50% exophytic, ≤4 mm to nearest collecting system, neither anterior or posterior, crosses the axial renal midline and was not hilar.

TREATMENT

Following appropriate patient positioning in the right lateral decubitus position, robotic and assistant port insertion, into the intraperitoneal space, the left colon was mobilised. The left renal artery and vein were identified and looped with a vessel loop (figure 2A). The kidney was defatted superiorly and anteriorly to identify the tumour (figure 2B). A superior renal artery was identified and clipped, not noted in the preoperative radiology reviews. The main left renal artery was occluded with two bulldog clips, ICG was given and under firefly imaging, confirmation of the avascular renal tumour was confirmed (figure 3). The tumour was dissected deep to renal sinus fat and into the collecting system, preserving the isthmus. Two 3/0



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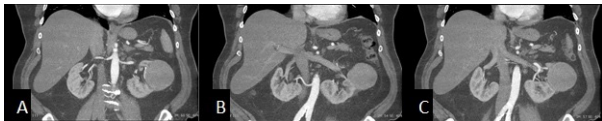


Figure 1 Preoperative imaging of left-sided renal mass within horseshoe kidney. CT images of the abdomen highlighting (A) right renal artery, (B) right lower pole accessory renal artery and (C) left renal artery.

V-Loc continuous sutures to the base of the defect and eight interrupted 1/0 vicryl sutures to the parenchyma to perform the renorrhaphy. Total warm ischaemic time was 53 min.

OUTCOME AND FOLLOW-UP

Histology confirmed a chromophobe renal cell carcinoma measuring 75 mm with no capsular, lymphovascular or perineural invasion and clear surgical margins. The patient had an uneventful postoperative recovery. His postoperative creatinine was 98 and discharged on day 4. His first surveillance CT scan 6 months postoperatively shows no signs of recurrence. He will continue routine surveillance as per local low risk guidelines.

DISCUSSION

Management of renal tumours in horseshoe kidneys continues to present challenges for the urologist. The rarity of incidence as well as high variability of anatomy have proven difficult to develop guidelines for surgical planning for these patients.

We report the largest lesion in the literature, 75 mm, that was safely excised with a robotic partial nephrectomy in a horseshoe kidney. Larger renal lesions described in the literature in horseshoe kidneys have required heminephrectomies.^{4,5} In a systematic study by Graves, six basic patterns of arterial blood supply to the horseshoe kidney were described,¹ noting that further variability can occur, particularly due to tumour angiogenesis. Preoperative planning is paramount, with arterial phase CT and the use of three-dimensional models to identify and create a management plan for aberrant vascular anatomy.⁵⁻⁹ Offclamp laparoscopic tumour enucleation is possible and feasible in a horseshoe kidney.¹⁰ However as we know, with increasing renal score comes increasing complexity of partial nephrectomy. During tumour resection, intraoperative confirmation of occluded blood supply with the use of ICG and firefly imaging can assist in preventing haemorrhage and reduce the risk of conversion to heminephrectomy, even in situations of thorough preoperative planning and an experienced urological surgeon. The clear demarcation of vascular supply to the kidney would

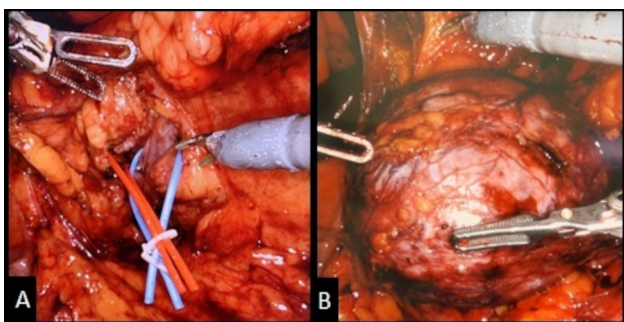


Figure 2 Intraoperative images. Exposure of (A) left renal hilum with artery and vein looped and (B) left renal tumour in the horseshoe kidney.

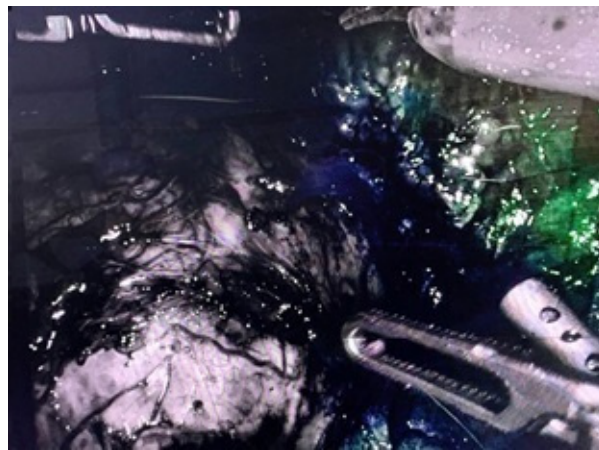


Figure 3 Intraoperative indocyanine green fluorescence navigation. Area of green highlighting perfused tissue while renal tumour appears black and white confirming ischaemia.

have assisted in a successful heminephrectomy should it have needed to be performed without compromising the contralateral kidney. Our case is the first to highlight the benefit of this in a robot-assisted partial nephrectomy in a horseshoe kidney.

In conclusion, appropriate preoperative planning of renal vasculature and intraoperative ICG navigation can help guide a

Patient's perspective

It was all a bit of shock really. First off I started to get this real bad pain that was worse and worse, which they found out was the gallbladder. When they were figuring that out, they then found out about the mass in the kidney. The gallbladder operation was very quick, in and out in a day, but then I had a bit of time to get used to the idea of the next procedure, about a month.

I've got one of those 'C'est la vie' personalities and I knew I just had to get the next steps done. I was a bit anxious at the start, but then realised that I just have to get things sorted.

The surgeon was very good. He really explained things to me in a lot of detail and I knew exactly what was going on. I had no fear or anything. All of the staff were actually very good, including the nurses on the ward—the whole team.

Since the operation I've had no complaints about the operation or follow-up or anything at all. It was actually surprisingly simple really. Genuinely it was very good. I never feared once.

Learning points

- ▶ Shared decision making is important for patients who should be adequately counselled about risks and benefits of nephron sparing surgery.
- ▶ Use of intraoperative indocyanine green fluorescence is useful for confirming vascular control prior to excision of deep/complex renal tumours, thus minimising risks of bleeding and conversion to more significant surgery.
- ▶ Appropriate preoperative imaging must be conducted to ensure understanding of aberrant vascular anatomy in the horseshoe kidney.

safe robotic partial nephrectomy of a large tumour in a horseshoe kidney.

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Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

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