

Case Report

Unrecognized horseshoe kidney precipitating a severe renal pelvis injury during routine laparoscopic cholecystectomy: a case report

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ABSTRACT

Horseshoe kidney (HSK) is a common congenital fusion anomaly characterized by lower renal positioning, malrotation, and aberrant ventrally displaced collecting systems. Iatrogenic urinary tract trauma during laparoscopic cholecystectomy is exceedingly rare, but distorted retroperitoneal anatomy can predispose patients to inadvertent injury. A 25-year-old female presented on postoperative day 10 following an uneventful laparoscopic cholecystectomy with worsening lower abdominal pain, gross hematuria with blood clots, and an acute hemoglobin drop from 14.0 g/dl to 8.0 g/dl requiring two units of packed red blood cells. Immediate postoperative hematuria had been initially confounded with ongoing menses. Multiphase computed tomography (CT) urography and intraoperative fluoroscopy revealed an unsuspected horseshoe kidney with a grade IV renal injury and active urinary extravasation originating from the right moiety. The patient was managed conservatively with retrograde double-J ureteral stenting, bed rest, and close clinical observation. Hemostasis and resolution of the extravasation were achieved without requiring open or minimally invasive surgical re-exploration. The stent was subsequently removed with complete clinical recovery. Postoperative gross hematuria following routine laparoscopic procedures demands prompt evaluation to exclude retroperitoneal injury. Even high-grade urinary extravasation secondary to congenital fusion anomalies can be managed successfully with timely endoscopic retrograde stenting and conservative monitoring.

Keywords: Horseshoe kidney, Iatrogenic renal injury, Laparoscopic cholecystectomy, Hematuria

INTRODUCTION

Horseshoe kidney is one of the most common congenital renal anomalies, occurring in almost 1 out of 500 live births, with males being diagnosed with it twice as often as females.^{1,2} The fused kidneys are usually in a lower position compared with normal kidneys, in addition to being malrotated and having complex vascular anatomy.³ Usually, this disease increases the risk of multiple renal complications, including ureteropelvic junction obstruction, nephrolithiasis, and urinary tract infections.⁴

Even though in a horseshoe kidney, each ureter drains its corresponding renal moiety.⁵ The ureters usually follow an abnormal course through their descent due to the characteristic anatomical features of a horseshoe kidney.³

Laparoscopic cholecystectomy have revolutionized the management of biliary disease; the adoption of the laparoscopic approach was driven by the lower postoperative pain and discomfort, and faster recovery.⁷ Laparoscopic cholecystectomy surgeries have a risk of causing injuries to internal structures, including the common bile ducts and large blood vessels.^{8,9} In a retrospective analysis of 740 patients, the most common complications were iatrogenic perforations of the gallbladder, bleeding from the tissues adjacent to the gallbladder which were present in 5.27% and 2.83% of patients, respectively.¹⁰

Iatrogenic urinary tract injuries during laparoscopic cholecystectomy are exceedingly rare but can be precipitated by congenital anatomical variations. We present a unique case of a delayed-presentation grade IV

renal injury in a patient with an unsuspected horseshoe kidney anomaly. The objective of this case report is to raise awareness among general surgeons regarding the altered retroperitoneal spatial relationships inherent to fusion anomalies, underscore the necessity of prompt cross-sectional or fluoroscopic imaging when postoperative gross hematuria occurs, and illustrate that even high-grade extravasation can be successfully managed endoscopically without the need for minimal invasive surgery.

CASE REPORT

A 25-year-old female patient presented to an emergency department complaining of lower abdominal pain and gross hematuria with clots for the past few days. Her surgical history was significant for a laparoscopic sleeve gastrectomy performed six months ago and a laparoscopic cholecystectomy performed 10 days prior to her current presentation. According to the primary attending surgeon who performed the surgery, no intraoperative complications were encountered. The intraoperative course was uneventful, and the patient’s immediate postoperative recovery was stable without any concerning clinical findings or abnormal postoperative events apart from gross hematuria that the patient and her primary physician misinterpreted as menses.

On post-operative day (POD) 0 following her cholecystectomy, the patient reported a blood-stained urine. However, she wasn’t concerned about it since she was already menstruating. She also has experienced mild lower abdominal pain, which was attributed to post-surgical discomfort. She was deemed stable and subsequently discharged home.

In the outpatient setting, the patient's hematuria persisted. By POD 10, her lower abdominal pain became severe, and she began passing blood clots in her urine, prompting her to seek emergent medical care.

Upon arrival at the emergency department, her vital signs were stable. Her haemoglobin has dropped from 14.0 g/dl to 8.0 g/dl, necessitating a 2-unit transfusion of packed red blood cells.

Given the presentation of severe pain and gross hematuria with clots a multiphase CT of the abdomen and pelvis with delayed-phase urography was performed, which revealed an active urinary extravasation. Patient was taken to the OR, intraoperative fluoroscopy (Figure 1) was performed, which demonstrated a grade IV renal injury with active extravasation of urine originating from the right moiety. The imaging incidentally revealed a previously undiagnosed (missed) horseshoe kidney anomaly.

Following the diagnosis of a grade IV renal injury renal injury with associated urinary extravasation. A retrograde ureteral stent was successfully placed to facilitate proper urinary drainage. Alongside stent placement, the patient was managed conservatively with strict bed rest and close clinical observation. Serial packed cell volume measurements were monitored to ensure hemodynamic stability and rule out active retroperitoneal hemorrhage. The patient remained clinically stable without extravasation throughout the observation period, after which the DJ was removed and the patient is clinically stable.

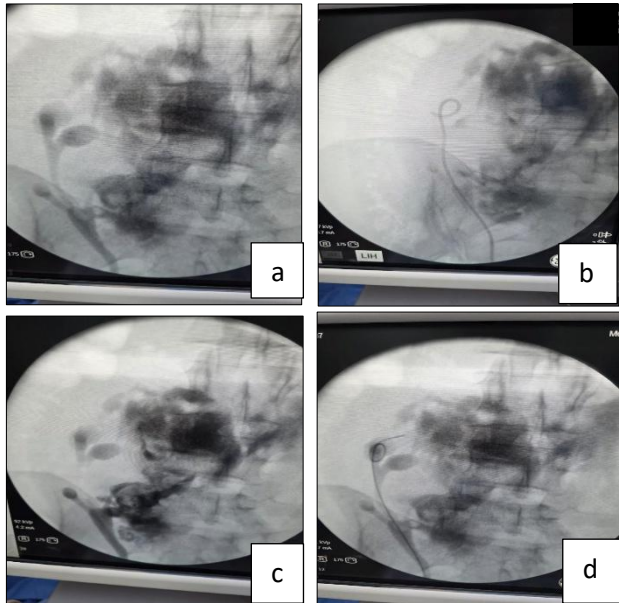


Figure 1 (a-d): Intraoperative fluoroscopy showing grade IV renal injury and extravasation of urine.

Table 1: A summary of articles reported renal injuries among patients with horseshoe kidney.

Author (year)	Surgery type and patient	Key anatomical hazards identified	Prevention /surgical navigation strategy	Surgical outcome
Kojima et al (2023) ²⁴	Laparoscopic sigmoid colectomy with D3	Left ureter passed anteriorly across the	Preoperative 3D-CT angiography	Safe completion of surgery with real-time

Continued.

Author (year)	Surgery type and patient	Key anatomical hazards identified	Prevention /surgical navigation strategy	Surgical outcome
	lymph node dissection in a 60-year-old male with sigmoid colon cancer	front of the renal isthmus; aberrant renal arteries arising from the aorta and right common iliac artery	combined with placement of a fluorescent near-infrared (NIR) ureteral catheter (IRIS system) before surgery	identification of the left ureter under near-infrared light; no ureteral injury occurred. Operative time 214 min, blood loss 25 mL, discharged on postoperative day 7 without complications.
Yoshizawa et al (2021)²³	Laparoscopic abdominal perineal resection (APR) with D3 lymph node dissection in an adult female with advanced lower rectal adenocarcinoma	Left ureter ran directly in front of the isthmus (with calculus formation); aberrant excess renal artery supplying the isthmus arising from the aorta above the isthmus	Preoperative 3D-CT angiography for detailed mapping of vascular and ureteral anatomy	Clear dissection plane identified between mesentery and isthmus; left ureter, gonadal vessels, and hypogastric plexus preserved on the anterior surface of the isthmus. Surgery completed safely with no ureteral injury. Operative time 338 min, estimated blood loss 200 mL, no complications.
Shoji et al (2024)²⁵	Robot-assisted laparoscopic low anterior resection (LAR) with D3 dissection and ileostomy in an adult patient with rectal cancer	Left ureter and seminal vessels ran anterior to the kidney; hypogastric nerve traveled ventral to the horseshoe kidney; isthmus elevated and surrounding the inferior mesenteric artery	Preoperative contrast-enhanced CT for anatomical mapping combined with robotic three-dimensional visualization and articulated instruments	Precise intraoperative identification and protection of the ureter and nerves around the elevated isthmus. Surgery completed safely with no ureteral injury.
Kubo et al (2018)²²	Laparoscopic high anterior resection (52yo male with rectosigmoid cancer)	Inferior mesenteric artery (IMA), left ureter, left gonadal vessels, and hypogastric nerve plexus all tightly bundled and passing over the anterior HSK isthmus.	High-resolution preoperative 3D-CT angiography used to map the precise coordinates of the aberrant isthmus-crossing vasculature prior to dissection.	All anomalous structures successfully mapped and preserved; iatrogenic injury completely avoided.
Zhou and Chen (2019)²⁶	Laparoscopic radical hysterectomy and lymphadenectomy (42yo female with cervical cancer)	Extended dissection zone from left renal vein to iliac artery region; highly variable anterior ureteral pathways overlapping pelvic, presacral, and para-aortic lymph node fields.	Meticulous, slow-step retroperitoneal dissection using advanced multi-slice CT mapping to trace the anomalous ventral ureters.	Unpredictable surgical risks safely navigated; serious vascular and ureteric complications avoided.
De Caridi et al (2015)²⁷	Open infrarenal abdominal aortic aneurysm (AAA) repair (male patient with HSK and AAA)	Large aneurysm directly beneath the HSK isthmus; accessory renal arteries originating directly from the aneurysmal wall and common iliac arteries.	Utilization of a left retroperitoneal approach on the retro-renal space rather than a standard transperitoneal approach.	Avoided isthmus resection entirely, successfully preventing urinary tract (ureteral) disruption and renal tissue infarction.

DISCUSSION

HSK is the most common fusion malformation of the kidneys occurring in approximately 1 in 400-500 individuals.² During gestation the inferior portions of the metanephric blastema fuse forming an isthmus, usually in the lower renal pole, and anterior to both the aorta and inferior vena cava. This abnormal anatomy and positioning lead to abnormal vascularization and urologic complications including hydronephrosis, renal stones and increased risk for malignancy especially for Wilms tumor.¹³

Aside from these complications, HSK can present with intraoperative challenges and complications during both urologic and non-urologic procedures. That complication can be attributed to three key features. First, the abnormal lower positioning of the kidneys as they are typically located at the L3-L4 rather than T12-L3. Vascular anomalies, with variable and complex arterial systems arising from the aorta below the isthmus, common iliac arteries that may cross the ureters. Lastly, Malrotation is the third challenging feature as both renal pelvis and ureters are positioned anteriorly rather than medially, with ureters crossing over the isthmus or lower poles.^{2,13} This constellation of features increases the risk of direct injury, especially with the anterior positioning of the collecting systems and aberrant ureteral course making these structures more vulnerable during abdominal and pelvic surgeries.

Iatrogenic renal injury is a serious complication that can lead to intra-abdominal sepsis, renal failure and loss of ipsilateral renal unit.¹⁴ Most renal injuries are iatrogenic and they present postoperatively as they largely remain undiagnosed intraoperatively. The incidence of such injuries has increased with the increased implementation of laparoscopic and robotic techniques within surgical specialties, especially with the increased usage of ureteroscopy in Urology. Common causes include gynecologic procedures, colorectal surgery, and ureteroscopic stone surgery, with varying mechanisms for injuries such as laceration, crush injury thermal injury or ligation.¹⁵ The rate of diagnosis intraoperatively can be as low as 21% as reported in some series.¹⁶

CT urography with both nephrographic and excretory phases remains the gold standard for suspected ureteral injuries, although retrograde pyelography, ureteroscopy, and intravenous urography can also be implemented.¹⁴

Management of renal injuries depends on multiple factors. These include the type, location and grade of the lesion, the timing of the diagnosis and the patient's condition. Initially those injuries are managed by placing renal stents or through percutaneous nephrostomy drainage, surgical reconstruction may be reserved or rather optimal in selected patients.¹⁴ Principles that help guide a proper reconstruction include good vascular supply, adequate

drainage, and a wide spatulated tension-free mucosa-to-mucosa anastomosis.¹⁵

In patients with HSK the risk of iatrogenic renal injury is significantly elevated due to the aforementioned abnormal characteristics of anatomy, position, rotation and vasculature.^{2,13} Careful attention to the anatomy, vasculature and draining from renal pelvis during operations is essential to assure good postoperative results in patients with horseshoe kidney. Despite this well-described anatomical risk, a systematic search of the indexed literature (PubMed/PMC, Springer, and related databases) identified no published case reports or series documenting actual iatrogenic ureteral injury in patients with horseshoe kidney. Literature rather focused on the recognition of the risk and descriptions of successful preventive strategies.

Prevention of iatrogenic ureteral injury consists of both primary and secondary prevention strategies.¹⁷ Primary prevention aims to avoid injury through accurate ureteral identification, while secondary strategies focus on early intraoperative diagnosis of the injury to permit immediate repair. Multiple modalities have been implemented to prevent ureteral injury in surgeries in general, these include intraoperative cystoscopy which is typically performed after intravenous administration of dyes such as indigo carmine or methylene blue allowing direct visualization of ureteral efflux and has been shown to detect 88-100% of injuries when used routinely.¹⁸ Prophylactic ureteral stenting is also used before the primary procedure as it can help facilitate the identification and localization of the ureters, particularly in the presence of distorted anatomy, while also enabling detection of full-thickness injuries.^{19,20} Another prevention strategy is lighted ureteral stents which further enhances visual identification by appearing as illuminated structures within the operative field.²¹ Special considerations are reserved for minimally invasive and robotic-assisted surgery, where tactile feedback is absent. Prevention mainly emphasizes on techniques that improve visual delineation of the ureters. Intraureteral injection of indocyanine green (ICG) with subsequent visualization under near-infrared fluorescence also represents a promising approach that supports both primary identification and secondary detection of ureteral injuries.¹⁷

In the context of iatrogenic renal injury in HSK patients, literature demonstrates that preventing iatrogenic ureteral injury during complex abdominal and pelvic surgeries requires a combination of advanced preoperative vascular mapping, intraoperative optical navigation, and precise surgical entries. Preoperative three-dimensional computed tomography (3D-CT) angiography stands out as the standard diagnostic tool across multiple fields. For instance, Kubo et al utilized high-resolution 3D-CT angiography prior to a laparoscopic high anterior resection to plot the exact structural coordinates of a tightly bundled group consisting of the inferior mesenteric artery, left ureter, and hypogastric plexus that crossed directly over

the anterior aspect of the renal isthmus, which allowed the surgical team to perform a targeted, non-disruptive mesenterial mobilization.²² Similarly, Yoshizawa et al relied on 3D-CT angiography during a laparoscopic abdominal perineal rectal resection to establish a clean dissection plane between the mesentery and the underlying abnormal parenchyma, successfully isolating and protecting a ventral left ureter complicated by calculus formation, as well as the adjacent hypogastric plexus and gonadal vessels.²³ To increase intraoperative awareness beyond simple imaging, modern approaches frequently merge these 3D reconstructions with real-time tracking modalities. Kojima et al combined preoperative 3D-CT mapping with the placement of an intraoperative near-infrared fluorescent ureteral catheter (using the IRIS system) during a laparoscopic sigmoid colectomy.²⁴ This technique illuminated the left ureter as it crossed the ventral face of the isthmus, enabling real-time optical identification and safe retroperitoneal mobilization.

Expanding on this technological integration, Shoji et al paired contrast-enhanced CT with a robotic platform during a low anterior resection, using the robotic system's high-magnification 3D optics and used instrumentation to carefully separate and protect the left ureter, seminal vessels, and hypogastric nerves as they coursed ventral to an elevated isthmus wrapped around the inferior mesenteric artery.²⁵ In extensive gynecologic oncology procedures, Zhou and Chen implemented multi-slice CT mapping to trace highly variable ventral ureteral pathways before executing a laparoscopic radical hysterectomy, subsequently relying on a slow-step retroperitoneal dissection method to clear the broad pelvic, presacral, and para-aortic lymph node fields without disrupting the urinary tract.²⁶ Beyond colon and pelvic resections, specialized approaches are applied in open vascular and reconstructive urological procedures. De Caridi et al managed the anatomic constraints of an open infrarenal abdominal aortic aneurysm repair by abandoning the standard transperitoneal route in favor of an open left retroperitoneal surgical approach targeting the retro-renal space.²⁷ By accessing the aneurysm from behind the kidney, they bypassed the anteriorly situated horseshoe kidney isthmus entirely, completely eliminating the need for an isthmusectomy and eliminating the risk of mechanical ureteral disruption or renal tissue infarction.

CONCLUSION

Postoperative gross hematuria after laparoscopic cholecystectomy warrants prompt cross-sectional imaging. Surgeons should be aware of the altered anatomy of horseshoe kidney. Even grade iv injury with urinary extravasation can be managed successfully with retrograde stenting and conservative monitoring.

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