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Partial nephro ureterectomy in duplex renal system

Preoperative 3D virtual rendering and retroperitoneal laparoscopic approach in children

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1.1. ABSTRACT

Introduction:

the aim of this study is to presents the results of our preliminary series of 8 partial nephroureterectomy performed by retroperitoneoscopy using harmonic scalpel with a preoperative 3D virtual reconstruction of bidimensional magnetic resonance images in children affected by duplication of the renal system.

Materials and methods: We perform a retrospective study in our Pediatric Surgery Unit from January 2007 to January 2012 of all children affected by duplication of the renal system treated by retroperitoneal laparoscopic approach. Images collected were reconstructed using IRCAD VR render software. Data include: sex, age at surgery, clinical and radiological features, surgical procedure, follow-up and complications.

Results: retroperitoneal laparoscopic partial nephroureterectomy was performed in 8 children (6 males and 2 females). All patients had a non-functioning moiety of a duplex kidney and in addition recurrent urinary tract infections. Two cases were associated with ureterocele; of them in one case we performed a previous endoscopic incision of the obstructing ureterocele. All patients underwent radiological evaluation prior to surgery, by ultrasound,

voididng cystourethrography, renal scintigraphy and contrast-enhanced MRI evaluations. Images collected were reconstructed using IRCAD VR render software. Patients were treated by a 3-4 trocars technique and parenchymal section was performed using harmonic scalpel. The mean operative time was 180 minutes; no cases required open conversion. The mean hospital stay was 5 days. The mean follow-up was 38 months. No cases of secondary atrophy of the lower pole were observed.

Discussion: Volume rendering gives high anatomical resolution and it can be useful to guide the surgical procedure. Laparoscopic retroperitoneal partial nephrectomy is a safe and feasible procedure in children for experienced pediatric laparoscopic surgeons.

1.2. INTRODUCTION

Duplication of the renal system, with one moiety non functional, is one of the most common congenital anomalies of the urinary tract requiring a partial nephrectomy (1). In 1993, Jordan and Winslow first reported sequential bilateral upper pole laparoscopic partial nephrectomy in a girl with bilateral duplication anomalies (2). Since the first description, this procedure has been reported using transperitoneal and retroperitoneal approach and has became the treatment of choice (1). Transperitoneal, and retroperitoneal laparoscopic heminephrectomies has been compared to open series in pediatric patients. All of this series revealed the safety and efficacy of the laparoscopic procedures, as well as decreased hospital stay and narcotic requirements compared to open procedures (3).

We reported our experience with retroperitoneoscopic partial nephroureterectomy using harmonic scalpel with a preoperative 3D virtual reconstruction of bidimensional magnetic resonance images in children affected by duplication of the renal system.

1.3. MATERIALS AND METHODS

We perform a retrospective study in our Pediatric Surgery Unit from January 2007 to January 2012 of all children affected by duplication of the renal system treated by retroperitoneal laparoscopic approach. The indications were either repeated UTIs or persistent hydronephoris after endoscopic incision of ureterocele. Patient demography, symptoms, radiological studies, operation time, hospital stay, postoperative complications and follow-up were reviewed in each case. Images collected were reconstructed using IRCAD VR render software (figure 1, 2).

VR Render

VR rendering is a well known visualization method for the 3D reconstruction of medical images. We used the software VR render. It is an IRCAD image view software that allows to visualize bidimensional images in 3D thanks to volume rendering. It works with CT scans and MRI images. It is based on transparencies and coloration of voxels. Indeed a medical image is composed by a set of voxels that is a pixel in 3D. By given a specific coloration to each voxel we obtain a new 3D image with magnification of anatomical details. It is also possible to manipulate the volume rendering view using clipping plane in order to focus on the lesion.

Technique

The patient is placed laterally and retroperitoneal access achieved through the first trocar incision at 10 mm from the tip of the 12th rib. Gerota's fascia is approached by a muscle-splitting incision with blunt dissection, then opened under direct vision and the first trocar (5 or 10 mm) introduced directly inside the opened Gerota's fascia. The retroperitoneal space is insufflated with CO2 to a pressure of 10 mmHg. Two further 5 mm trocars are inserted under

direct vision. One above the iliac crest and the other below the tip of the 11th rib. The kidney is approached posteriorly. The affected moiety ureter is carefully mobilized (figure 3). The proximal ureter could be ligated with an Endoloop before cutting it in order to facilitating the dissection of the upper pole or it is possible to ligate and cut it after a skin incision in the bikini line in order to avoid leaving an ureteral stump (figure 4). The upper pole ureter is traced towards the pelvis and the main vascular pedicle is identified. The branches to the affected moiety are carefully dissected and divided using an ultrasound scalpel, without stretching the main pedicle. To minimize mobilization of the lower pole and consequently the risk of indirect vascular trauma of the renal pedicle, the lower pole remains attached to the peritoneum during all the steps of the procedure. The upper pole is freed completely from peritoneal attachment before transecting the parenchyma, to avoid any transperitoneal bowel injury. The kidney is then divided through the zone of demarcation (figure 5, 6).

The distal part of the upper ureter is left opened and its contents aspirated to decompress the ureterocele. If it is a refluxing ectopic ureter the distal is dissected as far as possible and ligated. A soft drain is left in the peri-nephric space.

The access to the lower pole is the same as for that for the upper pole.

1.4. RESULTS

During the period of the study a retroperitoneal laparoscopic partial nephroureterectomy was performed in 8 children (6 males and 2 females) 12 months to 4 years (mean age 2.4 years). All patients had a non-functioning moiety of a duplex kidney and in addition recurrent urinary tract infections. Of these patients 7 were upper pole heminephrectomy. Two cases were associated with ureterocele; of them in one case we performed a previous endoscopic incision of the obstructing ureterocele. All patients underwent radiological evaluation prior to surgery, by ultrasound, voididng cystourethrography, renal scintigraphy and contrast-enhanced MRI evaluations. Images collected were reconstructed using IRCAD VR render software. Patients were treated by a 3-4 trocars technique and parenchymal section was performed using harmonic scalpel. In one case we has been obliged to perform an incision in pelvic region in order to complete remove the ureter. The mean operative time was 180 minutes; no cases required open conversion. The mean hospital stay was 5 days. The mean follow-up was 38 months. No cases of secondary atrophy of the lower pole were observed.

1.5. DISCUSSION

The indications for a partial nephrectomy in children are mainly to remove a non-functioning upper or lower pole secondary to complicated duplex anomalies of the kidney (4). Laparoscopic partial nephrectomy is technically more demanding than a laparoscopic nephrectomy. This procedure can be by a retroperitoneal or transperitoneal approach (5). A laparoscopic technique has the benefits of good overall exposure of the anatomy of the kidney and its vascularisation, with no need to mobilized the remaining part of the kidney (6).

The duplex system anomalies have a well-defined vascular line of demarcation between the upper and the lower pole of the kidney. However, sometimes it is difficult to identify and separate the upper pole vessels (7).

The lower pole is more technically demanding than an upper pole nephrectomy. In this case identifying the polar vessels requires a full dissection (8). Preoperatively the use of 3D reconstructions provides unique insights into the anatomical architecture of the malformation and allows to define the relationship with adjacent structures. VR rendering is a well known

visualization method for the 3D reconstruction of medical images. It is an IRCAD image view software that allows to visualize bidimensional images in 3D thanks to volume rendering. It works with CT scans and MRI images. It is based on transparencies and coloration of voxels. Indeed a medical image is composed by a set of voxels that is a pixel in 3D. By given a specific coloration to each voxel we obtain a new 3D image with magnification of anatomical details. It is also possible to manipulate the volume rendering view using clipping plane in order to focus on the lesion. All cases studies with VR render permit to confirm the diagnosis made with standard MRI scans and give to the surgeon a better comprehension of the anatomical details (9).

In our opinion, in this cases VR render is useful to distinguish the demarcation between the upper and the lower pole of the kidney in case of duplex system anomalies. The figures show a reconstruction of the duplex system made from both MRI scans. VR render images permit to appreciate the the anatomical borders of the kidney and the presence of the ureterocele as it is possible to see in the figure.

This data are very important prior to perform a miniinvasive heminephrectomy.

The retroperitoneal approach gives some advantages over the transperitoneal approach. Postoperative ileus and the risk of intestinal injuries are restricted by avoiding the peritoneal cavity. This approach allows a rapid access to the renal pedicle and the anatomy of the duplex system is well-documented. Urinoma or seroma collections remains restricted to the retroperitoneal space (10).

Major technical difficulties are related to general ergonomy: the operation is generally performed in young children with a limited retroperitoneal working space. Any patients, in our report, were under 12 months and probably this fact facilitated the surgical approach, decreasing the risk of complications depending on the age of patients (7).

One of the most difficult and important points of this procedure was thought to be the approach to the polar vessels. Generally the retroperitoneal approach, it is easy to find the renal artery but difficult to find the renal vein. Because dissection of the renal vein has to be performed behind the renal artery, it is very important to find the renal vein and transect the upper pole branch quickly in order to save time (10).

Borzi reported that in patients younger than 5 years the majority of the ureteral length can be excised using the posterior retroperitoneal approach (11). Castellan et all suggested that for this patients, a transperitoneal approach is required when complete excision of the ureter is required, in order to avoid leaving an ureteral stump (12). In one case we has been obliged to perform an incision in pelvic region in order to complete remove the ureter.

Inadvertent injury to peritoneum does not mandate routine conversion to transperitoneal laparoscopy, and it can be a transient problem resolving when the pressure difference in the retroperitoneal space equilibrates, sometimes solving with a needle decompression of the peritoneum. In our experience, we didn’t convert anytime to open surgery and we never use a decompression of peritoneum in order to equilibrate retroperitoneal pressure (13).

The use of harmonic scalpel gived us the possibility to better control all the vessels and it allows to achieve a complete resection of the upper or lower pole without bleeding or injury to the pelvis or calcies (14).

We strictly believe that a good preoperative study of the anatomical region, advanced laparoscopic skills and the use of harminc scalpel are all critical to the success of this kind of surgical approach.

Volume rendering gives high anatomical resolution and it can be useful to guide the surgical procedure. Laparoscopic retroperitoneal partial nephrectomy is a safe and feasible procedure

in children for experienced pediatric laparoscopic surgeons. The laparoscopic magnification provides an excellent exposure of the duplicated anatomy, allowing a full dissection in situ with no need to mobilized the kidney.

1.6. REFERENCES

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1.7. IMAGES

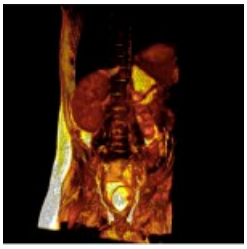

Fig. 1 – 3D Vr render reconstruction. It is possible to well visualize the duplex renal system and ureterocele.

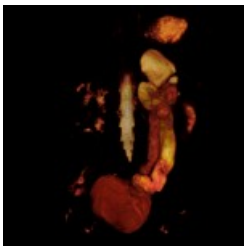

Fig. 2 – 3D Vr render reconstruction. Anatomy of the duplex renal system.

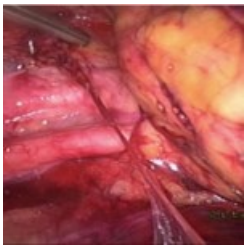

Fig. 3 – Intraoperative image. The image show the duplex ureter system.

Fig. 4 – Extracorporal ligation of ureteral stump.

Fig. 5 – Demarcation line after dissection and ligation of the vessels.

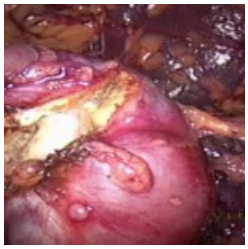

Fig. 6 – Dissection of parenchyma by harmonic scalpel.