Laparoscopic Plasty for Reconstruction of Symptomatic Horseshoe Kidney

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Purpose: To report our experience of transperitoneal laparoscopic plasty for reconstruction in patients with horseshoe kidney.

Materials and Methods: We retrospectively analyzed 12 patients with the symptomatic horseshoe kidney who presented to our institution from March 2005 to July 2008 and underwent laparoscopic reconstruction for horseshoe kidney. Computed tomography angiography was performed prior to surgery for evaluation of the anatomic variations, since preoperative knowledge is necessary for achieving reliable vascular control. Five patients had renal stones which were extracted during surgery. All laparoscopic operations were performed by the same urologist.

Results: All procedures were completed successfully and no one needed for conversion to open surgery. Mean operative time was 150 min and no major complications were observed. The average follow-up time was 28.7 months. All patients had good renal function and improved drainage with successful reconstruction.

Conclusion: Laparoscopic reconstruction has since been demonstrated to be an attractive alternative in the management of the horseshoe kidney. It provides a feasible and effective alternative to conventional management.

Keywords: horseshoe kidney; kidney; abnormalities; laparoscopy; urologic surgical procedures; kidney pelvis; surgery.

INTRODUCTION

Horseshoe kidney is the most common renal fusion abnormality occurring in approximately 1/400 births to 1/1000 births.[1-3] In the great majority of cases the kidneys are fused at the lower pole which can be a brand of fibrous or a thick functional renal parenchymal isthmus.[1,4] The normal ascent of the kidney is arrested by the inferior mesenteric artery and fails to normally rotate.[5-7] Consequently, the renal pelvis is ventrally placed and the ureters often course over the isthmus.

The vascular supply to the horseshoe kidney may be complex.[2] The blood supply consists of a single renal artery to each kidney in only 30% of the cases.[4] In most cases, it may be atypical with duplicate or even triplicate renal arteries and veins that supply each kidney. The isthmus usually has a separate blood supply which may arise from each main renal artery or from the aorta, inferior mesenteric or iliac arteries. Although most patients with horseshoe kidney are asymptomatic, they may be associated with complications based on ureteropelvic junction obstruction, such as hydronephrosis, nephrolithiasis and recurrent urinary tract infections.[4,7-10] As the most common complication of the horseshoe kidney which necessitating surgical intervention, urolithiasis has an incidence of 20% to 60% and ureteropelvic junction (UPJ) obstruction occurs at an incidence of 15% to 33%.[5,11,12] The most common etiology is believed to be the abnormal course of the ureter as it passes over the anterior surface of the isthmus, high insertion of the ureter into the renal pelvis, and secondary to an anomalous blood supply to the isthmus crossing the UPJ.[9,13,14] In the long term, they may cause renal damage and results in nephrectomy.

Laparoscopy is becoming the standard surgical management for many renal diseases, and major advances in laparoscopic surgery have enabled less invasive surgery in urology with the benefits of decreased postoperative discomfort and improved convalescence. Application of laparoscopic reconstruction in the horseshoe kidney has been limited. We report our experience of transperitoneal laparoscopic plasty for reconstruction in patients with horseshoe kidney. The details of the technique were provided in the report.

MATERIALS AND METHODS

Between March 2005 to July 2008, five men and seven women (aged 8 and 59 years) were referred to our institution for symptomatic ureteropelvic junction obstruction (UPJO) associated with horseshoe kidney (**Table**). In eleven patients only the left kidney was affected, and one patient had bilateral involvement of the kidney on preoperative evaluation. Five patients had associated renal stones that were extracted during laparoscopic reconstruction. The major presenting symptoms were recurrent back pain in 7 patients (58%), intermittent lower abdominal pain in 2 (17%), recurrent urinary tract infection in 2 (17%) and hematuria in 1 (8%). None of the patients had previous abdominal surgery (**Table**). All patients were evaluated with intravenous urography (IVU) and isotope renogram, and all had normal renal function before surgery. Preoperative computed tomography angiography (CTA) (**Figure 1A and 1B**) of the abdomen provides the surgeon with valuable anatomic information, including isthmus thickness, calyceal extension into the isthmus and ectopic location. Magnetic resonance imaging (MRI) with three-dimensional reconstruction was performed to delineate the renal anatomy optimally prior to surgery. All laparoscopic operations were performed by the same urologist.

The laparoscopic transabdominal approach was used in all cases. The patients were put in the right lateral decubitus position under general anesthesia. Prophylactic antibiotics were given. A 14 mmHg pneumoperitoneum was established first. Positioning and trocar placement are shown in **Figure 2**. The posterior peritoneal reflection was incised and the colon reflected medially. We exposed the lower pole of the left kidney, so the dilated renal pelvis and the isthmus with crossing vessels were visible.

The isthmus was then exposed using blunt dissection and keeping a special watch on the aberrant blood supply. The isthmus was freed circumferentially, where many anterior and posterior vessels were selectively controlled using hemo-o-lock (**Figure 3**). We observed the range of blood supply before we ligated these vessels. The blood supply consists of a single renal artery to each kidney in five cases. Seven patients had atypical with duplicate or even triplicate renal arteries. The isthmus received a branch from main renal artery or from the aorta in three cases. Four patients had accessory renal artery supply to the lower pole of the left kidney which was ligated for the purposes of nephropexy. The isthmus was divided using the endoscopic stapler (REF 6TB45, 45 mm Staple Line, 3.5 mm Staple Leg Length, 6 Rows, Ethicon Endo-Surgery, LLC, Ethicon, Inc. New Jersey, USA) (**Figure 4**). Generally we chose two figure-of-eight suture instead of classic nephropexy (**Figure 5**). No significant bleeding was noted from the divided isthmus. Choice of laparoscopic pyeloplasty was based on the nature of the ureteropelvic junction obstruction and anatomical findings at surgery. Dismembered pyeloplasty was the first choice for most patients. In all cases a 6 French (F) double J ureteral stent was inserted in an antegrade fashion through a 5 mm trocar with the assistance of a ureteral open-end catheter before completing the suture. If crossing vessels were present, the ureter and renal pelvis were transposed to the opposite side of the vessels before completion of the anastomosis. In 5 patients renal stones were removed using pyelolithotomy. No additional lithotripsy techniques were used. If the right kidney has hydronephrosis or stones, we may handle it later or simultaneously, depending on the patient's situation. The operative duration was defined from the initial port incision to the closure of all laparoscopic ports. A procedure was defined as successful by the reduction in the hydronephrosis and absence of symptoms.

RESULTS

All procedures were completed successfully and no one needed for conversion to open surgery in our series. The main results are shown in **Table**. The mean operative duration was 150 (125~170) min and

Table. Demographic and clinical characteristics of study subjects.

Patient No, Age	Concomitant Disease	Main Presenting Symptoms	Procedure	Operation Duration (min)	Blood Loss (mL)	Results*	Follow up, Radiologic, Clinical (months)
1, 15	None	Intermittent lower abdominal pain	Lt .laparoscopic reconstruction	135	50	Improved drainage	15, 25
2, 15	None	Recurrent back pain	Lt. laparoscopic reconstruction	160	75	Improved drainage	15, 26
3, 26	Bilateral pelvis stones	Recurrent back pain	Lt. laparoscopic reconstruction and pyelolithotomy	155	135	A residual stone treated with SWL	15, 24
4, 15	None	Hematuria	Lt. laparoscopic reconstruction	170	105	Improved drainage	15, 24
5, 5	Left pelvis stones	Recurrent urinary tract infection	Lt. laparoscopic reconstruction and pyelolithotomy	155	150	Improved drainage	15, 24
6, 5	None	Recurrent back pain	Lt. laparoscopic reconstruction	125	70	Mild residual hydronephrosis at 3 months	51, 60
7, 51	Left pelvis stones	Recurrent back pain	Lt. laparoscopic reconstruction and pyelolithotomy	155	85	Improved drainage	15, 24
8, 15	Left pelvis stones	Recurrent urinary tract infection	Lt. laparoscopic reconstruction and pyelolithotomy	160	120	Improved drainage	15, 24
9, 15	None	Recurrent back pain	Lt. laparoscopic reconstruction	145	125	Improved drainage	15, 25
10, 15	None	Recurrent back pain	Lt. laparoscopic reconstruction	160	95	Improved drainage	15, 25
11, 15	None	Recurrent back pain	Lt. laparoscopic reconstruction	140	105	Improved drainage	39 , 39
12, 39	Left pelvis stones	Intermittent lower abdominal pain	Lt. laparoscopic reconstruction	145	90	Improved drainage	13, 24

Abbreviations: Lt, left; SWL, extracorporeal shock wave lithotripsy.

* Confirmed by computed tomography angiography, isotope renogram and intravenous urography.

estimated blood loss was 100 mL. There were no intraoperative complications. In five patients with renal stones, these were removed laparoscopically. An X-ray after surgery showed good positioning of the double J ureteral stent in all cases. No additional lithotripsy was needed during surgery, but there was a residual calculus in one patient, who was successfully treated later with extracorporeal shockwave lithotripsy (SWL). Physical activity and oral intake were resumed on the day after surgery. The mean hospital stay was 7.6 days and the mean follow-up was 28.7 months (range 24 to 60). No long term complication was devel-oped. The patients were scheduled for follow up at 4~6 weeks post-operatively for stent removal. Patients underwent computed tomography angiography (CTA), isotope renogram and IVU at 3-month postoperatively and annually thereafter. All had good renal function and improved drainage with successful isthmectomy confirmed by CTA at 3-month after surgery (**Figure 6**). Postoperative IVU also showed improved drainage. One patient had mild residual hydronephrosis at 3 months, but this was resolved completely at 1 year.

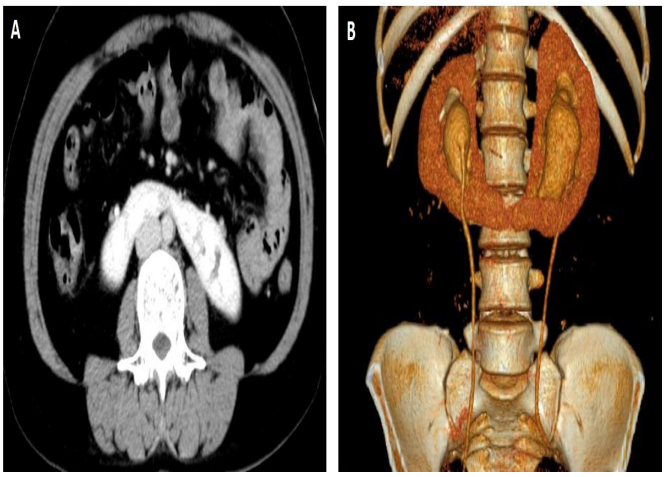

Figure 1. Preoperative computed tomography angiography.

DISCUSSION

The first description of horseshoe kidney was by Berengario da Carpi in 1522.[15] Due to the rarity of this renal anomaly, few reports address the treatment of UPJO in adults with horseshoe kidney. For several decades, open pyeloplasty was the main treatment for UPJO. For open surgical repair, the need to divide the isthmus, nephropexy of the ipsilateral kidney and dismembered pyeloplasty have been described.[9,16,17] Minimally invasive techniques were developed in the 1980s and applied in horseshoe kidney to decrease postoperative morbidity associated with open surgery.[11] Retrograde endopyelotomy treatment was reported by Jabbour and colleagues,[18] with a long-term success and no major bleeding complications. Several groups have since reported their experience with different laparoscopic procedure in horseshoe kidneys in case reports and small series. Laparoscopic pyeloplasty offers the advantages of a minimally invasive approach and the success rates comparable with an open procedure.[19] Application of

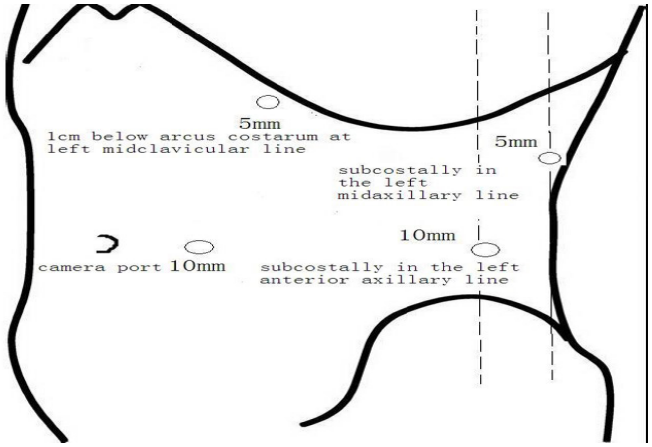

Figure 2. Port sites.

laparoscopic pyeloplasty in the horseshoe kidney has been limited; the first laparoscopic pyeloplasty was reported in 1996[20] and the largest published series has only five patients.[21]

The laparoscopic management of UPJO in patients with horseshoe kidneys follows similar principles for treatment of patients with conventional open surgery. We report the technique of laparoscopic plasty for the reconstruction of horseshoe kidney. The laparoscopic approach provided excellent surgical exposure with a comparable operative time as open surgery. Concomitant pyelolithotomy could also be performed using the laparoscopic approach, allowing for intact stone removal in a single operative session. Although improvements in laparoscopic instruments have been introduced recently, the unique anatomic considerations and difficulty of this technique are still disadvantages.

Accordingly, the transabdominal approach was chosen because of a wide working space is needed for this kind of complicated procedure.[22] The unique features of horseshoe kidney, such as its low fixed position secondary to malrotation, the anterior renal pelvis, its variant and multiple vasculature, and presence of functional parenchyma in the isthmus, are technical challenges that contribute to making a laparoscopic approach for reconstruction in horseshoe kidney technically challenging.[10,23-26] CTA is required prior to surgery for evaluation of the anatomic variations, including ectopic location, malrotation, the thickness of the isthmus, and extrarenal anatomy of the renal artery and vein for preoperative knowledge that will be necessary for achieving reliable vascular control.[26] Also CTA could conduct isthmectomy and show the patency of the ureter during treatment.

The isthmus usually consists of parenchymal tissue with its own blood supply.[4] Occasionally it is a flimsy midline structure composed of fibrous tissue.[27] Several techniques have been described for division of the isthmus and this procedure was achieved by use of microwave coagulator device,[28] argon beam, harmonic scalpel[13] or more commonly the endoscopic stapler.[26,29,30] The isthmus, with or without functional parenchyma, was divided using the endoscopic stapler for this purpose as it is safe and may aid in maintaining patency of the repair. Identification of any vessel supplying the isthmus if present is essential.[25,27] In our experience, endoscopic stapler are always effective. Depending on the thickness of the isthmus, the staplers can be used several times and should be consecutively placed in line and transected at the aortic impression where the thinnest part of the isthmus presents. During placement of the stapler, one must be aware that the isthmus is supplied by vessels entering dorsally, and intrusion into the collecting system or parenchyma during placement must be avoided. In our serial, the endoscopic stapler was employed well away from the remaining collecting system and with excellent hemostasis.

The overall success rate in our series is higher than previous reports for either open surgery (55%-80%) and endoscopic management (78%), equivalent to laparoscopic surgery with horseshoe kidney (91%).[15,16,21] If repair is considered for these patients, thorough preoperative evaluation and counseling are recommended. The operative duration of 150 min, was no more than other laparoscopic treatments in patients with horseshoe kidney using standard laparoscopy, and in the present series this duration included the extraction of calculi in five casesThe mean hospital stay of 7.6 days was longer than other series. This is explained by that the health insurance covers hospitalization expenses regardless of duration, making the patient tend to a longer hospital stay. Therefore, the mean hospital stay might be a poor measure of comparison.[3]

Some technical points should be emphasized. When performing laparoscopic surgery for the patients with horseshoe kidney, understanding

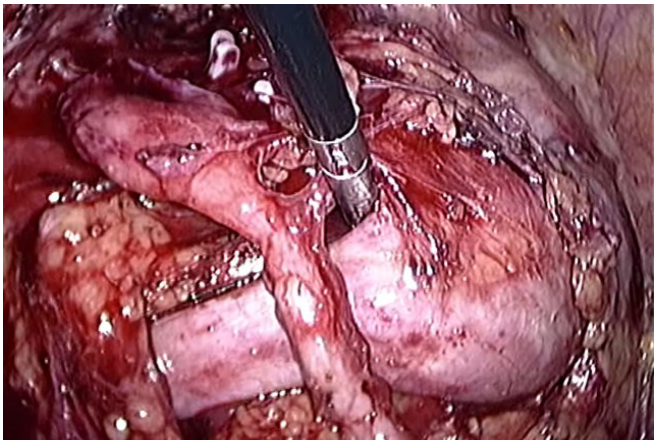

Figure 3. The isthmus was freed circumferentially and vessels were selectively controlled.

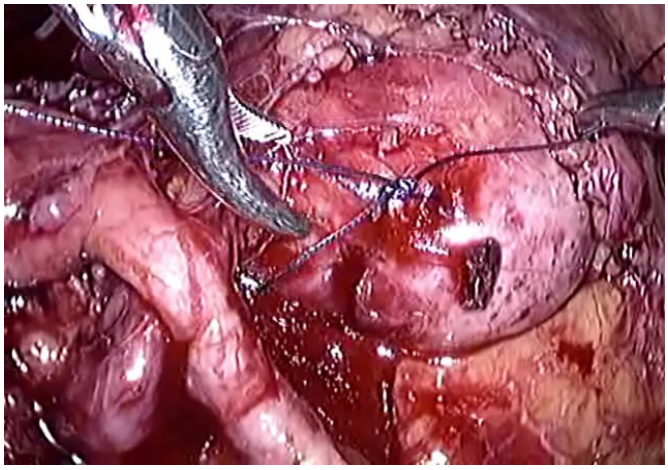

Figure 4. Nephropexy is shown.

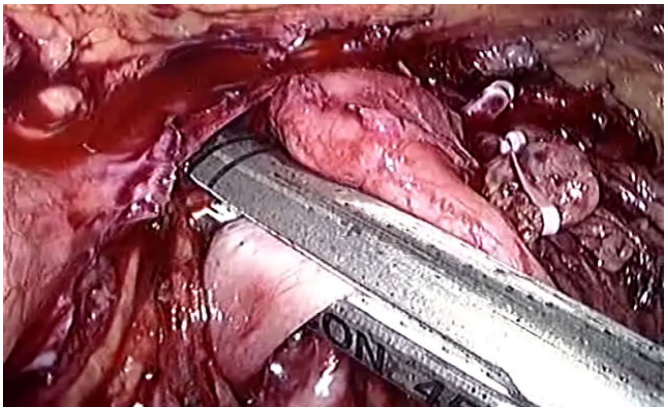

Figure 5. The isthmus was divided using the endoscopic stapler.

of the number,[13] location and extra-renal anatomy of the renal artery, vein and accessory vessels leads to the achievement of reliable vascular control and makes the operation successfully, otherwise particularly the direct branches from the aorta to the isthmus, or isthmectomy will result in severe hemorrhage.[31] From a technical perspective, isthmectomy allows the kidneys to lie in a more dependent position that maintains the patency of the repaired outflow tract, as the medial portions of the separated kidneys rotate to lessen the obstruction and get better urine drainage for the lower calyx.[13] Another important point is careful isthmus dissection while it is important not to violate the collecting system of the contralateral kidney at the lower pole. We considered that the conventional notion that nephropexy should accompany division of the isthmus to protect the remaining kidney from developing UPJO caused by renal vein. In some patients, pyeloplasty alone could not help because of the abnormal compression of the ureter passing between the left renal vein and isthmus, so we abducted the lower pole of the left kidney and fixed it to psoas muscle to release the ureter from outside compression. The pyeloplasty after isthmectomy may adjust high insertion of the ureter into the renal pelvis. Long term follow up CTA revealed improved drainage and satisfactory separation of the divided horseshoe kidney.

Minimally invasive surgery using laparoscopy is rapidly coming to the forefront as a reasonable option for horseshoe kidney. Preoperative CT and MR angiography may be helpful in guiding surgical therapy. The improvement in laparoscopic instruments and techniques has since paved the way for the management of reconstruction of the horseshoe kidney.

CONCLUSION

Transperitoneal laparoscopic reconstruction has since been demonstrated to be a feasible and effective method in the management of the horseshoe kidney. It is a challenging approach and more experience is needed before it becomes the standard of care. The present series involved division of the isthmus, and had good clinical and radiological results. Good laparoscopic skill and patience plays a definitive role in the management of complications associated with the horseshoe kiney.

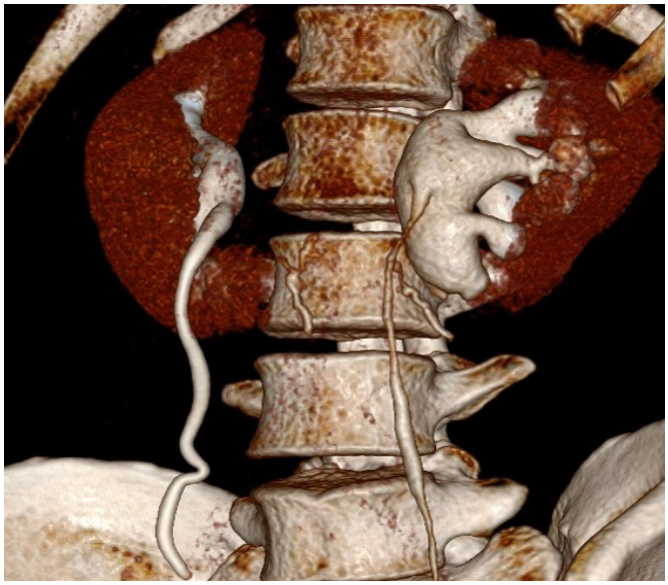

Figure 6. Computed tomography angiography at 3 months postoperatively showed improved drainage.

CONFLICT OF INTEREST

None declared.

REFERENCES

1. Tobias-Machado M, Massulo-Aguiar MF, Forseto PH Jr, Juliano RV, Wroclawski ER. Laparoscopic left radical nephrectomy and hand-assisted isthmectomy of a horseshoe kidney with renal cell carcinoma. Urol Int. 2006;77:94-6.

2. Janetschek G, Kunzel KH. Percutaneous nephrolithotomy in horseshoe kidneys. Applied anatomy and clinical experience. Br J Urol. 1988;62:117-22.

3. Chammas M Jr, Feuillu B, Coissard A, Hubert J. Laparoscopic robotic-assisted management of pelvi-ureteric junction obstruction in patients with horseshoe kidneys: technique and 1-year follow-up. BJU Int. 2006;97:579-83.

4. Stroosma OB, Schurink GW, Smits JM, Kootstra G. Transplanting horseshoe kidneys: a worldwide survey. J Urol. 2001;166:2039-42.

5. Viola D, Anagnostou T, Thompson TJ, Smith G, Moussa SA, Tolley DA. Sixteen years of experience with stone management in horseshoe kidneys. Urol Int. 2007;78:214-8.

6. Etemadian M, Maghsoudi R, Abdollahpour V, Amjadi M. Percutaneous nephrolithotomy in horseshoe kidney: our 5-year experience. Urol J. 2013;10:856-60.

7. Symons SJ, Ramachandran A, Kurien A, Baiysha R, Desai MR. Urolithiasis in the horseshoe kidney: a single-centre experience. BJU Int. 2008;102:1676-80.

8. Lampel A, Hohenfellner M, Schultz-Lampel D, Lazica M, Bohnen K, Thürof JW. Urolithiasis in horseshoe kidneys: therapeutic management.

Urology. 1996;47:182-6.

9. Nakamura K, Baba S, Tazaki H. Endopyelotomy in horseshoe kidneys. J Endourol. 1994;8:203-6.

10. Nouri-Mahdavi K, Izadpanahi MH. Laparoscopic heminephrectomy in horseshoe kidney using bipolar energy: report of three cases. J Endourol. 2008;22:667-70.

11. Yohannes P, Smith AD. The endourological management of complications associated with horseshoe kidney. J Urol. 2002;168:5-8.

12. Hsu TH, Presti JC Jr. Anterior extraperitoneal approach to laparoscopic pyeloplasty in horseshoe kidney: a novel technique. Urology. 2003;62:1114-6.

13. Nadler RB, Thaxton CS, Kim SC. Hand-assisted laparoscopic pyeloplasty and isthmectomy in a patient with a horseshoe kidney. J Endourol. 2003;17:909-10.

14. Darabi Mahboub MR, Zolfaghari M, Ahanian A. Percutaneous nephrolithotomy of kidney calculi in horseshoe kidney. Urol J. 2007;4:147-50.

15. Pitts WR Jr, Muecke EC. Horseshoe kidneys: a 40-year experience. J Urol. 1975;113:743-6.

16. Das S, Amar AD. Ureteropelvic junction obstruction with associated renal anomalies. J Urol. 1984;131:872-4.

17. Culp OS, Winterringer JR. Surgical treatment of horseshoe kidney: comparison of results after various types of operations. J Urol. 1955;73:747-56.

18. Jabbour ME, Goldfischer ER, Stravodimos KG, Klima WJ, Smith AD. Endopyelotomy for horseshoe and ectopic kidneys. J Urol. 1998;160:694-7.

19. Siqueira TM Jr, Nadu A, Kuo RL, Paterson RF, Lingeman JE, Shalhav AL. Laparoscopic treatment for ureteropelvic junction obstruction. Urology. 2002;60:973-8.

20. Janetschek G, Peschel R, Altarac S, Bartsch G. Laparoscopic and retroperitoneoscopic repair of ureteropelvic junction obstruction. Urology. 1996;47:311-6.

21. Bove P, Ong AM, Rha KH, Pinto P, Jarrett TW, Kavoussi LR. Laparoscopic management of ureteropelvic junction obstruction in patients with upper urinary tract anomalies. J Urol. 2004;171:77-9.

22. Kawauchi A, Fujito A, Yoneda K, et al. Laparoscopic pyeloplasty and isthmectomy for hydronephrosis of horseshoe kidney: a pediatric case. J Endourol. 2005;19:984-6.

23. Patankar S, Dobhada S, Bhansali M. Case report: laparoscopic hemi nephrectomy in a horseshoe kidney using bipolar energy. J Endourol. 2006;20:639-41.

24. Tsivian A, Shtricker A, Benjamin S, Sidi AA. Laparoscopic partial nephrectomy for tumour excision in a horseshoe kidney: part II. Eur Urol. 2007;51:1433-4.

25. Araki M1, Link BA, Galati V, Wong C. Case report: hand-assisted laparoscopic radical heminephrectomy for renal-cell carcinoma in a horse shoe kidney. J Endourol. 2007;21:1485-7.

26. Donovan JF1, Cooper CS, Lund GO, Winfield HN. Laparoscopic nephrectomy of a horseshoe kidney. J Endourol. 1997;11:181-4.

27. Saggar VR, Singh K, Sarangi R. Retroperitoneoscopic heminephrectomy of a horseshoe kidney for calculus disease. Surg Laparosc Endosc Percutan Tech. 2004;14:172-4.

28. Hayakawa K1, Baba S, Aoyagi T, Ohashi M, Ishikawa H, Hata M. Laparoscopic heminephrectomy of a horseshoe kidney using microwave coagulator. J Urol. 1999;161:1559.

29. Dasgupta R, Shrotri N, Rane A. Hand-assisted laparoscopic heminephrectomy for horseshoe kidney. J Endourol. 2005;19:484-5.

30. 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;155:1382-3.

31. Bhayani SB, Andriole GL. Pure laparoscopic radical heminephrectomy and partial isthmusectomy for renal cell carcinoma in a horseshoe kidney: case report and technical considerations. Urology. 2005;66:880.