Laparoscopic Heminephrectomy of a Horseshoe Kidney

Atif Khan, MRCS, Andrew Myatt, MBChB, FRCSEd(Urol), PhD, Victor Palit, MS, FRCS(Urol), Chandra Shekhar Biyani, MS, D. Urol, FRCSGlas(Urol), FEBU

ABSTRACT

Minimally invasive surgery has revolutionized surgery for urologic disorders, and laparoscopic procedures have become widely available for several different ablative and reconstructive operations. Laparoscopic heminephrectomy in patients with horseshoe kidney can be a technically challenging procedure due to aberrant vessels, functional parenchyma in the isthmus, and abnormal location. We report the management of a case of symptomatic nonfunctioning left moiety of a horseshoe kidney with emphasis on its surgical technique combined with a review of the literature. Laparoscopic heminephrectomy is a feasible option in the surgical management of benign and malignant conditions of the horseshoe kidney and can be performed safely using a transperitoneal or a retroperitoneal approach.

Key Words: Horseshoe kidney, Laparoscopic, Nephrectomy.

INTRODUCTION

It has been nearly 2 decades since the first description of a laparoscopic nephrectomy by Clayman et al. Since then, laparoscopy has revolutionized the minimally invasive management of benign and malignant renal disease. Congenital renal anomaly may pose a technical challenge during laparoscopic nephrectomy due to complex vascular anatomy.

Horseshoe kidney, the most common fusion anomaly, occurs in up to 0.25% of the general population. Although most horseshoe kidneys are asymptomatic, calculi, pelvic ureteric junction obstruction and renal masses are most frequent findings that require surgery. Since the initial report of a laparoscopic nephrectomy, few authors have advocated the laparoscopic approach for benign and malignant conditions associated with a horseshoe kidney. We searched previous reports using the PUBMED database and the specific key words “horseshoe kidney,” “laparoscopy,” “nephrectomy,” “heminephrectomy,” and “congenital kidney anomaly.” All articles identified in the English language were reviewed, and 2 non-English reports were excluded. We describe our experience and a detailed review of the literature.

CASE REPORT

A 32-year-old male presented initially with a history of intermittent left loin pain. He was obese with a BMI of 39. He was advised to lose weight before surgery, but because pain was affecting his work and mobility, he opted to have surgery without any delay. He smoked 10 cigarettes a day and drank 15 units of alcohol per week. His blood biochemistry including urea and electrolytes was satisfactory. An abdominal examination showed mild tenderness over the left renal angle. An intravenous urogram (IVU) demonstrated a horseshoe kidney with poor excretion on the left side. He underwent a retrograde ureterogram, and ureteroscopy was attempted. It was felt he had a possible stricture at the ureteropelvic junction. A double-J stent was placed; however, it was removed 48 hours later due to stent symptoms. A CT scan showed a horseshoe kidney with a normal-functioning right moiety and hydronephrotic left moiety with a very thin cortex and no evidence of any renal tract calculus (Figure 1).
Subsequently, the patient underwent a MAG3 scan, which showed a nonfunctioning left moiety. The options of an open or laparoscopic nephrectomy were discussed, and the patient was scheduled for a transperitoneal, laparoscopic nephrectomy.

During pre-assessment, it was noted that he had symptoms suspicious of sleep apnea syndrome. His Epworth sleepiness score was 16 (>10 is abnormal). He underwent a formal sleep study and was diagnosed with sleep apnea syndrome. He was commenced on continuous positive airway pressure (CPAP) ventilation at night.

At surgery, the patient was placed in a right lateral position, and 5 ports were placed. The camera port was placed lateral to the umbilicus followed by two 5-mm ports above and below the camera port (~5cm) along the lateral border of the rectus muscle. Two 12-mm ports were in the anterior axillary line. A 10-mm (ENDO RETRACT™II, Auto Suture, Norwalk, CT).

A 5-prong fan retractor was used to facilitate blunt dissection. The colon was mobilized, and the upper pole of the kidney was dissected. Multiple vessels were clipped with a Hem-o-lock and divided. The upper pole was freed laterally and posteriorly. Gonadal vessels were identified and traced upwards. The kidney was mobilized at the lower pole. The kidney was dissected medially, and the upper part of the isthmus was identified. The ureter was identified and divided after clipping. Gonadals were identified and divided after clipping. The upper and lower poles of the kidney were lifted to visualize the isthmus. The isthmus was isolated and clipped with a 15-mm Hem-o-lock (and was divided with a Harmonic scalpel (Figure 2). A PDS Endoloop was also tied around the isthmus. The kidney was freed, bagged, and removed through the extended lower port site. A drain was placed and was removed after 24 hours. The total operating time was 180 minutes, and estimated blood loss was 200mL. The patient spent 1 night in the intensive care unit due to his sleep apnea. He subsequently recovered well and was discharged home on postoperative day 4.

The histopathology revealed chronic pyelonephritis most likely attributable to pelviureteric junction obstruction. He was symptom free at discharge from the clinic 9 months after surgery with no evidence of port-site hernia.

**DISCUSSION**

The horseshoe kidney is probably the most common of all renal fusion anomalies. In this anomaly, 2 distinct renal units...
| Ref | Age/Sex/Side | Presentation | Imaging | Pre-auxiliary | Approach | Ports | Division of Isthmus | Duration | Hospital Stay (Days) | Complications | Blood Loss |
|-----|--------------|--------------|---------|---------------|----------|-------|-------------------|----------|------------------|-------------|-----------|
| 5   | 28 M Left    | Hydronephrosis | CT      | Nephrostomy   | Trans-peritoneal | 5     | Endo-GIA          | 8 hr     | 3 days           | Nil          | 0         |
| 4   | 61 F Right   | Hydro        | CT      | Nephrostomy   | Trans-peritoneal | 4     | Under direct vision (extra corporeal) electrocautery Endo-GIA | 270 min  | 9 days           | Nil          | 270 mL    |
| 5   | 28 F Left    | Hydronephrosis | CT arteriogram | J stent Ureteric catheter | Trans-peritoneal | 4     | Endo-GIA          | 5.1 hr   | 4               | 50          |           |
| 6   | 17 M Right   | Flank pain   | USS, CT | Nephrostomy   | Trans-peritoneal | 4     | Microwave coagulator Harmonic scalpel | 8 hr     | 11 days          | Paralytic ileus Nil | 560 mL    |
| 7   | Left         | Flank pain   | USS, PU, USS, CT, DMSA, MAG 3 | Nil | Retro-peritoneal | 3     | Argon-beam laser coagulation Endo-GIA | 10 min   | 1 day            | Nil          | 10 mL     |
| 8   | 56 M Left    | Flank pain Urinary tract infection | CT | J stent | Trans-peritoneal | ?     | Endostapler       | 3 hr     | 5 days           | Nil          | 150 mL    |
| 9   | 15 month M, Left | Urinary tract infection | CT | J stent | Trans-peritoneal | ?     | Endostapler       | 5 hr     | 3 days           | Nil          | 150 mL    |
| 10  | 55 M Right   | Flank pain   | CT      | Nephrostomy   | Trans-peritoneal | 3     | Harmonic scalpel  | 300 min  | 7 days           | Sick sinus syndrome, cardiac complications | 350 mL    |
| 11  | 35 F Right   | Urinary tract infection, Recurrent stones | IVU, CT | Hand-assisted transperitoneal | Hand port, 12mm x2 | 4     | Ultrasonic scalpel | 165 min  | 4 days           | 200 mL      |
| 12  | 57 M Left    | Flank pain, Stag horn stone | USS, DTPA | Endostapler | Retro peritoneal | 4     | Bipolar energy (Gyrus) 60W coagulation Endo-GIA | 140 min  | 2 days           | 160 mL      |
| 13  | 52 M Left    | Incidental renal mass | CT, Angio graphy | Trans peritoneal | 3     | Parenchymal sutures + argon beam Endo-GIA | 195 min  | 2 days           | 600 mL      |
| 14  | 20 F Left    | Flank pain, Urinary tract infection | CT, Angio graphy | J stent | Hand-assisted transperitoneal | Hand port, 12mm x2 12mm x5 | 300 min  | 4 days           | 150 mL      |
| 15  | 65 M Bilateral | Renal failure | Dialysis | Endostapler | Retro-peritoneal | 12mm x2 | Bipolar coagulation | 280 min  | 12 days          | 290 mL      |
| 16  | 64 F Left    | Haematuria, Renal mass | CT | Trans peritoneal | 3     | Electrocautery, Digital compression | 360 min  | 4 days           | ?           |           |
| 17  | 52 M Right   | Flank pain   | USS, IVU, USS, CT, DMSA, MAG 3 | Nephrostomy | Retro peritoneal | 3     | Bipolar energy (Gyrus) 60W coagulation Endo-GIA | 140 min  | 2 days           | 160 mL      |
| 18  | 24 M Right   | Flank pain   | USS, CT, USS, CT | Isotope scan | Trans peritoneal | 3     | Bipolar energy (Gyrus) 60W coagulation Endo-GIA | 165 min  | 1 day            | 75 mL       |
| 19  | 8 F Right    | Abdominal pain | USS, CT, USS, CT, MAG 3 | Nephrostomy preoperatively | Trans peritoneal | 4     | Bipolar energy (Gyrus) 60W coagulation Endo-GIA | 102 min  | 10 days          | 50 mL       |
| 20  | 63 F Left    | Incidental mass | CT angio graphy | CT | Hand-assisted transperitoneal | Hand port, 12mm x2 | Endo-GIA | 273 min  | 2 days           | Nil          | 290 mL    |
| 21  | 18 M Left    | Hematuria following blunt trauma | CT | Trans peritoneal | 3     | Bipolar coagulation | 240 3  | Nil            | 200         |
| 19  | 19 M Right   | Flank pain   | USS, CT, DTPA | CT angio graphy | Trans peritoneal | 3     | Bipolar coagulation | 180 3  | Nil            | 200         |
| 22  | 48 F Left    | Urinary tract infection | CT angio graphy | CT | Trans peritoneal | 4     | Bipolar coagulation | 307 1  | Colonic serosal tear | 100         |
| 23  | 29 N/A       | Kidney stones | ? | Bilateral ureteric stents | Hand-assisted transperitoneal | 3     | ? | Skin separation | ?           |
| 27  | 27 N/A       | Pelvis rupture due to trauma | CT | Bilateral ureteric stents | Hand-assisted transperitoneal | 3     | ? | Urinoma. Anoeculation, neuralgia | ?           |

aNR= not reported, USS=ultrasound, CT=computed tomography, IVU=intravenous urography.
## Table 2.
**Summary of Treatment Data.**

| Reference | Pre-auxiliary Approach | Ports | Division of Isthmus | Duration | Hospital Stay (Days) | Histology | Complications | Blood Loss (mL) |
|-----------|------------------------|-------|---------------------|----------|---------------------|-----------|---------------|----------------|
| 3         | Nephrostomy            | Transperitoneal | 5 | Endo-GIA | 8 hrs | 3 | NR | 0 |
| 4         | Nephrostomy            | Transperitoneal | 4 | Under direct vision (extra corporeal) electrocautery | 270 min | 9 | 0 | 270 |
| 5         | J stent                | Transperitoneal | 4 | Endo-GIA | 5.1 hrs | 4 | 50 |
| 6         | Nephrostomy            | Transperitoneal | 4 | Microwave coagulator | 8 hrs | 12 | Paralytic ileus | 560 |
| 7         | 0                      | Retropertitoneal | 3 | Harmonic scalpel | 5.5 hrs | 1 | 10 |
| 8         | 0                      | Transperitoneal | 3 | Endo-stapler | 3 hrs | 3 | 150 |
| 9         | J stent                | Transperitoneal | 3 | Endo-stapler | 5 hrs | 3 | 150 |
| 10        | 0                      | Retropertitoneal | 3 | Ultrasonic scalpel | 115 min | 4 | NR | 60 |
| 11        |                       | Hand-assisted transperitoneal | Hand port, 12mm x2 | Endo-GIA | 165 min | 4 | Chronic pyelonephritis | 200 |
| 12        |                       | Retropertitoneal | 3 | Ultrasound scalpel | 80 min | 2 | 50 |
| 13        |                       | Transperitoneal | 3 | Parenchymal suture + argon beam | 195 min | 2 | pT1 clear cell carcinoma | 400 |
| 14        | J stent                | Hand-assisted transperitoneal | Hand port, 12mm x2 | Endo-GIA | 165 min | 4 | Chronic inflammation | 150 |
| 15        | Dialysis               | Hand-assisted transperitoneal | Hand port, 12mm x3 | Electrocautery | 280 min | 12 | Sick sinus syndrome, cardiac complications | 350 |
| 16        |                       | Transperitoneal | 3 | Electrocautery, Digital compression | 360 min | 2 | pT2N0M0 clear cell carcinoma | NR |
| 17        |                       | Retropertitoneal | 3 | Bipolar energy (Gyrus) 60W coagulation | 140 min | 2 | 160 |
| 18        | Nephrostomy            | Retropertitoneal | 3 | Endo-stapler | 140 min | 1 | 75 |
| 19        | Ureteric catheter preoperatively | Transperitoneal | 4 | Electrocautery | 302 min | 10 | 50 |
| 20        |                       | Hand-assisted transperitoneal | Hand port, 12mm x2 | Endo-GIA | 273 min | 2 | pT2 clear cell carcinoma | 250 |
| 21        |                       | Transperitoneal | 3 | Bipolar coagulation | 240 min | 3 | 200 |
| 22        |                       | Transperitoneal | 4 | Bipolar coagulation | 160 min | 2 | 200 |
| 23        | Bilateral ureteric stents | Transperitoneal | 4 | Endo-GIA | 307 min | 1 | XPN | 100 |
| 24        |                       | Hand-assisted transperitoneal | 3 | NR | 207 min | NR | Skin separation | NR |
| 25        |                       | Hand-assisted transperitoneal | 3 | NR | 319 min | NR | Urinoma, Anejaculation, neuralgia | NR |

*NR = not reported.*
lie vertically on either side of the midline and are connected at their respective lower poles by a bulky parenchymatous or fibrous isthmus that crosses the midplane of the body. Generally, the isthmus is bulky and consists of parenchymatous tissue with its own blood supply. The isthmus is located adjacent to the L3 or L4 vertebra just below the origin of the inferior mesenteric artery from the aorta. As a result, the horseshoe kidneys tend to be somewhat lower than normal in the retroperitoneum. The isthmus most often lies anterior to the aorta and vena cava but very rarely may pass between the inferior vena cava and the aorta or even behind both great vessels.

Often, one-third of all patients with a horseshoe kidney are asymptomatic, and the anomaly gets noticed incidentally on radiologic examination. The most common associated finding in horseshoe kidney is ureteropelvic junction obstruction, which occurs in up to 35% of cases and is often the cause of problems. Kidney stones develop in 20% to 60% of patients and may be associated with obstruction and recurrent infections. Urinary stasis and urolithiasis also predispose the horseshoe kidney to infection, which occurs in 27% to 41% of patients. The frequency of certain neoplasms is higher. Renal cell cancer, the most common, accounts for 45% of all tumors. The risk of Wilms’ tumor is 2-fold in a horseshoe kidney and accounts for 28% of malignant lesions. Transitional cell cancer and sarcoma account for 20% and 7% of tumors, respectively.

Various authors have demonstrated that a laparoscopic approach to urologic disease of the horseshoe kidney is an effective and equivalent minimally invasive alternative to traditional open surgery. Depending on the surgeon’s expertise, different approaches have been used. These include transperitoneal, retroperitoneal, and hand-assisted. Anatomic variations like lower renal location, aberrant vessels, and the isthmus necessitate special consideration during laparoscopic surgery.

There is a wide variation in horseshoe kidney vascular supply. In 30% of the cases, it consists of one renal artery for each kidney, but the blood supply may be atypical, with 1 to 8 renal arteries supplying one or both kidneys. The isthmus and adjacent parenchymal masses may receive a branch from each main renal artery, or they may have their own arterial supply originating from the aorta (65%) either above or below the level of the isthmus. Not infrequently, this area is supplied by branches from the inferior mesenteric artery, the common or external iliac arteries, or the sacral arteries.

Appropriate imaging is crucial in presurgical planning to identify the renal vasculature and orientation of the collecting system. An aberrant vascular supply is one of the major anatomic features in horseshoe kidneys; thus, the vascular supply cannot be easily predicted during intervention. Therefore, angiography is indispensable in the preoperative planning, especially in patients with renal cancer.

A MEDLINE search revealed 23 (27 patients) case reports of nephrectomy for horseshoe kidney with laparoscopy, published between 1995 and 2010. Two of these reports published in French and Japanese were excluded. Patient data are summarized in Table 1. Flank pain was the most common presentation, and 4 patients had renal mass. Most authors used computerized tomography to assess vascular anatomy.

A transperitoneal approach was used in the majority (15) of cases, while a retroperitoneal route was used in 5 cases, and 6 patients were treated with a hand-assisted approach. This procedure can be technically demanding due to variable vasculature and abnormal anatomy; therefore, a few simple steps may facilitate a good outcome. First, identification of the ureter is important as is insertion of a double J stent or ureteric catheter. Second, to start dissection of the upper pole, it is helpful to first identify the vasculature. In a horseshoe kidney, most of the vessels are above the isthmus. Next, we recommend releasing the lower pole; this maneuver will allow lifting the kidney thereby isolating the isthmus very clearly. At this stage, it is critical to look for a direct blood supply to the isthmus. The isthmus can be divided in a variety of ways (Table 2), but in our case a 15-mm Hem-o-lok clip was used followed by a PDS Endoloop. In our case, no major problems were encountered during dissection.

Laparoscopic nephrectomy seems technically feasible, safe, and reliable for benign and malignant diseases in a horseshoe kidney. Anatomic variations necessitate proper imaging and special consideration for a successful outcome.

References:

1. Clayman RV, Kavoussi LR, Soper NJ, et al. Laparoscopic nephrectomy: initial case report. J Urol. 1991;146:278–282.
2. Stuart BB. Anomalies of the upper urinary tract. In: Walsh PC, Retik AB, Vaughan ED Jr., Wein AJ, eds. Campbell’s Urology. 8th ed. Vol 3. Philadelphia: WB Saunders; 2002;1885–1924.
3. Riedel CR, Huebner WA, Schramek P, Pflueger H. Laparoscopic hemi-nephrectomy in a horseshoe kidney. Br J Urol. 1995;76:140–141.
4. Ao T, Uchida T, Egawa S, Iwamura M, Ohori M, Koshiba K. Laparoscopically assisted heminephrectomy of a horseshoe kidney: a case report. J Urol. 1996;155:1382–1383.
5. Donovan JF, Cooper CS, Lund GO, Winfield HN. Laparo-
scopic nephrectomy of a horseshoe kidney. J Endourol. 1997;
11:181–184.
6. Hayakawa K, Baba S, Aoyagi T, Ohashi M, Ishikawa H, Hata
M. Laparoscopic heminephrectomy of a horseshoe kidney using
microwave coagulator. J Urol. 1999;161:1559.
7. Lapointe SP, Houle AM, Barrières D. Retroperitoneoscopic
left nephrectomy in a horseshoe kidney with the use of the
harmonic scalpel. Can J Urol. 2002;9:1651–1652.
8. Yoshines P, Dinlenc C, Liatsikos E, Rotariu P, Pinto P, Smith
AD. Laparoscopic heminephrectomy for benign disease of the
horseshoe kidney. JSLS. 2002;6:381–384.
9. Leclair MD, Camby C, Capito C, de Windt A, Podevin G,
Heloury Y. Retroperitoneoscopic nephroureterectomy of a
horseshoe kidney in a child. Surg Endosc. 2003;17:1156.
10. Kitamura H, Tanaka T, Miyamoto D, Inomata H, Hat-
akeyama J. Retroperitoneoscopic nephrectomy of a horseshoe
kidney with renal-cell carcinoma. J Endourol. 2003;17:907–908.
11. Tan YH, Young MD, Preminger GM, Albala DM. Hand-
assisted laparoscopic heminephrectomy in horseshoe kidney. J
Endourol. 2004;18:562–564.
12. Saggar VR, Singh K, Sarangi R. Retroperitoneoscopic hemi-
nephrectomy of a horseshoe kidney for calculus disease. Surg
Laparosc Endosc Percutan Tecb. 2004;14:172–174.
13. Bhayani SB, Andriole GL. Pure laparoscopic radical hemic-
nephrectomy and partial isthmusectomy for renal-cell carcinoma
in a horseshoe kidney: case report and technical considerations.
Urology. 2005;66:880.
14. Dasgupta R, Shroti N, Rane A. Hand-assisted laparoscopic hemi-
nephrectomy for horseshoe kidney. J Endourol. 2005;19:484–485.
15. Hammontree LN, Passman CM. Case report: bilateral hand-
assisted laparoscopic nephrectomy in a patient with polycystic
horseshoe kidney. J Endourol. 2006;20:397–398.
16. Tobias-Machado M, Massulo-Aguiar MF, Forseto PH Jr., Ju-
liano RV, Wroclawski ER. Laparoscopic left radical nephrectomy
and hand-assisted isthmectomy of a horseshoe kidney with renal
cell carcinoma. Urol Int. 2006;77:94–96.
17. Patankar S, Dohbada S, Bhansali M. Case report: laparo-
scopic heminephrectomy in a horseshoe kidney using bipolar
energy. J Endourol. 2006;20:639–641.
18. Modí P, Patel S, Dodia S, Goel R. Case report: retroperito-
necoscopic nephrectomy in pyephronic nonfunctioning moiety
of horseshoe kidney. J Endourol. 2006;20:330–331.
19. Kojima Y, Hayashi Y, Yasui T, Itoh Y, Maruyama T, Kohri K.
Laparoscopic nephrectomy for a girl with giant hydronephrosis
of a horseshoe kidney. Int J Urol. 2007;14:647–649.
20. Araki M, Link BA, Galati V, Wong C. Case report: hand-
assisted laparoscopic radical heminephrectomy for renal-cell
carcinoma in a horseshoe kidney. J Endourol. 2007;21:1485–
1487.
21. Nouri-Mahdavi K, Izadpanahi MH. Laparoscopic hemine-
nephrectomy in horseshoe kidney using bipolar energy: report of
three cases. J Endourol. 2008;22:667–670.
22. Sausville J, Chason J, Phelan M. Laparoscopic heminep-
rectomy in a horseshoe kidney affected by xanthogranulomatous
pyelonephritis. JSLS. 2009;13:462–464.
23. Blazè J, Ceuterick M, Hauzeur C, Wespes E. Laparoscopic
radical nephrectomy for a tumor in a horseshoe kidney. Prog
Urol. 2007;17(1):99–100.
24. Fukumoto R, Ohtoshi T, Kobayashi K, et al. A case report:
retroperitoneoscopic nephrectomy for a giant hydronephrosis of
a horseshoe kidney. Hinyokika Kiyo. 2009;55(10):615–618.
25. Johns MW. Sleep. A new method for measuring daytime
sleepiness: the Epworth sleepiness scale. Sleep. 1991;14(6):540–
545.
26. Love L, Wasserman D. Massive unilateral non-functioning
hydronephrosis in horseshoe kidney. Clin Radiol. 1975;26:409–
415.
27. Jarmin WD. Surgery of the horseshoe kidney with a post-
aortic isthmus: report of two cases of horseshoe kidney. J Urol.
1938;40:1.
28. Dajani AM. Horseshoe kidney: a review of twenty-nine
cases. Br J Urol. 1968;38:388–402.
29. Grainger R, Murphy DJ, Lane V. Horseshoe kidney—a re-
view of the presentation, associated congenital anomalies and
complications in 73 patients. Ir Med J. 1983;76:315–317.
30. Glen JF. Analysis of 51 patients with horseshoe kidney. N Engl J Med. 1959;261:684.
31. Papin E. Chirurgie du rein. Paris: G Doin; 1928;205–229.
32. Boatman DL, Cornell SH, Kolln CP. The arterial supply of
horseshoe kidneys. AJR Am J Roentgenol. 1971;113:447–451.