Original Article

Laparoscopic heminephrectomy in horseshoe kidneys: A single center experience

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Abstract

Introduction: Laparoscopic approach in horseshoe kidney (HSK) is a challenge because of the aberrant vessels, the renal isthmus and the renal ectopia are all unique features of this anomaly encountered during the surgery. We report our single center experience with this technique in managing three patients with HSK.

Methods: A total of 15 cases (9 males and 6 females) were operated between June 2011 and December 2016 for various indications. Of these four patients were managed laparoscopically, two patients with HSK had non-functioning renal moiety underwent transperitoneal heminephrectomy. The third patient with a mass in right moiety with thin fibrous isthmus was successfully managed with laparoscopic heminephrectomy. Fourth patient with pelvi-ureteric junction obstruction with multiple renal calculi was managed with pyeloplasty and complete clearance of all calyceal the stones.

Result: Mean operating time was 140 ± 1.8 (100–180) min, and estimated blood loss was 131 ± 12.6 (30–320) ml. The mean hospital stay was 2.3 ± 1.4 (1–5) days. There were no major intra- and post-operative complications except minimal postoperative discomfort.

Conclusion: Laparoscopic nephrectomy is technically feasible, safe, and reliable for benign and malignant diseases in a HK with mainly three factors posing challenges during the surgery are the abnormal vasculature, division of the isthmus, and lower location of the kidney.

Keywords: Aberrant vessels, horseshoe kidney, laparoscopic

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Received: 29.07.2017, **Accepted:** 04.09.2017

INTRODUCTION

The laparoscopy has revolutionized the minimally invasive management of benign and malignant renal disease since its description of first laparoscopic nephrectomy by Clayman *et al.* two decades ago.[1] Horseshoe kidneys (HSK) anomaly presents a challenge secondary to its anatomic position, association with aberrant vessels, and in dealing isthmus during heminephrectomy. We report our laparoscopic experience in managing three patients with HSK for benign and malignant diseases. We have also reviewed in detail vascular anatomy of HSK and different techniques of laparoscopic heminephrectomy in HSK.

Access this article online	
Quick Response Code:	Website: www.urologyannals.com
	DOI: 10.4103/UA.UA_114_17

MATERIALS AND METHODS

Between June 2011 and December 2016, 15 patients (9 males and 6 females) with HSK anomaly were retrospectively reviewed. Of these 4 patients underwent

How to cite this article: Agrawal S, Kalathia J, Chipde SS, Mishra U, Tyagi A, Parashar S. Laparoscopic heminephrectomy in horseshoe kidneys: A single center experience. Urol Ann 2017;9:357-61.

heminephrectomy (three by laparoscopy and one by open approach) and one patient underwent laparoscopic pyeloplasty with stone retrieval. Remaining 10 patients were operated for percutaneous nephrolithotomy for renal stone. We have already reported our first case as a case report in June 2014 following which we have operated 4 more cases. The included 3 patient's major presenting symptoms were recurrent back pain and urinary tract infection. Patients were preoperatively evaluated with intravenous urography, computed tomography angiography (CTA) and isotope renogram. None of the patients had previous abdominal surgery. All these three cases of laparoscopic heminephrectomy (2 females and one male) were operated through the transperitoneal approach.

Case 1

A 20-year-old unmarried female patient presented with pain on the right side of abdomen for the past 3 months. The abdominal examination revealed lump in the right lumbar area. Ultrasonography (USG) revealed grossly hydronephrotic right kidney with thinned out parenchyma. The computed tomography (CT) scan confirmed the HSK with hydronephrotic right moiety with papery thin parenchyma and normal left kidney joined by isthmus. The diethylene triamine pentaacetic acid (DTPA) scan confirmed nonvisualized right kidney and normally functioning left kidney. The patient underwent laparoscopic right heminephrectomy using three ports in a 70° left lateral position. The camera port (10 mm) was placed at umbilicus followed by one 5 mm port below right costal margin in mid-clavicular line and other 10 mm port in right iliac fossa. Entire right colon was mobilized and duodenum was kocherized and reflected medially. Upper pole of the kidney was dissected first, which revealed atretic small caliber renal artery and vein entering into upper pole. These vessels were dealt with 10 mm Ligasure™. The hydronephrotic sac was evacuated with the help of Veress needle to ease the handling of the sac. After emptying the sac clear demarcation could be appreciated between hydronephrotic sac and fleshy parenchymatous isthmus. The isthmus was isolated and cut with 10 mm Ligasure™ keeping the line of division toward the hydronephrotic sac [Figure 1]. There was no major blood supply entering the hydronephrotic part of isthmus and lower pole; therefore, all the dissection could be carried out with Ligasure™. The total operating time was 180 min and estimated blood loss was 50 ml and discharged on the postoperative day 4.

Case 2

A 54-year-old female patient was admitted with a history of flank pain for the past 3 months. Pain was dull in nature and was not associated with vomiting, hematuria, or fever.

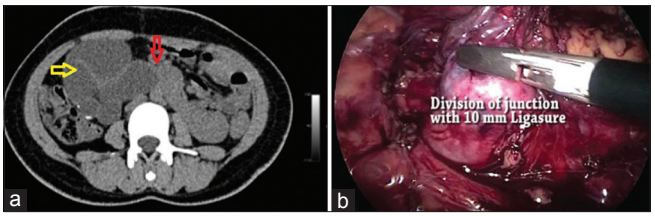

Figure 1: (a) Computed tomography scan showing junction between hydronephrotic right moiety (yellow arrow) and normal isthmus (red arrow). (b) Division of junction by 10 mm Ligasure™

Routine blood investigations and serum creatinine were normal. USG of the abdomen revealed a mass arising from the right moiety of the HSK. The contrast-enhanced computed tomography (CECT) confirmed the mass of size 5 cm × 6 cm arising from the right middle pole with abnormal vascular supply to it. CTA reconstruction clearly delineated vascular anatomy [Figure 2]. CT demonstrated thin nonparenchymal isthmus tissue connecting the two lower poles.

The patient underwent transperitoneal right laparoscopic radical heminephrectomy with removal of the right moiety. One 10 mm camera port, one 10 mm, and two 5 mm working port were put. After reflecting the colon, renal artery was dissected and all the branches were clipped separately as the main stem of renal artery was behind inferior venecava (IVC). There was single renal vein which was clipped with 10 mm hem-o-lock clip®. Then, the upper pole was dissected and lifted off the IVC. Same plane of dissection continued inferiorly reaching up to isthmus. Isthmus was thin and fibrous as seen in CT scan, which was clipped with two hem-o-lock clips. Kidney was bagged and removed though Pffannestiel incision. Total operating time was 165 min and blood loss was 50 ml. The patient had uneventful recovery and was discharged on the 3rd postoperative day.

Case 3

A 24-year-old male presented with a history of severe flank pain and high-grade fever for the past 15 days. On evaluation, he was found to have HSK with gross hydronephrosis with papery thin parenchyma. CECT was done to delineate proper anatomy, which confirmed HSK and revealed poorly functioning right renal moiety with gross hydronephrosis, thinned out renal parenchyma, [Figure 3]. DTPA renal scan showed nonvisualized right kidney. Right laparoscopic heminephrectomy was performed by transperitoneal approach. The port position was same as in the 2nd case. Vessels were dealt with hem-o-lock® clips and dissection was done from upper pole to lower pole. Isthmus was handled with monopolar hook cautery cutting slightly toward hydronephrotic

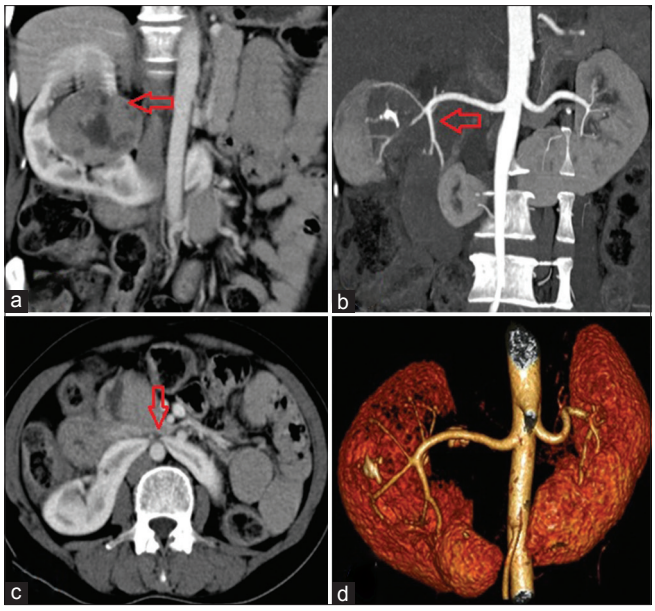

Figure 2: (a) Mass in the right moiety of horseshoe kidney. (b) Nonparenchymatous fibrous isthmus. (c) Abnormal vascular supply. (d) Three-dimensional reconstruction of horseshoe kidney

side so that avoiding the parenchymal part. Specimen of kidney was removed through pfannenstiel incision. Total operating time was 210 min and blood loss was 150 ml. The patient had uneventful recovery and was discharged on the 4th postoperative day.

RESULTS

The mean age of the patients was 45.8 ± 4.6 (range; 28–77) years. Two patients presented with a history of flank pain and one female patient with renal mass presented with gross hematuria.

Mean operating time was 140 ± 1.8 (100–180) min, and mean estimated blood loss was 131 ± 12.6 (30–320) ml. The mean hospital stay was 2.3 ± 1.4 (1–5) days. Isthmus was divided with the help of Ligasure 10 and electrocautery in 2 patients with non-functioning kidney. Hem-o-lock clip 15 mm was used to divide isthmus in the renal mass patient. The etiologic factors were urolithiasis (n = 2) and renal mass (n = 1). Histopathological examination of the specimens revealed chronic pyelonephritis in the 1st case, xanthogranulomatous pyelonephritis in case 3rd and pT1 clear cell renal cell carcinoma Fuhrman grade 2 in the 2nd case. None of the patients had any major intra- or post-operative complications.

DISCUSSION

With advent of minimally invasive surgery, patients' demand for laparoscopic surgery has been steadily increasing. First

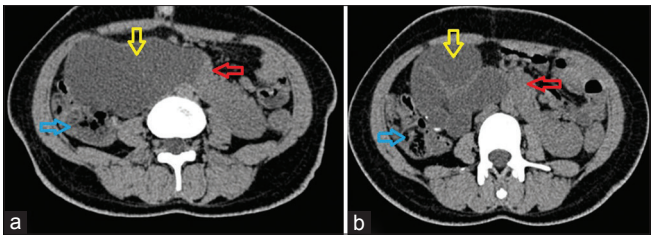

Figure 3: (a and b) Yellow arrow showing horseshoe kidney with right gross hydronephrosis with papery thin parenchyma, blue arrow showing right retro colon, and red arrow showing isthmus

laparoscopic heminephrectomy was reported by Riedl *et al.* from Austria.[2] They operated on a 24-year-old male patient for left nephrectomy which took 8 h and patient was discharged after 3 days. In 2011, Khan *et al.* reviewed all the cases of laparoscopic heminephrectomy from 1995 to 2010. They found 23 case report comprising of 27 patients.[3] After that, many more cases have been reported which mostly includes single patient report for diverse indication. Longest series till date is from Turkey where 13 cases of laparoscopic heminephrectomies done in 5 different centers were reported. This shows that acceptance of laparoscopic approach and indication for laparoscopic nephrectomy is expanding.[4]

Achilles heel of laparoscopic heminephrectomy in HSK is division of isthmus and vascular anomalies. These two things are the main hindrance for laparoscopic approach. Proper delineation of anatomy and pre-operative planning to deal with isthmus and vessels can ease the procedure.

Vascular anatomy of horse shoe kidney

Arterial supply and venous drainage in HSK is very variable. Kidney may receive aberrant renal artery from many sources and may have multiple renal veins. Apart from aorta, second most common site of origin of aberrant renal artery is common iliac artery (CIA). Right moiety has more chances of getting aberrant vessel from CIA than left. In a fantastic review by Glodny *et al.*, of 185 cases of HSK, aberrant vessel came from CIA in 39.8% of cases, internal iliac artery in 1.94% of cases, external iliac artery in 0.97% of cases, lumbar artery 2.9%, median sacral artery 2.9%, and phrenic artery in 0.97% of cases. They found out that average number of renal artery on the right and left were 2.4 and 2, respectively.[5]

HSK patients may have multiple renal vein also and their drainage pattern can also vary. Average number of vein on the right and left were 2.4 and 1.8, respectively, in Glodny's study. Apart from IVC, it sometimes drains into common iliac vein. Looking at the above details, any generalization or classification is not possible about HSK vasculature.

However, Glodny *et al*. made some important observation which may be helpful to surgeon in case one does not have angiography beforehand. In patients having multiple renal artery and vein, cranial renal arteries and vein on both sides show hardly any variations.[5] However, second artery on the right side is precaval and second vein on left side is retro aortic more often. The isthmus may receive blood supply from main renal artery or it may own blood supply directly from aorta in 65% of cases above or below the isthmus.[3]

With so much variation, exact knowledge of vasculature is imperative to intraoperative surprises and mishap. Three-dimensional CTA is excellent tool to detect renal vascular anomaly.[6] It is better than magnetic resonance imaging (MRI) and angiography as MRI/angiography underestimate the number of arteries and veins. Glodny *et al*. advised CT angiography covering the entire region from T11 to S5 as renal artery may come from as high from phrenic artery and below from internal iliac or median sacral artery.[5]

Managing vessels during nephrectomy

After reflecting the colon on either side one may approach the kidney in two ways. One can both tackle the vessels first and then divide the isthmus or isthmus may be cut first lifting the lower pole of kidney and then sequentially clipping the vessels later. We have done all our case by dividing the vessels first and freeing the kidney all around. Division of isthmus becomes easier this way.

Port position during transperitoneal procedure

There is certain variation in laparoscopic approaches for HSK. The transperitoneal approach has been advocated for laparoscopic radical heminephrectomy and partial nephrectomy for malignant diseases in patients with HSK.[7,8] However, Lee *et al*. have suggested retroperitoneal approach for laparoscopic partial nephrectomy in a HK for posterior and posterolateral lesions.[9] Researches have reported transperitoneal as well as retroperitoneoscopic approaches for this, but transperitoneal route remains the popular one because of large working space and more familiarity with this approach.

As compared to normally positioned kidney, HSK is little more caudally located. Therefore, initial port (camera port) position is little lower as compared to standard laparoscopic nephrectomy. All other working ports are put in similar fashion in relation to camera port. Additional working port may be required sometime to retract liver.

Managing isthmus during nephrectomy

Isthmus is part of kidney where two moieties fuse with each other at lower pole. In contrast CT, fusion site is defined as the place where two halves of kidney are connected by a layer of renal cortex.[5] HSKs are mainly two types; with midline fusion and with lateral fusion. It is very important to identify this site externally to prevent damage the other kidney calyx and for good hemostasis. This may be easy when isthmus is only formed with band of connective tissue which may in 4.5%–20% of cases.[5,10] However, in majority of the cases have parenchymatous isthmus with renal cortex and may have medially directed calyx from either side. Thin fibrous isthmus can be dealt easily with hem-o-lock clip or vessel sealer as in our 2nd case. Dealing thick parenchymatous isthmus is difficult as it can bleed heavily or opposite kidney calyx can be injured.

Managing isthmus in cases of hydronephrotic non-functioning kidney is technically easier than in cases of renal mass. Clear cut zone of demarcation can be appreciated between normal parenchyma and hydronephrotic sac. This can be used as land mark for identifying the site of division of isthmus. It can easily be cut, little bit erring toward hydronephrotic side. We have used 10 mm Ligasure and monopolar hook cautery for this. Little remnant epithelium can be burned with monopolar cautery. This maneuver saves time and achieves perfect hemostasis.

Identification of the exact location of fusion becomes very important in patients with parenchymatous isthmus which happens in majority of cases. Narrowest part is usually considered as isthmus. However, it is not a rule. Glodny *et al*. in their radiological review found that in almost 41% of cases isthmus did not correspond to fusion site.[5] CT scan can give us an idea about site and laterality of fusion. Demarcation between devascularized parenchyma and normal kidney can be another clue to identify the isthmus.

Various energy sources and devices have been described to divide the isthmus and achieve the hemostasis. The most common device used is endostapler followed by bipolar coagulation, ultrasonic scalpel, microwave coagulation, argon beam fulguration, hem-o-lock clip, Ligasure, parenchymal suturing, etc. In very thick isthmus stapler application may not be possible and bipolar coagulation may not be adequate. In these cases, intracorporeal suturing of edges becomes essential to achieve complete hemostasis. Other technique is to exteriorize the isthmus through small incision, put a Satinsky clamp and then run over suture the parenchymal edges. Specimen can be taken out thought the same incision. Tuncel *et al*. in their largest series of 13 cases used Endo GIA stapler in 5 patients, ultrasonic scalpel in 3, hem-o-lock® clip in 3, vessel sealing system in 1 and endoscopic suture with 0 polyglactin in one patient. Out of 13 patients, 12 were non-functioning kidney and only one had renal mass.[4]

Entry to opposite calyx should be avoided at any cost. Ureteric catheter can be put in opposite moiety and push methylene blue dye to detect inadvertent calyceal entry. It can be sutured intracorporeally if identified.

CONCLUSION

Laparoscopic management of benign or malignant conditions of HSK is technically feasible, safe and effective with excellent outcome.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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