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African Journal of Urology (2023) 29:16
https://doi.org/10.1186/s12301-023-00349-3

African Journal of Urology

CASE REPORTS

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Vascular injury during laparoscopic partial nephrectomy in a solitary kidney: management, outcome and audit

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Abstract

Background Vascular injury during laparoscopic partial nephrectomy is a dreadful complication. Though it is a commonly discussed complication, the literature on the circumstances leading to vascular injury, methods of managing the complication and reporting of final outcomes in those cases are limited. We report a case of vascular injury during laparoscopic partial nephrectomy for a hilar tumor in a solitary kidney. We highlight the management of the complication, present the outcome and review the surgical technique.

Case presentation A 62-year-old male with solitary kidney presented with left renal hilar mass of size 4.4 × 3.8x3.6 cm. The renal nephrometry score was 10ph. The serum creatinine at the time of presentation to the hospital was 1.4 mg/dl. Laparoscopic partial nephrectomy was performed. The patient had severe intraoperative bleeding due to a segmental renal artery injury. The bleeding presented after hilar unclamping and was managed by intracorporeal vascular repair. The blood loss was around 500 ml. The postoperative period was uneventful without the need for hemodialysis. The histopathology report was suggestive of clear cell renal cell carcinoma with negative surgical margin. The follow-up magnetic resonance urogram did not show evidence of any arterial pseudoaneurysm or residual/recurrent tumor. At 18-month follow-up, the serum creatinine was 1.9 mg/dl and the patient did not have any complaints.

Conclusions Complication of vascular injury while performing laparoscopic partial nephrectomy for complex hilar tumors should be anticipated beforehand. Contingency plans to tackle this complication must be in place before attempting the surgery. Intracorporeal repair of vascular injury during laparoscopic partial nephrectomy is feasible when expertise is available. Low threshold for using endoscopic ultrasound, employing cold ischemia techniques, careful usage of hot cut during tumor resection and complete defatting of the kidney can all be considered 'safe surgical practices' during laparoscopic partial nephrectomy for complex hilar tumors. Following aforementioned 'safe surgical practices' helps in improving the outcomes and reducing the possibility of complication of vascular injury and helps in managing the complication effectively if it happens despite the precautions.

Keywords Solitary kidney, Hilar tumor, Complex tumor, Laparoscopic partial nephrectomy, Vascular injury, Arterial bleeding, Vascular repair

1 Background

Intraoperative bleeding during laparoscopic partial nephrectomy is a troublesome complication and may necessitate open conversion in a proportion of patients [1]. The management of intraoperative bleeding becomes

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more difficult in cases where the bleeding manifests torrentially after hilar unclamping as a result of major vascular injury. Though vascular injury is a reported complication during LPN for hilar tumors [2], detailed literature on the circumstances leading to vascular injury, methods of managing the complication and reporting of final oncological and renal functional outcomes in those cases are limited. We performed laparoscopic partial nephrectomy (LPN) for a high complexity renal hilar tumor in a solitary kidney. We had to face the complication of severe intraoperative bleeding due to a segmental renal artery injury. We report the case highlighting the complication with its management and present the outcome. Pertinent to the reported case scenario, the authors also recommend a few safe surgical practices.

2 Case presentation

A 62-year-old male presented to our hospital for the first time with recently detected left renal mass on ultrasonography. The patient had undergone right radical nephrectomy 16 years back for renal cell carcinoma (RCC) at some other institution. The patient did not have any known comorbid medical conditions. The serum creatinine at the time of presentation to the hospital was 1.4 mg/dl. The preoperative hemoglobin value was 12.2 g/dL. On computed tomography urogram, a 4.4 × 3.8 × 3.6cm partially exophytic heterogeneously enhancing renal lesion was noted (Fig. 1). The RENAL nephrometry score was 10ph and was categorized under high complexity type [3].

The patient underwent LPN. The procedure was performed by a surgeon with prior experience of performing approximately 400 LPN. Initially complete defatting of the kidney was performed (Fig. 2a). Renal hilum was also dissected (Fig. 2b). As a part of the tumor was exophytic (Fig. 2c), the authors at that stage believed that the tumor could be enucleated by dissecting circumferentially around the pseudocapsule and felt endoscopic ultrasound was not required. The en masse hilar clamping was then performed with a satinsky clamp (Fig. 3a), and the tumor resection was begun with cold cut by scissors (Fig. 3b). For hot cut during surgery, we used electrosurgical suction irrigation device with pistol grip and L hook (Conmed, Largo (Tampa Bay), FL 33,773, USA) (Fig. 4a). As the tumor resection with cold cut was proceeded with, there was continuous oozing from the raw renal parenchyma and oozing was obscuring the vision. As a result, hot cut with electrosurgical suction/irrigation device was performed intermittently during tumor resection (Fig. 4b). During tumor resection by hot cut, we had inadvertently injured a segmental renal artery which was not recognized at that stage (Fig. 4c). Tumor was eventually resected with normal parenchymal margin all

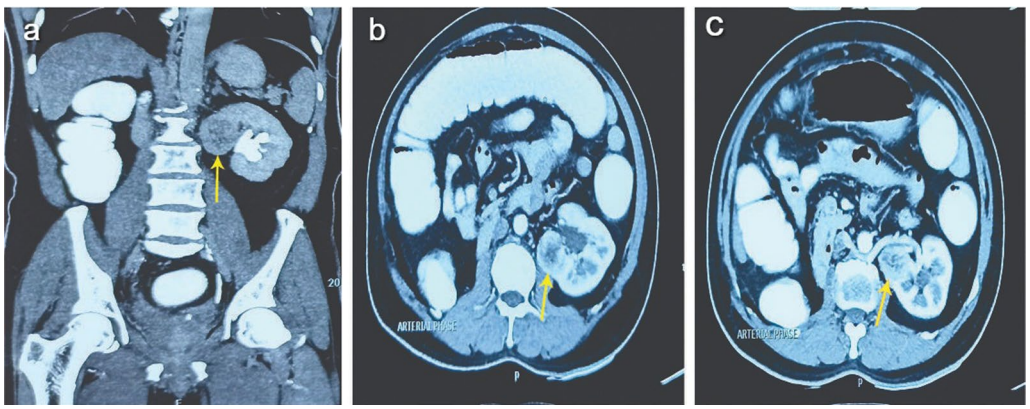

Fig. 1 **a**, **b** and **c** Computed tomography showing left renal complex hilar tumor (marked with yellow arrow)

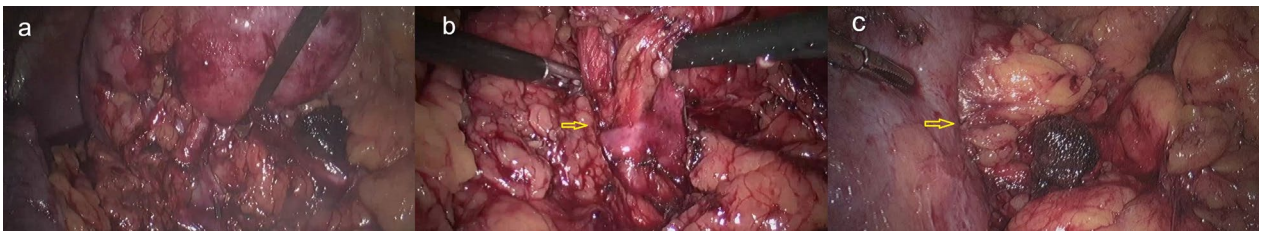

Fig. 2 **a** Left kidney after complete defatting. **b** Completely dissected left renal hilum (marked with yellow arrow). **c** Partially exophytic left renal tumor (marked with yellow arrow)

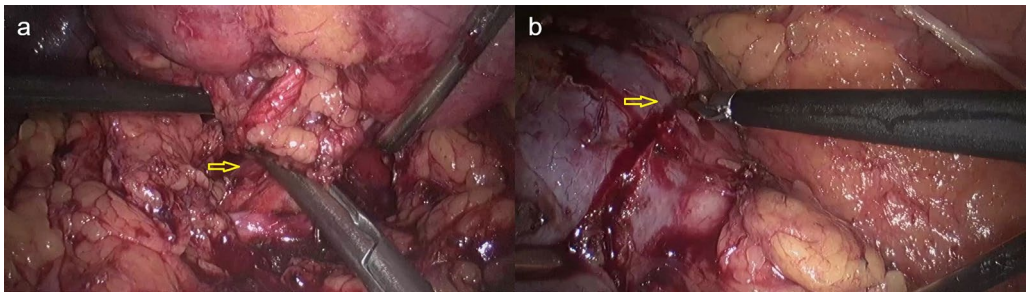

Fig. 3 **a** Satinsky clamp (marked with yellow arrow) applied en masse to left renal hilum. **b** Tumor resection begun with scissors (marked with yellow arrow)

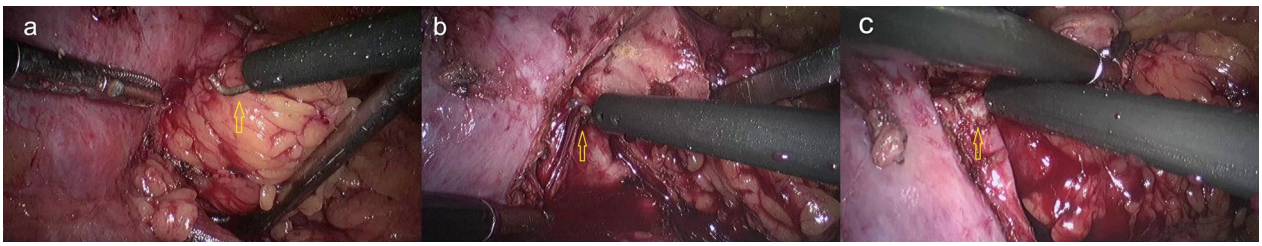

Fig. 4 **a** Electrosurgical suction irrigation device with L hook used for hot cut (marked with yellow arrow). **b** Progression of tumor resection by electrosurgical suction irrigation device (marked with yellow arrow). **c** Segmental arterial injury during tumor resection (marked with yellow arrow) (not identifiable at that stage and was identified during retrospective analysis of the recorded video)

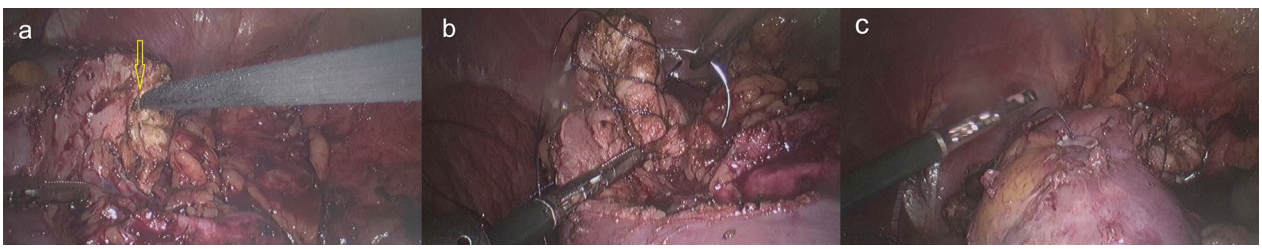

Fig. 5 **a** Surface coagulation by electrosurgical spatula (marked with yellow arrow). **b** and **c** Renorrhaphy by sliding clip technique

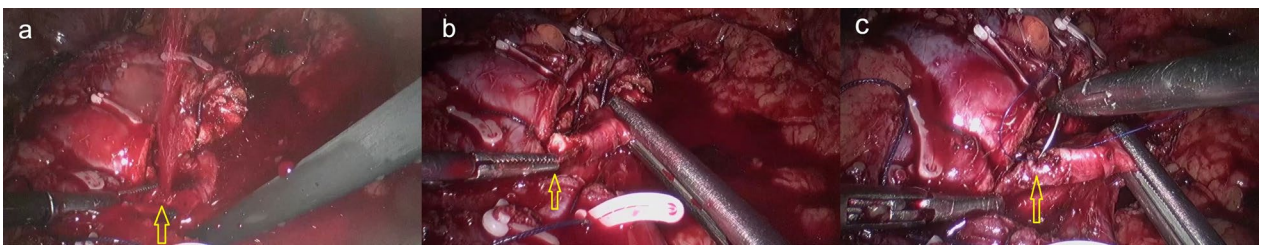

Fig. 6 **a** Bleeding from the segmental renal arterial tear after hilar unclamping (marked with yellow arrow). **b** Arterial tear with ragged edges noticed after selective segmental artery clamping (marked with yellow arrow). **c** Repair of arterial injury with prolene (marked with yellow arrow)

around. Targeted surface coagulation with electrosurgical spatula was then performed over the raw oozing parenchymal surface (Fig. 5a). Single-layered renorrhaphy was then performed with '0' vicryl by sliding clip technique (Fig. 5b and c) [4]. Global renal warm ischemia time was 28 min. Hilar unclamping was done, following which a brisk arterial bleeding was noted (Fig. 6a). Tear in a segmental renal artery was then identified. The edges of the arterial tear were ragged and irregular and were suggestive of injury due to hot cut usage during tumor resection

(Fig. 6b). The arterial tear was repaired intracorporeally with 5–0 prolene (Fig. 6c). Selective segmental arterial clamping and suturing had to be done twice before complete hemostasis could be achieved. The first and second selective warm ischemia time were 15 and 4 min, respectively. There was mild bluish discoloration of the upper pole of the kidney at the end of the procedure (Fig. 7a). The excised tumor (Fig. 7b) was then retrieved out.

The estimated blood loss was around 500 ml. The patient needed two units of blood transfusion in the perioperative period for hemodynamic stability. The postoperative period was uneventful. The hemoglobin value on postoperative day 1 was 10.6 g/dL. Oral fluids were begun on postoperative day 1. Urethral catheter and surgical drain were removed on postoperative day 2. The patient was discharged on postoperative day 4 with a serum creatinine of 2.3 mg/dl. Histopathology report was clear cell RCC, and the parenchymal resection margin was free of tumor with 4 mm clearance. Follow-up magnetic resonance urogram performed at 3 months and 18 months did not show any arterial pseudoaneurysm or residual/recurrent tumor. Serum creatinine at 18-month follow-up was 1.9 mg/dl, and the patient was asymptomatic at 18-month follow-up.

3 Discussion

LPN for hilar tumor is associated with good outcomes in the hands of an experienced laparoscopic surgeon.[5]. At high volume centers, LPN has been performed efficaciously and safely in a solitary kidney [6]. Even at high volume centers, the incidence of significant intraoperative bleeding can range as high as 3.5% and may require open conversion in 1% of the cases [1]. The current guidelines recommend the approach for partial nephrectomy to be decided according to surgeon's expertise and skills [7]. Partial nephrectomy by laparoscopy is the preferred approach at the author's institution, and hence, we decided to proceed with LPN in the above case.

The incidence of vascular injury during LPN is higher in complex renal hilar tumors. Successful management should begin with prior anticipation of the complication and adequate preparatory measures before surgery. From the experience of managing the vascular injury in the above case, the authors compiled a list of 'safe surgical practices' by which the complication of vascular injury could have been prevented and can be effectively managed if it happens despite preventive measures. The 'safe surgical practices' include low threshold for using endoscopic ultrasound, employing cold ischemia techniques, careful usage of hot cut during tumor resection and complete defatting of the kidney. The 'safe surgical practices' discussed by the authors are not new and are all described in the literature. But revisiting them in the context of the reported case underscores their relevance and significance. The compiled 'safe surgical practices' include those which were followed in the reported case as well those which were regretfully not followed in the reported case.

Endoscopic ultrasound is helpful in determining the extent of the tumor and is useful in achieving delicate balance between negative tumor margin and maximal renal parenchymal preservation [8]. The authors feel endoscopic ultrasound could have been considered in a complex hilar tumor like ours, and vascular complication due to deeper resection could have possibly been avoided. Various cold ischemia techniques have been described in LPN and have been said to be protective on renal function, especially in cases where longer ischemia times are expected [9, 10]. Considering the prolonged warm ischemia (as was expected in a hilar tumor) in our case, performing the procedure in cold ischemia could have been more friendly on renal functions.

Hot cut for tumor resection can cause increased loss of nephrons. It can create as well as mask an underlying vascular injury. In our case, the hot shear gave a false sense of assurance of hemostasis, only to present with a major bleeding complication later. The authors therefore

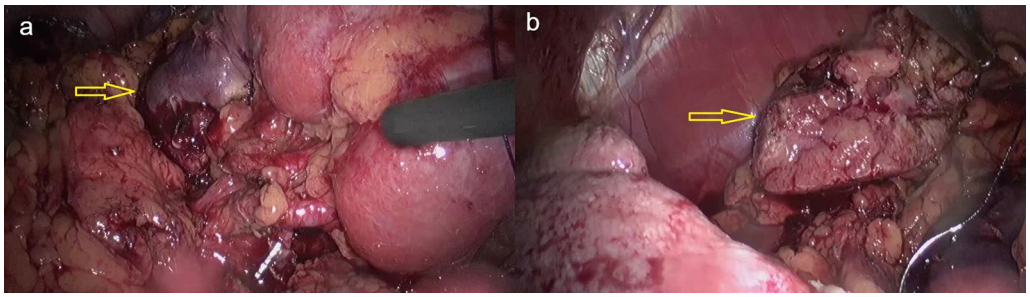

Fig. 7 **a** Appearance of the kidney after renorrhaphy and final satinsky unclamping. Mild bluish discoloration is noticed at the upper pole (marked with yellow arrow). **b** Excised partial nephrectomy specimen (marked with yellow arrow)

recommend avoiding usage of hot cut in hilar tumors, and if unavoidable to practice extreme caution while using. Complete defatting of the kidney makes renorrhaphy easier in large hilar defects [11]. It also makes vascular repair easier if needed, by providing better exposure of hilar vasculature. Retrospectively analyzing, good exposure during vascular repair in our case was facilitated by complete posterior defatting (including that of renal hilum) performed prior to tumor resection.

The authors agree that open conversion and vascular repair are the standard of care in the event of vascular injury during LPN. However, the authors believe that an intracorporeal vascular repair is a management option when expertise is available. The preoperative and postoperative estimated glomerular filtration rate values were not assessed in our case, and calculating them would have given more precise information on the impact of LPN on renal function in our case.

4 Conclusions

Complication of vascular injury while performing LPN for complex hilar tumors should be anticipated beforehand. Contingency plans to tackle this complication must be in place before attempting the surgery. Intracorporeal repair of vascular injury while doing laparoscopic partial nephrectomy is feasible when expertise is available. Low threshold for using endoscopic ultrasound, employing cold ischemia techniques, careful usage of hot cut during tumor resection and complete defatting of the kidney can all be considered 'safe surgical practices' during LPN for complex hilar tumors. Following 'safe surgical practices' helps in improving the outcomes and reducing the possibility of complication of vascular injury and helps in managing the complication effectively if it happens despite the precautions.

Abbreviations

LPN	Laparoscopic partial nephrectomy
RCC	Renal cell carcinoma

Acknowledgements
The authors thank Mr Bijoy (visual editor) for editing the photographs. The authors also thank Ms Nice, Ms Ambily and Ms Sophia Shelly (operating room nurses) for technical assistance during surgery.

Author contributions
VSV contributed to concept, design, literature search, manuscript preparation and manuscript review. DGP contributed to design, manuscript editing and manuscript review. GPA contributed to operating the patient, manuscript editing and manuscript review. All authors have read and approved the final manuscript.

Funding
No external funding received.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
At our institute not needed for this case report.

Consent for publication
Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Competing interests
The authors declare that they have no competing interests.

Received: 10 January 2023 Accepted: 16 March 2023
Published online: 29 March 2023

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