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## Two cases of pseudoaneurysm of the renal artery following laparoscopic partial nephrectomy for renal cell carcinoma: CT angiographic evaluation

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**Abstract** Partial nephrectomy via a laparoscopic approach can be technically challenging, and associated vascular complications such as pseudoaneurysm may occur. CT with CT angiography is ideal for the noninvasive imaging of this process. This article reports two cases of pseudoaneurysm of the renal artery detected on CT as a complication of laparoscopic partial nephrectomy and demonstrates the usefulness of 3-D CT angiography in the evaluation of vascular pathology.

**Keywords** Computed tomography angiography · Partial nephrectomy · Pseudoaneurysm

### Introduction

Partial nephrectomy for patients with malignant renal tumors was introduced in the 1950s, but has recently become the procedure of choice for elective indications [1]. This is in response to improved surgical technique and the significant rise in the incidental CT detection of early stage renal cell carcinoma [2]. Early detection can be attributed to an overall increase in the number of CT scans performed, but is also the result of recent advances in technology including improved resolution afforded by multidetector CT scanning with 3-D volume rendering. Conservative management is ideal for

these small renal lesions, avoiding overtreatment for benign disease and sparing renal function in patients with renal cell carcinoma, who have a 3.8% risk of requiring further surgery for lesions in the contralateral kidney [3]. A laparoscopic rather than open approach is being performed increasingly for selected indications including benign diseases as well as for the removal of small exophytic tumors (<2 cm) [4]. While the laparoscopic approach has the advantages of low morbidity and a better aesthetic result, the limited working space makes hemostasis challenging [5]. To our knowledge, there have been no reports in the literature documenting pseudoaneurysm as a complication of either open or laparoscopic partial nephrectomy. Here we present pseudoaneurysm of the renal artery as a complication of laparoscopic partial nephrectomy confirmed by conventional renal angiographies in two postoperative patients. In both cases, the multiplanar capabilities of multidetector CT combined with 3-D volume rendering aid in the accurate diagnosis.

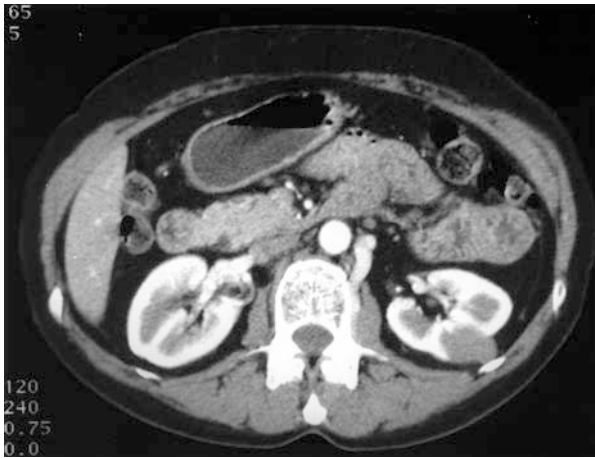
### Materials and methods

This report is based on data collected from two patients who had recently undergone a laparoscopic partial nephrectomy. The first patient was known to have bilateral conventional renal cell carcinomas and first underwent a right laparoscopic partial nephrectomy for conservation of renal function prior to a radical left nephrectomy. The second patient underwent an elective laparoscopic partial nephrectomy for an enhancing renal mass discovered incidentally on an abdominal CT scan (Fig. 1). Pathological analysis revealed that this lesion was a papillary renal cell carcinoma. Postoperatively, both patients developed gross hematuria associated with a decreasing hematocrit and were evaluated with abdominal CT scans.

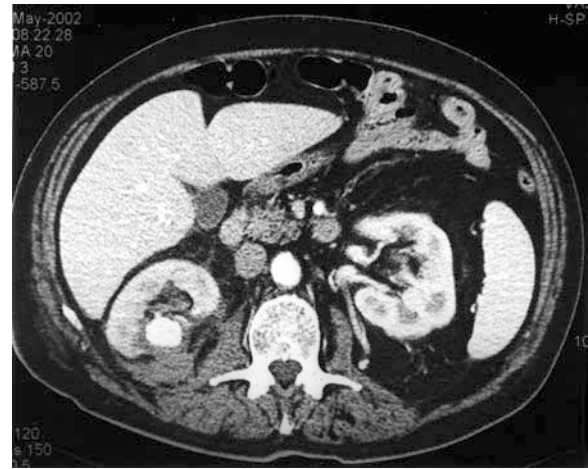
We currently scan the abdomen and pelvis after the intravenous administration of 125 ml iodinated contrast medium (Omnipaque 350) injected at a rate of 3 ml/s. Imaging of the arterial phase is performed after a 25-s delay and venous phase images are acquired after a 55-s delay. All scanning is performed on a Somatom Plus 4 Volume Zoom (Siemens, Forchheim, Germany). Images are acquired using four detectors with 1 mm collimation, a table speed of 12 mm/s, and a slice thickness of 1.25 mm reconstructed at 1-mm intervals.

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**Fig. 1** A 53-year-old man with an enhancing left renal mass incidentally discovered on abdominal CT scan. Cortical/medullary phase axial CT demonstrates a peripheral mass in the mid pole of the left kidney



**Fig. 3** A 60-year-old man with bilateral renal cell carcinomas after right laparoscopic partial nephrectomy for removal of the right renal mass. CT scan shows a well-circumscribed collection of contrast near the lower pole of the right kidney with surrounding hemorrhage compatible with a pseudoaneurysm



**Fig. 2** The same patient as in Fig. 1 after left laparoscopic partial nephrectomy for removal of the enhancing renal mass. CT scan shows a large collection of contrast in the mid pole of the left kidney compatible with a pseudoaneurysm. There are surrounding surgical clips from the recent laparoscopic partial nephrectomy and minimal perinephric fluid/hemorrhage



**Fig. 4** The same patient as in Fig. 1 after left laparoscopic partial nephrectomy. 3-D volume rendered coronal CT image with an oblique cut plane demonstrates a clear vascular connection to the contrast collection, confirming the diagnosis of a 4-cm pseudoaneurysm arising from the anterior branch of the left renal artery (*arrow*)

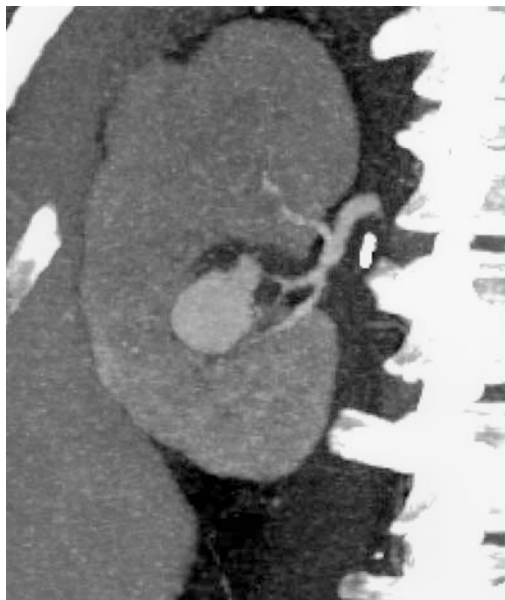
## Results

Axial CT images of the abdomen in both cases showed a well-circumscribed dense collection of contrast located within the renal hilum which was associated with mild surrounding perinephric hemorrhage and a slightly delayed nephrogram compared to the contralateral kidney (Figs. 2, 3). The diagnosis of pseudoaneurysm can be difficult to distinguish from a urinoma, which is a well-known complication of partial nephrectomy. 3-D reconstructions using volume rendering techniques create a vascular map of the kidney which clearly depict the connection of the contrast collection with branches of the renal arteries, making the differentiation of pseudoaneurysm from a urinoma much easier (Figs. 4, 5). The

patients subsequently underwent selective renal angiograms and therapeutic coil embolization of the renal artery pseudoaneurysms in the interventional radiology department and were discharged in good condition.

## Discussion

The management of patients with renal cell carcinoma is challenging due to the varied imaging appearance and unpredictable growth pattern of this tumor, which can recur as late as 15 years after surgical excision [3]. The CT findings of a renal mass demonstrating enhancement



**Fig. 5** The same patient as in Fig. 3 after right laparoscopic partial nephrectomy. Coronal 3-D maximum intensity projection (MIP) demonstrates a 2-cm pseudoaneurysm arising from the posterior-inferior branch of the renal artery

greater than 12 HU is suggestive of renal cell carcinoma, but specificity for differentiating renal cell carcinoma from oncocytomas, adenomas, and hemorrhagic cysts is only 85–90%. [3, 6]. MRI cannot differentiate between oncocytoma and renal cell carcinoma [3]. Biopsy is usually not performed because negative cytology does not rule out malignant tumor, and associated risks include hemorrhage, arteriovenous fistulas, pseudoaneurysms, and spilling of tumor cells. Therefore, treatment of patients with suspected nonmetastatic renal cell carcinoma is surgical. Currently, partial nephrectomy is electively performed both on patients with benign conditions such as ureteral duplication and horseshoe kidney and on those patients who have a less than 4-cm peripheral renal mass and a normal contralateral kidney [4]. Partial nephrectomy is mandatory to avoid dialysis in patients who have synchronous bilateral renal lesions or who have a malignant lesion in a single kidney [4].

The literature has shown that outcomes in patients with renal cell carcinomas treated with partial versus radical nephrectomies are comparable [7]. The long-term cancer-free survival rate in patients with renal cell carcinoma less than 3.5 cm in size treated with partial nephrectomy are similar to those in patients who underwent a radical nephrectomy [4]. In a large single center trial, Steinbach et al. retrospectively studied 140 patients who underwent a partial nephrectomy for renal lesions, 121 of which were renal cell carcinomas. The study found that the 5-year overall and cause-specific survival rates were 82% and 90% respectively and the postoperative local tumor recurrence rate was only 4.1% [3]. Uzzo et al. compared 28 radical and 52 partial nephrectomies and demonstrated that hospital cost and

complications were not significantly different in the two groups [8]. Renal-related postoperative complications are also similar in radical and in partial nephrectomies. Campbell et al. analyzed 259 nephron-sparing operations for renal cell carcinoma and reported a 30% renal-related complication rate including 45 urinary fistulas, 33 cases of acute renal failure, and 6 cases of perinephric hemorrhage [9].

In recent years, attempts have been made to use minimally invasive endoscopic procedures to replace the open approach to partial nephrectomy, which is associated with a large parietal wound, significant postoperative pain, and a lengthy convalescence [4]. Peripheral renal masses (<2 cm) are better candidates for a laparoscopic approach because, compared to central lesions, they require shorter renal arterial occlusion times (34 versus 55 min) and the collecting system is less frequently opened [4]. However, there has been no significant difference in functional and oncological outcomes between peripheral versus central renal cell carcinomas in patients treated with a laparoscopic partial nephrectomy [4]. Both transabdominal and retroperitoneal laparoscopic approaches have been successful and are performed with equal frequency [4]. The extraperitoneal route is beneficial because it affords direct access to the retroperitoneal organs without the need for colonic mobilization [4]. In addition, any postoperative fluid is collected and confined to the extraperitoneal space, avoiding the risk of peritonitis [4]. The operative technique involves a polar segmental nephrectomy, isolating the involved branch of the renal artery and identifying corresponding renal segments with dye injection into the vessel branches. If the lesion encompasses more than one renal segment, wedge resection or transverse resection is required [4].

Hemostasis and closure of the renal cavity are crucial steps of the operative technique and are difficult with a laparoscopic approach due to working space limitations and suturing difficulties [4]. To overcome these problems, technical tools have been investigated including intraoperative imaging with laparoscopic ultrasound and argon beam coagulator and surgical glues for hemostasis [4]. Other challenges with the laparoscopic approach are the lack of tactile assessment of anatomical structures for determination of the appropriate surgical margin and longer operating times [4].

## Conclusion

In this report, we have demonstrated that pseudoaneurysm of the renal artery is a complication of laparoscopic partial nephrectomy, most likely related to the difficulty of maintaining hemostasis in a small working environment. The peripheral renal lesions in both patients satisfied the current recommended criteria for a laparoscopic approach and both patients had similar postoperative symptoms of gross hematuria and a declining hematocrit. The high resolution and multiplanar

capabilities of multidetector CT with 3-D volume rendering techniques significantly improve accuracy in diagnosing pseudoaneurysm, delineating the connection of the contrast collection with the vasculature.

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