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Laparoscopic Nephrectomy in Patients with Congenital Kidney Anomalies: Single-Centre Results

Konjenital Böbrek Anomalisi Olan Hastalarda Laparoskopik Nefrektomi: Tek Merkez Sonuçları

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ABSTRACT Objective: This study examines the results of laparoscopic nephrectomy conducted on patients with congenital kidney anomalies such as horseshoe kidney and ectopic pelvic kidney. **Material and Methods:** Between January 2016 and August 2018, ten patients with non-functioning kidney with congenital anomaly were included in the study. The patients' operation time, blood loss, time spent in hospital, preoperative and postoperative complications, and follow-up time were evaluated. **Results:** Of the 10 patients,6 had laparoscopic heminephrectomy because of horseshoe kidney and 4 had laparoscopic nephrectomy because of pelvic kidney. The patients' average age was 49.7 years. The average operation time was 138.4 minutes, and the average time spent in hospital was 2.7 days. No intraoperative or postoperative complications occurred. **Conclusion:** While there may be some surgical difficulties due to kidney localization and vascular variations in patients with congenital kidney anomalies, laparoscopic nephrectomy in experienced hands is a safely applied, minimally invasive treatment option.

Keywords: Laparoscopic nephrectomy; horseshoe kidney; ectopic pelvic kidney

ÖZET Amaç: Bu çalışmada atnalı böbrek ve ektopik pelvik böbrek gibi konjenital böbrek anomalileri olan hastalarda yapılan laparoskopik nefrektomi sonuçları değerlendirildi. **Gereç ve Yöntemler:** Ocak 2016 ile Ağustos 2018 arasında konjenital anomalili nonfonksiyone böbreği olan 10 hasta çalışmaya dahil edildi. Hastaların operasyon süresi, kan kaybı, hastanede kalış süresi, peroperatif ve postoperatif komplikasyonlar ve takip süreleri değerlendirildi. **Bulgular:** 10 hastanın 6'sına atnalı böbrek nedeniyle laparoskopik heminefrektomi, 4'üne pelvik böbrek nedeniyle laparoskopik nefrektomi yapıldı. Hastaların ortalama yaşları 49,7 yıl idi. Ortalama operasyon süresi 138,4 dakika olup, ortalama hastanede kalış süresi 2,7 gündü. İntraoperatif ve postoperatif herhangi bir komplikasyon gelişmedi. **Sonuç:** Konjenital böbrek anomalisi olan hastalarda böbreğin lokalizasyonu ve vasküler varyasyonların çeşitliliği dolayısıyla cerrahi açıdan bazı zorlukları olsa da laparoskopik nefrektomi tecrübeli ellerde güvenle uygulanabilen minimal invaziv bir tedavi seçeneğidir .

Anahtar Kelimeler: Laparoskopik nefrektomi; at nalı böbrek; ektopik pelvik böbrek

Kidney and urinary-system congenital anomalies are the most common congenital organ malformations, occurring 0.3-1.6 times out of 1000 births. Fusion anomalies and ectopic kidney localizations comprise a significant proportion of these.[1] Horseshoe kidney is the most common congenital renal-fusion anomaly, and its incidence rate is 1 out of 400.[2] Ureteropelvic junction (UPJ) obstructions, urolithiasis, and other urinary-system anomalies may occur with horseshoe kidney.[3] Another congenital

anomaly of the kidney is the ectopically placed kidney. The most common ectopy type is pelvic kidney, and its incidence rate varies between 1/2100 and 1/3000.[3] There is a tendency for kidney-stone formation and hydronephrosis in ectopic kidneys.[4] Congenital kidney-anomaly patients' kidneys may lose function due to urinary-system anomalies, and nephrectomy could be needed. Thanks to the development of minimally invasive techniques, laparoscopic nephrectomy is an option for kidney anomalies. Jordan et al. performed the first successful laparoscopic heminephrectomy on a benign kidney anomaly.[5] Laparoscopic nephrectomy on kidneys with anomalies faces some difficulties, such as localization of ectopic kidney and horseshoe kidney, frequency of vascular variations, and occurrence of an isthmus (which connects two kidneys together) in horseshoe kidney, and these difficulties may cause iatrogenic trauma.[2,6] In this study, the results of the laparoscopic nephrectomy technique on kidneys with anomalies have been evaluated.

MATERIAL AND METHODS

The data of ten patients (six with horseshoe kidney and four with pelvic kidney) who had non-functional kidneys with anomalies and who underwent a laparoscopic nephrectomy operation between January 2016 and August 2018 were analyzed retrospectively. Patients who had congenital kidney-anomaly nonfunction due to kidney stone or UPJ obstruction were included (Figure 1). DMSA renal scintigraphy had been used for kidney-function evaluation. The patients' operation time, blood loss, time spent in hospital, preoperative and postoperative complications, and follow-up time have been analyzed retrospectively. A transperitoneal approach was used on all patients. After general anesthesia was applied to the patients, a nasogastric tube and urinary-bladder catheter were put in place. The patients were then placed in a lateral decubitus position and pneumoperitoneum was induced using a Veress needle until 18 mmHg pressure was reached. After 10 mmHg was reached, a camera port was placed in lateral to umbilicus, a second 10-mm port was placed under the direct vision 1/3 lateral of the line between the spina iliaca anterior superior and umbilicus (in pelvic kidneys, this port is placed more medially), and a third 5-mm port was placed on the midclavicular line 1-2 cm below the costa borderline. An extra 5-mm port was placed for liver extraction in one case. After the ports were put in, intraabdominal pressure was reduced to 12 mmHg. A Harmonic Scalpel® (Ethicon, UK) or LigaSure® (Covidien Healthcare, MA, US) was used as an energy source during dissection. The ureter was found after the colon was medicalized, and the ureter was followed and the renal pedicle reached. Arteries and veins were cut and closed using a Hem-o-lok® (Weck-Teleflex, US) clip. After that, the ureter was clipped and cut. The horseshoe-kidney isthmus was separated using a 60-mm Endo GIA® stapler (Covidien Healthcare, MA, US), Harmonic Scalpel® (Ethicon, UK), 10-mm LigaSure® (Covidien Healthcare, MA, US). All of the surgical operations were performed by one surgeon with laparoscopy experience.

FIGURE 1: Nonfunction ectopic pelvic kidney.

RESULTS

All of the patients' operations were completed laparoscopically. In the six patients with horseshoe kidney, nonfunctionality existed due to kidney stone in three and due to UPJ obstruction in three. In the four patients with ectopic pelvic kidney, nonfunctionality existed due to kidney stone in

TABLE 1: The patients' perioperative and demographic data.

Variables	Values
Number of patient (n)	10
Male:Female (n)	6:4
Mean age,years ±SD (range)	49.7 ± 10.4 (35-67)
BMI, mean ± SD (range)	27±4.03 (21-31)
Right/Left (n)	4/6
Mean operative time, min ± SD (range)	138.4±19.6 (105-170)
Mean estimated blood loss, ml ± SD (range)	142.5±87.28 (30-300)
Mean hospital stay, days ± SD (range)	2.7±1(2-5)
Complications (n)	0
Mean follow-up, months ± SD (range)	17.3±8.2 (1-32)

BMI: Body mass index.

three and due to UPJ obstruction in one. Four patients who had the surgery were male, four were female, and their average age was 49.7±10.4 (35-67) years. The average operation time was 138.4±19.6 (105-170) minutes, and no patient had enough bleeding to warrant blood transfusion. For the five patients with horseshoe kidney, isthmus resection was done using Endo GIA on three, Harmonic Scalpel and suturation on one, and LigaSure on two. No intraoperative or postoperative complications occurred. Patients' average stay in hospital was 2.7±1 (2–5) days. No late complications were found during the average 17.3±8.2 (1–32) months of follow up. The patients' demographic and perioperative data are shown in Table 1.

DISCUSSION

Horseshoe kidney is the most common renal-fusion anomaly. In this anomaly, two distinct kidneys lie vertically along the middle line and in their lower poles are connected with parenchymatous or a fibrous isthmus. Generally, the isthmus is formed by parenchymatous tissue with its own blood source.[7] The isthmus is located just under the inferior mesenteric artery's aorta exit, adjacent to the L3 or L4 vertebra. The isthmus is mostly seen in front of the aorta and vena cava, but it can rarely pass between the inferior vena cava and aorta or behind both of the large veins.[8,9] About one-third of cases are asymptomatic, and these are found randomly using radiological methods. The most common accompanying disease is UPJ obstruction, which occurs in 35% of patients.[10] In horseshoe kidney, the ureter's high insertion, which includes a typically elongated renal pelvis due to deformed UPJ, is responsible for hydronephrosis, stasis, and kidney-stone formation in 60–70% of cases.[11] The vascular anatomy of horseshoe kidneys includes diverse variations. In only 30% of patients, each kidney is fed by one renal artery.[12] The isthmus and close parenchyma are fed by an artery originating in the aorta in 65% of cases.[13] Due to this abnormal vascularity in horseshoe kidneys, Donovan et al. suggest the use of routine computerized tomography (CT) angiography.[14] While this helps significantly with laparoscopic heminephrectomy for malignity, due to the tendency for atrophic veins to exist in non-functional kidneys, some do not suggest its routine use.[15] Of the six cases included in this study, the first three did not use preoperative CT angiography, but because of aberrant renal arteries and veins apart from the main renal artery and renal vein, CT angiography was used in the last three cases (Figure 2). In order to avoid preoperative vein complications, we suggest preoperative CT angiography for all patients before they undergo heminephrectomy in

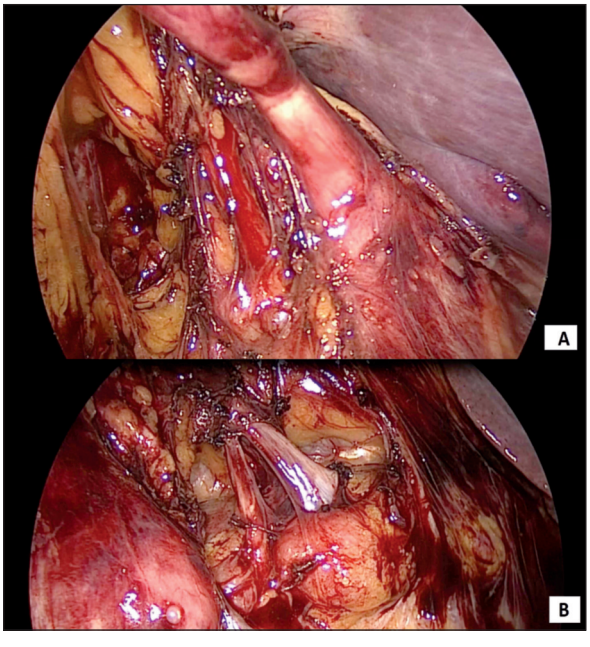

FIGURE 2: A) Main renal artery and vein, **B)** Aberrant renal artery and vein in horseshoe kidney.

response to malignity in a horseshoe kidney or non-functional kidney.

The laparoscopic approach to horseshoe-kidney surgery is an efficient, minimally invasive equivalent treatment alternative to open surgery. Depending on the experience of the surgeon, various methods such as the transperitoneal, retroperitoneal, single port, or hand-aided may be used.[16,17] Due to anatomical variations such as horseshoe-kidney position, abnormal veins, and isthmus, utmost care is needed during laparoscopic surgery. The transperitoneal approach was chosen for all cases in this study due to the wide operating space made possible and anatomical familiarity. There are many reasons for laparoscopic nephrectomy on horseshoe kidney. Thirteen patients with horseshoe kidney underwent laparoscopic nephrectomy in a multicenter study done by Tuncel et al. Of these patients, 12 had non-functional kidney (seven because of kidney stone and five because of UPJ obstruction), and one patient had a kidney tumor.[16] In another study of three patients with horseshoe kidney who had laparoscopic heminephrectomy, a non-functional kidney-one due to trauma and the others due to kidney stone and UPJ obstruction-was stated as the etiological factor.[15] In this study, six patients with horseshoe kidney had laparoscopic heminephrectomy because of non-functional kidney. Of these patients, three had kidneys with function loss due to UPJ obstruction and three due to kidney stone.

One of the more important elements in horseshoe-kidney laparoscopic heminephrectomy is the resection of the isthmus. Because the isthmus is a parenchymatous structure with blood buildup, isthmus resection must be done with utmost care. It has been reported that classical electrocautery, bipolar cautery, Endo GIA® stapler (Covidien Healthcare, MA, US), parenchymal suture with satinsky clamp, endostapler, Harmonic Scalpel® (Ethicon, UK), LigaSure® (Covidien Healthcare, MA, US) methods can be reliably used in isthmus separation and bleeding control.[10,18] In our six cases, Endo GIA® stapler (Covidien Healthcare, MA, US) was used on three, Harmonic Scalpel® (Ethicon, UK) and parenchymal suturation on one, and LigaSure® (Covidien Healthcare, MA, US) on two. No complications were found in this series. Whichever method is used, the important part is to separate the isthmus without damaging the other kidney and get provide hemostasis.

The kidney is formed in the pelvic region during the embryological period and normally extends to the renal fossa aligned with the second lumbar vertebra.[19] Ectopic kidney occurs when the kidney is not in its normal anatomical position. If the kidney never rises, it stays in the pelvis and is called a pelvic kidney. Pelvic kidney vascularity occurs from the distal end of the aorta and iliac veins. The ureter is short and is positioned in the renal pelvis ventral.[19] Pelvic ectopic kidneys are mostly asymptomatic and randomly found using imaging methods.[20] Pelvic kidneys are prone to hydronephrosis and the forming of kidney stones. The reasons for this may be; the abnormal positioning of the kidney, to the ureter's entering the pelvis from above, or to veins in the pelvis pressuring the lower pole of the kidney or the upper end of the ureter and disrupting the drainage of urine.[21] Vein and rotation anomalies accompanying pelvic kidney may cause surgical operations to become more complex.[6] Laparoscopic surgeries in experienced hands can be completed successfully, but the constricted area of the pelvis and the hilar structures' position and dissection make it more difficult.[22,23] If laparoscopic intervention is going to be done on a pelvic kidney, preoperative evaluation of pelvic and vascular anatomy is of utmost importance. In this series, preoperative CT angiography imaging was done for the four laparoscopic nephrectomy cases for non-functional pelvic kidney. In three of the four cases, an aberrant renal artery was found. For nephrectomies done on pelvic kidneys, care must be taken in vein dissection, and preoperative CT angiography can help in this area.

Laparoscopic port insertion is also important due to the pelvic position of the kidney. We suggest that the entry points of the ports be modified with the help of preoperative CT angiography imaging

due to the pelvic kidney's having inferior and medial rather than normal positioning. Due to the ureter's being short, however, it can be hard to find the ureter during laparoscopic surgery. Chung et al. placed a ureter catheter to differentiate it from the other vascular structures in the pelvis area and to provide easier intraoperative recognition in one case of laparoscopic nephrectomy surgery on a pelvic kidney.[24] We did not use a ureter catheter in our cases, as it increases the operation's time and cost. We did not have any visualization problem in any of our cases.

CONCLUSIONS

To conclude, the kidney's anomalous anatomical localization, variations in kidney vascularity, and the existence of the isthmus in horseshoe kidneys in patients with congenital anomalies such as horseshoe kidney and ectopic pelvic kidney make laparoscopic surgery interventions more difficult, but laparoscopic nephrectomy of kidneys with anomalies is a procedure that can be done efficiently and safely in experienced hands. We believe that laparoscopic nephrectomy for kidneys with congenital anomalies can become the standard treatment option if supported by studies with more patients.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

All authors contributed equally while this study preparing.

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