Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 5
Open Access

Left Renal Vein Reconstruction for Functional Paraganglioma Resection: A Case Study

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Cite this paper as: Mohammed Alfozan (2024) Left Renal Vein Reconstruction for Functional Paraganglioma Resection: A Case Study. *Frontiers in Health Informatics,* (5), 1076-1082

Abstract
A 54-year-old woman with a history of uncontrolled hypertension was found to have a large retroperitoneal mass on the left side compressing the renal vein. Contrast-enhanced CT of the abdomen and pelvis demonstrated a sizable, highly vascular, encapsulated, and heterogeneous para-aortic retroperitoneal tumor causing renal vein compression. Laboratory evaluation of blood and urine catecholamines confirmed the tumor was functional. A multidisciplinary team comprising anesthesiologists and urologists coordinated the surgical plan. Since imaging suggested the lesion was inseparable from the pancreas, a midline transperitoneal approach was chosen. Although the tumor compressed the vein, no significant impairment of blood flow was evident on imaging. Intraoperatively, venous drainage into the renal vein was observed. Following tumor excision, the renal vein was reconstructed, with less than 20% reduction in its caliber. Postoperatively, the patient's blood pressure stabilized, allowing discontinuation of antihypertensive medications. Many studies and case control investigations must be performed to find the main criteria and surgical limitations of left renal vein reconstruction and how the surgeries can be optimized with minimal risk of bleeding and infections.

Keywords: Left Renal, Vein, Reconstruction, Functional, Paraganglioma, Resection.

Introduction

Paragangliomas are tumors that originate from the paraganglionic system, irrespective of their anatomical site. The exception is those arising in the adrenal medulla, commonly termed pheochromocytomas (1). While paragangliomas can occur throughout the paraganglia, the retroperitoneum is the most frequent extra-adrenal location (2). Their presentation often overlaps with other conditions depending on their size and anatomical involvement. Pheochromocytomas, in particular, are neuroendocrine tumors that typically develop from the adrenal medulla's chromaffin cells (3). Extra-adrenal paragangliomas derive from paraganglia clusters of specialized neural crest cells distributed symmetrically along the aorta in association with the sympathetic chain (4). Because of their rarity, these tumors frequently pose a diagnostic challenge before surgery, especially when arising in atypical regions. Paragangliomas do not present with a pathognomonic imaging appearance; while they are usually hypervascular and hyper-enhancing, this feature is not universally observed (5).

Their unusual anatomical sites and nonspecific clinical manifestations necessitate a high degree of suspicion for diagnosis. In fact, many patients still experience significant intraoperative hemodynamic instability despite adequate preoperative preparation (6). Common symptoms include back pain, hypertension, and catecholamine-related manifestations such as headache, palpitations, flushing, and visual disturbances. Notably, about 40% of retroperitoneal pheochromocytomas show no hormonal activity (7).

Case Presentation

A 54-year-old female patient was referred to our center with a large retroperitoneal mass on the left side compressing the renal vein. She had a three-year history of poorly controlled hypertension. Contrast-enhanced CT of the abdomen and pelvis revealed a hypervascular, capsulated, heterogeneous para-aortic mass in the retroperitoneum. The lesion compressed the renal vein, raising concern for venous invasion (Figure 1,2). The mass appeared inseparable from the inferior margin of the pancreatic body and the adrenal gland's lateral limb. Biochemical testing of plasma and urinary catecholamines confirmed the presence of a hormonally active tumor.

The patient underwent surgery after thorough preoperative preparation by a multidisciplinary team. Given the radiological impression that the mass could not be separated from the pancreas, a midline transperitoneal approach was selected. Intraoperatively, the tumor was found to be closely adherent to the renal vein and draining directly into it. Despite the compression, venous flow was preserved. The mass was carefully dissected and completely excised. Following removal, the renal vein was reconstructed, with the lumen narrowing by less than 20% compared to its original caliber. The patient recovered well, gradually tapered off antihypertensive therapy, and maintained stable blood pressure within normal limits during follow-up.

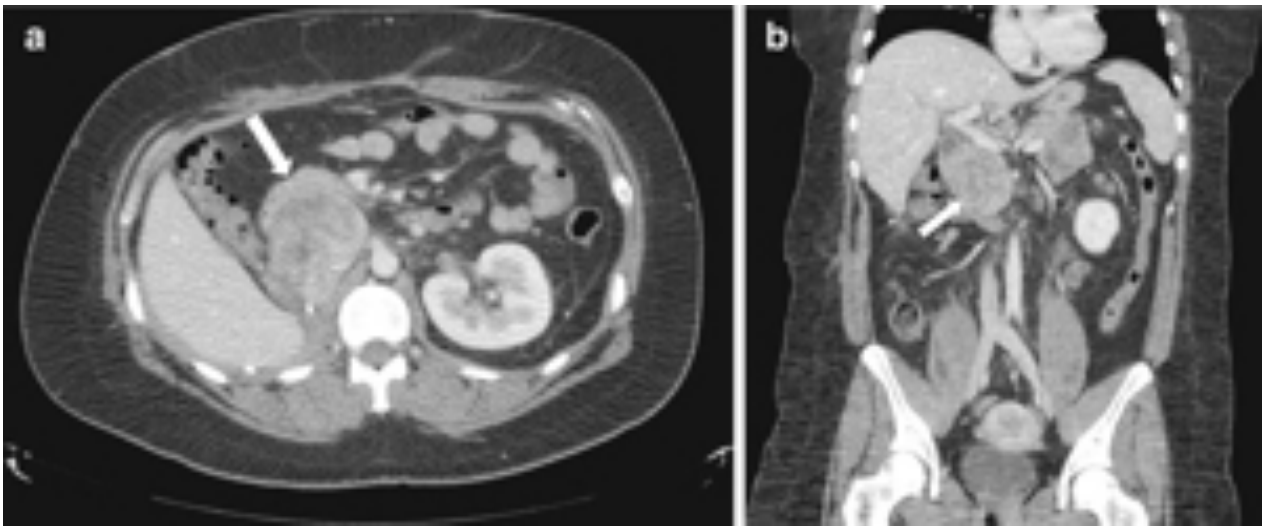

Figure 1: CT scan of the abdomen and pelvis with contrast revealed a well-defined, large,

highly vascular para-aortic mass.

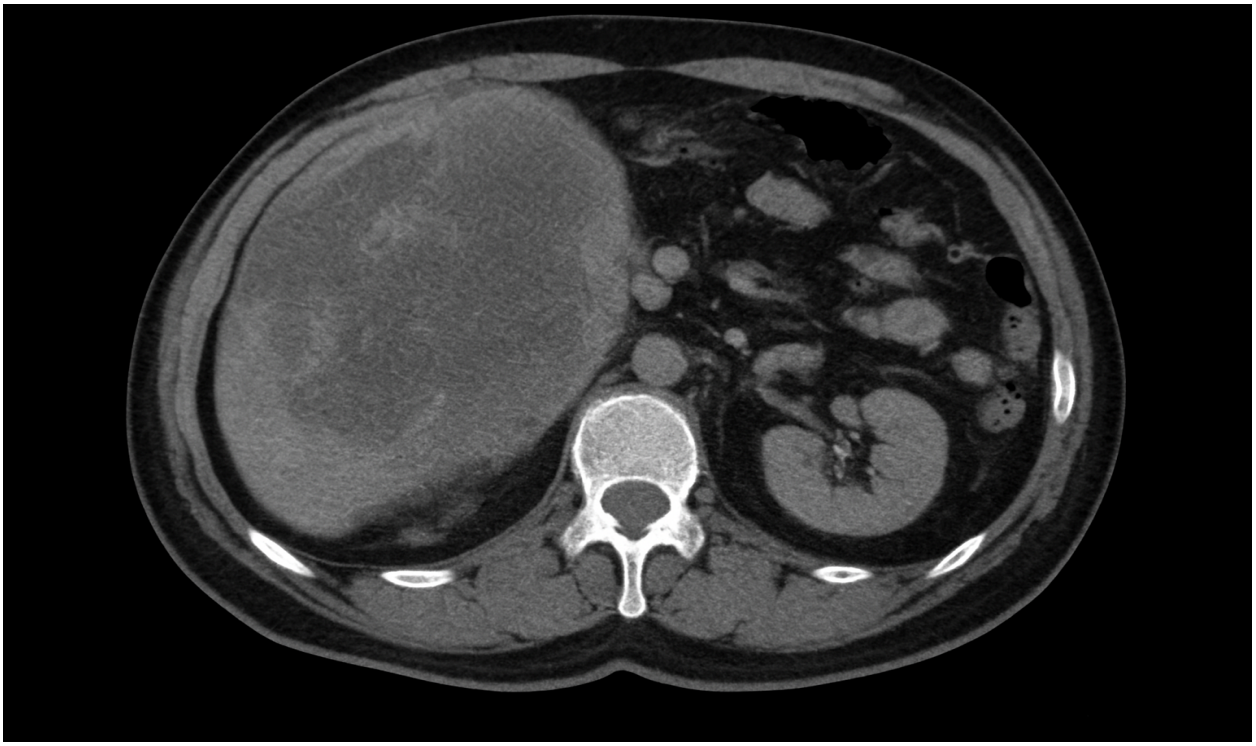

Figure 2: CT scan of the abdomen and pelvis with contrast revealed a heterogeneous retroperitoneal para-aortic mass.

The patient was initially referred to the endocrinology team, where preoperative medical optimization was initiated. As part of the standard protocol, long-acting alpha-blockers and beta-blockers were prescribed. After two weeks of treatment, her blood pressure was well controlled, and she was deemed fit for surgery.

Based on CT findings suggesting that the tumor could not be separated from the pancreas, a transperitoneal approach with a midline incision was chosen. During surgery, the pancreatic body was successfully dissected away from the mass, and collateral vessels were carefully managed (Figure 3). The renal vein wall, however, was infiltrated by the tumor and could not be dissected free. A Satinsky clamp was applied for partial venous control, after which the anesthesiologist noted a drop in blood pressure, confirming that the tumor predominantly drained into the renal vein. Following tumor excision, the renal vein was reconstructed, with its caliber reduced by less than 20%. Postoperatively, blood pressure was stabilized with inotropes during the initial 48 hours.

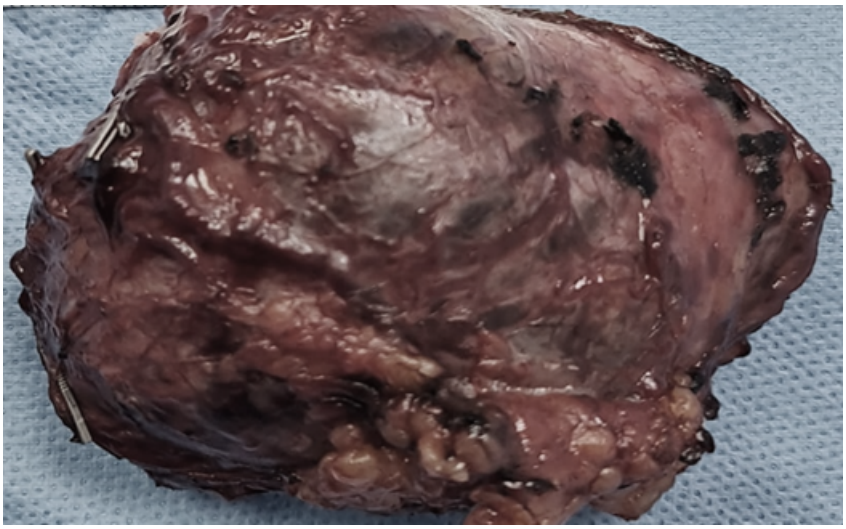

Figure 3: The mass resected and separated in this case

Discussion

Pheochromocytomas are adrenal tumors that originate from neural crest–derived germ cells, whereas retroperitoneal paragangliomas arise from specialized neural crest cells distributed along the aorta and connected to the sympathetic chain (8). These tumors are most often diagnosed in individuals between the ages of 30 and 40, with a higher prevalence in males (9). Their estimated incidence in the general population is approximately 1 per 100,000 person-years, but among hypertensive patients, the prevalence rises to 0.1% (10). Common extra-adrenal sites include the organ of Zuckerkandl, retroperitoneum, urinary bladder, and heart, although they can occur anywhere from the skull base to the bladder (11).

When symptoms of excess catecholamine are present, paragangliomas may be detected earlier (12). The Grading System for Adrenal Pheochromocytoma and Paraganglioma (GAPP), which incorporates histological pattern, cellularity, comedo-type necrosis, capsular or vascular invasion, Ki-67 proliferation index, and catecholamine type, suggests that 10–30% of paragangliomas carry malignant potential (13,14). Nevertheless, distant metastasis remains the only definitive marker of malignancy (15).

Most retroperitoneal paragangliomas arise in the para-aortic region. The importance of preoperative contrast-enhanced three-dimensional CT imaging to define the relationship of these tumors to major vessels. In the present case, follow-up CT scans were obtained after the initial diagnosis to monitor tumor progression and refine surgical planning (8). The lesion was identified posterior to the inferior vena cava (IVC) and the left renal vein, consistent with preoperative imaging assessments. Although comprehensive preoperative evaluation and surgical planning are crucial, unexpected intraoperative findings may necessitate technically demanding approaches to achieve

complete resection (9,14).

Experimental studies examining ischemia–reperfusion injury caused by temporary occlusion of the renal pedicle, arteries, or veins indicate that venous obstruction produces the most severe injury (12,13). This is thought to result from sustained arterial inflow against venous outflow obstruction, leading to microvascular damage and interstitial hemorrhagic congestion (4,10). To minimize this risk during resection, we employed periodic declamping of the renal vein-releasing the clamp every 5 minutes over a 40-minute resection period to alleviate venous congestion.

Differentiating renal paragangliomas from primary renal tumors or hilar lesions is challenging, as conventional modalities such as CT, MRI, MIBG scanning, and angiography often fail to localize the tumor origin precisely. Radioisotope imaging can be particularly useful when biochemical and clinical evidence suggests catecholamine secretion, but cross-sectional imaging is inconclusive (16).

Surgical management poses additional challenges because tumor manipulation may trigger catecholamine surges. For this reason, laparoscopic approaches remain controversial, especially in larger or anatomically complex cases (17). While open surgical excision is considered the standard, laparoscopic resection may be feasible in carefully selected small lesions at favorable sites, with advantages including faster recovery and comparable recurrence rates (4,18). Despite the malignant potential of 10–30% of these tumors, complete surgical excision remains curative for most patients (19).

Because the mass was inseparable from the pancreas, a transperitoneal approach with midline incision was adopted, enabling successful separation of the pancreatic body and control of collateral vessels. As reported in previous cases of renal hilar paragangliomas, surgical management may require nephrectomy in some instances (10,22–24), whereas in others, including our case tumor excision alone was sufficient (25,26). During surgery, the tumor's venous drainage became evident upon partial clamping of the renal vein, underscoring the importance of intraoperative hemodynamic monitoring. Postoperatively, inotropes were required to stabilize blood pressure, consistent with previous reports.

This case highlights the importance of integrating preoperative optimization, intraoperative vigilance, and postoperative monitoring into a multidisciplinary framework.

Conclusion

Retroperitoneal paragangliomas remain diagnostically and surgically challenging due to their rarity, variable presentation, and proximity to major vascular structures. Accurate preoperative imaging and biochemical evaluation are essential for identifying functional tumors and guiding surgical planning. Intraoperative management requires meticulous technique to minimize ischemia–reperfusion injury and to control hemodynamic instability triggered by catecholamine release. As demonstrated in this case, adopting a multidisciplinary approach that integrates endocrinologic optimization, precise surgical execution, and vigilant anesthetic support is critical for successful outcomes. Ultimately, complete surgical excision remains the cornerstone of treatment, offering both symptomatic relief and curative potential even in complex cases involving the renal vasculature.

Recommendations

Many studies and case control investigations must be performed to find the main criteria and surgical limitations of left renal vein reconstruction and how the surgeries can be optimized with minimal risk of bleeding and infections.

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