

Laparoscopic transposition of lower pole crossing vessels (vascular hitch) in children with pelviureteric junction obstruction

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Background: Congenital hydronephrosis due to intrinsic or extrinsic uretero-pelvic-junction (UPJ) obstruction (UPJO) is a common problem in childhood UPJO may be caused by intrinsic disorganization or by extrinsic compression from crossing vessels (CV); extrinsic causes usually present symptomatically in older children. This report the large Italian experience in the treatment of children with extrinsic-UPJO by CV.

Methods: We analyzed the data of 51 children (17 girls and 34 boys, median age 10, 7 years) affected by extrinsic-UPJO were treated in three Italian institutions with laparoscopic transposition of CV (Hellström Vascular Hitch modified by Chapman). The intraoperative diuretic-test was performed in all patients before and after the vessels transpositions confirming the extrinsic-UPJO. We included in the study only patients with suspicion of vascular extrinsic obstruction of the UPJ. Symptoms at presentation were recurrent abdominal/flank pain and haematuria. All patients presented intermittent ultrasound (US) detection of hydronephrosis (range, 18–100 mm). Preoperative diagnostic studies included: US/doppler scan, MAG3-renogram, functional-magnetic-resonance-urography (fMRU).

Results: Median operative time was 108 minutes; median hospital stay: 3, 4 days. Unique complications: a small abdominal wall hematoma and higher junction-translocation without obstruction. During follow-up (range, 12–96 months) all patients reported resolution of their symptoms, a decrease in the hydronephrosis grade and improved drainage on diuretic renogram.

Conclusions: We believe that Vascular Hitch is less technically demanding than laparoscopic pyeloplasty, resulting in a lower complication rate and a significantly reduced hospitalization. The results of our study allow us to conclude that laparoscopic VH may be a safe, feasible, and attractive alternative to treat obstructed hydronephrosis due to CV presenting a useful alternative to AHDP in the management of symptomatic children where CV are deemed the sole aetiology. We recommend careful patient selection based on preoperative clinical and radiologic findings that are diagnostic of extrinsic-UPJO, combined with intraoperative-DT to confirm the appropriate selection of corrective procedure.

Keywords: Extrinsic uretero pelvic junction obstruction; laparoscopy; vascular hitch

Submitted Sep 12, 2016. Accepted for publication Sep 22, 2016.

doi: 10.21037/tp.2016.09.08

View this article at: <http://dx.doi.org/10.21037/tp.2016.09.08>

Introduction

Uretero-pelvic-junction obstruction (UPJO) may be caused by intrinsic disorganization or by extrinsic compression from crossing vessels (CV); extrinsic causes usually present symptomatically in older children. The association was first described by Von Rokitansky in 1842 (1-3). Open or Laparoscopic Dismembered Pyeloplasty is the gold standard procedure to treat UPJO since the procedure was first described by Anderson and Hynes (AHDP) in 1949 (4). An alternative approach to pure extrinsic-UPJO was described by Hellström (5) in the same year, it involved displacing the lower pole vessels cranially and then anchoring them to the anterior pelvic wall using vascular adventitial sutures. Chapman (6) further modified this technique by securing a more superior position of the lower pole vessels within a wrap of the anterior pelvic wall without the need for vascular adventitial sutures. This technique has since been described in children as an alternative to open dismembered pyeloplasty, with the largest series reported in 1999 by Pesce (7).

Aberrant vessels usually cause intermittent UPJO. These cases have a normal perinatal history, followed by the subsequent onset of clinical signs and symptoms, often influenced by the child's hydration status, and characterized by intermittent hydronephrosis on imaging and normal kidney function. The aberrant vessels typically cross over the UPJ to perfuse the lower pole of the affected kidney. Currently, there are no definitive imaging techniques or intraoperative procedures available to confirm the aetiology of UPJO. As noted by Schneider (8), frequently one encounters anatomic variability in the relationship between the renal pelvis and the lower pole vessels. Therefore, we included intraoperative diuretic-test (DT) after polar CV-dissection in all our cases. In pure extrinsic-UPJO the pelvis drains rapidly, whereas inadequate drainage points toward intrinsic causes of obstruction.

Methods

From January 2006 and December 2014, 51 children (17 girls and 34 boys,) affected by extrinsic-UPJO were treated in three different institutions with laparoscopic transposition of aberrant CV (Chapman Vascular Hitch). All anatomical relationships between lower pole CV and UPJ were classified according to Schneider *et al.* (8). The technique was assessed by a leader centre that standardized the surgical steps.

Surgical indications included two or more of the following conditions: presence of clinical symptoms, obstruction on diuretic renogram ($^{99m}\text{Tc-MAG3}$), decrease on relative renal function, clear or suspected image of polar vessels on functional-magnetic-resonance-urography (fMRU), worsening of intermittent hydronephrosis on follow-up.

The median age at presentation was 127 months (range, 24–213 months). None of the children had prenatal diagnosis. All patients in the 3 centres were studied by ultrasound/Doppler Scan and $^{99m}\text{Tc-MAG3}$, while only 33 patients (64%) underwent to fMRU.

All had high-grade hydronephrosis (GIII–GIV) according to the Society of Fetal Urology classification [9]. All patients presented intermittent symptoms: flank pain, or renal colic, associated vomiting and marked hydronephrosis at the time of pain with primarily extrarenal dilatation, 5 presented haematuria.

The patients were hospitalized 24 hours before surgery, starting with liquid diet and bowel cleansing with laxative and enemas. The procedure adopted was for all patients the “Hellström Vascular Hitch modified by Chapman”, performed by only three surgeons (one senior surgeon for each team). The diuretic-test was performed after CV mobilization, by administering a bolus of normal saline (20 mL/kg IV) starting 10–15 minutes before the laparoscopic vessel mobilization, followed by furosemide 1 mg/kg IV early in the operative course.

Surgical technique consisted in mobilization of CV via the transperitoneal approach in a modified lateral decubitus (45°) with the patient placed at the edge of the surgical table. A bladder catheter and nasogastric tube were positioned before starting the procedure. As instruments we used an optical port of 5 or 10 mm with a 30° laparoscope (according to patient's age and weight) and two 3-mm working ports, in the epigastrium and in the ipsilateral iliac fossa at the midclavicular line, to allow an ideal triangulation during dissection of the aberrant CV and completion of the pelvic wrap. Pneumoperitoneum was induced with a 5–10 mmHg pressure CO_2 . We preferred a trans-peritoneal approach because it provides better anterior access to the renal pelvis and the anterior CV. The technique consisted in the exposure of the lower pole vessels through a window in the mesocolon (especially on the left side), or by partial ipsilateral colon flexure mobilization if necessary (especially on the right side). The CV were then dissected and mobilized off the UPJ. After careful dissection of the vascular bundle and release of ureteral adhesions, we usually observed the decrease of size of the renal pelvis.

Full mobility of the UPJ was confirmed by moving freely the upper and lower portions of the anterior pelvis wall just behind the CV as a shoeshine (shoeshine manoeuvre) ensuring the appropriate mobilization of the pelvis wall. The UPJ was carefully inspected for any intrinsic stenosis, and free urine passage was observed across the junction after vessel transposition (diuretic-test). Sequentially, the vessels were sutured in a tunnel formed by an invagination of the anterior pelvic wall as described in the Chapman procedure (8-11). One tip was to pass the first suture transparietally, stabilizing and fixing the vascular bundle into the pelvic tunnel to assist the remaining suture.

Two/three interrupted 4/0-polydioxanone absorbable sutures (pyelo-pyelic sleeve) may be necessary to achieve an adequate tunnel within the anterior pelvic wall.

During laparoscopy, each case was carefully evaluated regarding presence and position of CV, appearance of the UPJ, ureter course and DT-response of the dilated pelvis after vessels displacement. The main criteria to apply VH were the following: (I) presence of obstructing lower pole CV; (II) normal UPJ on inspection; (III) DT-response with emptying of the dilated pelvis after vessel displacement in order to confirm release of the obstruction and to exclude intrinsic-UPJ anomalies. In agreement with other authors, we considered a sign of absent obstruction the emptying of the renal pelvis under water load (with diuretic administration) after removal of vascular pedicle. No JJ-stent was inserted. Success after procedure was defined as resolution of symptoms, improvement of hydronephrosis, and/or increased elimination on diuretic renogram.

Results

Laparoscopic vascular relocation was feasible in all cases without open conversion. Median operative time was 108 minutes (range, 75–230 minutes). We recorded a small hematoma on the closure of the peritoneum and an higher junction translocation in 2 cases without obstruction. In accordance with Schneider's classification (8) 3 children presented type-2 as anatomical variation while the remaining type-3. Discharged occurred after 3, 4 days. All patients had clinical evaluation and a renal-US at 1–6 months, and diuretic-renogram 6 months following surgery. Follow-up (range, 12–96 months) showed complete resolution of symptoms (pain, hematuria), and decrease in hydronephrosis grade. Although none of the children displayed significant improvement in relative renal function, all of them showed improved drainage on 99mTc-

MAG3-renogram and became unobstructed.

Discussion

Usually UPJO is caused by the presence of an aperistaltic dysplastic segment of the UPJ. Besides this intrinsic aetiology, extrinsic factors, as aberrant lower pole CV, may be the causative factor.

Although there are no studies to date, crossing the UPJ by an aberrant vessel may be the most common extrinsic cause of UPJO above all in older children. CV are thought to cause from 40% to over 50% of extrinsic-UPJO in adults; they are more often ventrally located than dorsally to the UPJ. These aberrant vessels are usually normal morphologic vessels of the lower pole segment, which can be divided into additional renal arteries arising from the aorta and accessory renal arteries arising from branches of the aorta (12). The controversy regarding the functional significance of vessels crossing at the UPJ is not a new one, although the debate has been resurrected in recent years because of improved detection due to the advent of advanced imaging techniques such as CT and fMRU.

The incidence of UPJO by CV in children has been reported in a range from 11–15% (13), but was as higher as 58% in a series of older children with symptomatic UPJO and a history of normal antenatal renal ultrasonography (14).

The open-AHDP described in 1949 (4) remains the gold standard surgical treatment of intrinsic and extrinsic-UPJO. In the last years, the open technique has gradually given way to laparoscopic repair and more recently, to robotically assisted AHDP, with comparable results. The alternative approach, Chapman VH (5,6), has been described in children by Pesce (Paediatric Surgery Department in Vicenza) who reported a series of 61 children treated by open-VH with excellent outcomes (7). The UPJO by CV is intermittent and must be suspected in older children with recurrent renal colic pain and hydronephrosis. The renal function may be normal in children with UPJO without Urinary Tract Infection (UTI) (1,10,15,16). In our series, only three children had a major loss of kidney function, probably because of the high delay in the diagnosis (patients with hydronephrosis >4 cm). Similar results have been reported by Hacker (15) who found that children with UPJO by polar vessels had decreased relative renal function and delayed surgical management.

We reviewed the literature and found few published series of laparoscopic relocation of lower pole CV in children with intermittent UPJO. The most recent series

is reported by Schneider (8) (successful in up to 95% of patients), and Chiarenza-Bleve (17), (successful in 97% of patients), provided a careful selection of candidates.

Meng and Stoller (in 2003) were the first authors reporting vascular relocation using the Hellstrom technique via laparoscopic approach. They reported this procedure in nine adults, with resolution in all cases. These authors observed that the herniation and subsequent ureteral kinking were responsible for the obstruction and stated that changing the geometry may be enough to alleviate the obstacle (18).

Another important condition is the existence of several anatomic variations as studied by Sampaio (19). These double vascular bundles form a vascular window and could facilitate a UPJ prolapse with increasing obstruction (10). Vascular compression in these cases is not in the UPJ but in the proximal ureter. Therefore, the junction is certainly healthy, and correcting the herniation is all that is needed (8,11,20).

This observation is supported by histological analysis of the UPJ and CV. Normal muscle density was found and suggests an inherently different UPJ configuration between intrinsic and extrinsic obstruction.

Essential to the success of the VH-procedure is the careful pre and intraoperative selection of candidates: only patients with pure extrinsic-UPJO can be treated with this procedure, so any associated intrinsic UPJ abnormality must be ruled out. Some authors, as Janetscheck, have recommended that the UPJ should always be explored by a longitudinal incision in order to rule out such associated intrinsic anomalies, which they report in up to 33% of their patients (21).

Some reports analysed the histology of resected UPJ tissue, and have showed evidence of intrinsic fibrosis and inflammation in cases where CV was thought to be the aetiology of the obstruction. Lower pole vessels may predispose the UPJ to the narrowing that favours infection or inflammatory episodes, or that causes tension and ischemia, thus resulting in fibrosis and stenosis of the urothelium. The presence of this UPJ fibrosis could be one cause of hypothetical failure of the VH-procedure (8-11), even though there is no evidence to suggest that the fibrosis is progressive. In addition, electron microscopy studies of extrinsically obstructed UPJ tissue demonstrate no significant structural changes in muscle or collagen content, or in nerve distribution, immunohistochemically, when compared to normal controls. Conversely, intrinsically obstructed tissue showed thinning of muscle fascicles with dense collagenous

deposits when compared with controls (13).

On the basis of our large experience we would like to express our opinion on surgical treatment of extrinsic-UPJO by CV in paediatric patients. First, it is important to perform a complete preoperative work-up to give correctly the indication for surgery and to use it as the basis to check the patient after surgery. To maintain a high success rate with VH-procedure, we found that careful selection of patients is essential, and follows three criteria: preoperative patient selection, accurate diagnostic studies, and the performance of intraoperative-DT to confirm extrinsic-obstruction. As preoperative evaluation, various imaging modalities have been used including Doppler/US, spiral-CT, fMRU, and rarely, diuretic urography. None of these modalities has an accuracy of 100% in the diagnosis of pure extrinsic-UPJO caused by lower pole CV. Therefore, we believe that a careful clinical history remains the basis for correct patient selection. No patients had history of prenatal hydronephrosis. They all presented with intermittent colicky flank pain, sometimes associated with vomiting or haematuria. All showed marked hydronephrosis with a dilated pelvis but relatively mild calyceal dilatation when they were symptomatic, that resolved shortly after they became asymptomatic.

Godbole (11) reported success with a similar procedure in 12/13-patients with a median age of 10 years; we were successful in all 51.

Based on our experience, we believe that a success rate >90% may be achieved with the VH-procedure, but a close cooperation between surgeon and anaesthesiologists is required to perform the intraoperative-DT correctly. The saline bolus needs to be timed so that the renal pelvis is well dilated prior to vessel dissection and mobilization, and with IV furosemide administration, the operator will observe rapid emptying of the bloated renal pelvis, followed by normal ureteral peristalsis. If the UPJ has intrinsic abnormalities, pelvic dilatation remains.

The test is crucial because it allows to discriminate a variability of cases that can occur, related to the location of the abnormal vessels and their relations with the ureter and UPJ, the size of the vessels, the presence of hydronephrosis with sufficient tissue to consent the VH (index of the presence of an obstruction), the size of the junction and the presence of ureteral peristalsis.

Some authors have suggested the use of pelvic distension with saline by direct puncture of the pelvis or an intraoperative pelvic pressure measurement with laparoscopic visualization prior to ureteral dissection,

inserting percutaneously into the renal pelvis a fine-needle evaluating the ureteral opening pressure with a column device before and after the procedure was completed (1,8).

Our aim is to render this test (pelvic emptying) into objective parameters. It is clear, however, that this is a simple and reproducible “bedside” test. One of the great advantages of the VH-procedure is to preserve the UPJ integrity, eliminating the risk of leakage or urinoma and preserving the physiologic pyeloureteral motility and ureteral peristalsis. In several cases, it was possible to observe the pyeloureteral peristalsis after the vessels mobilization.

As for the technical point of view, in our mind laparoscopy is the procedure of choice to perform this procedure, but it is important that surgeons have a strong experience.

In conclusion we believe that Vascular Hitch is less technically demanding than laparoscopic pyeloplasty, resulting in a lower complication rate and a significantly reduced hospitalization. The association of a dynamic, objective demonstration of pelvic emptying (diuretic-test) with the precise anatomical localization of CV and UPJ provided by the laparoscopic approach, was associated, in this series, with very favourable outcomes. These findings allow us to conclude that laparoscopic VH may be a safe, feasible, and attractive alternative to treat obstructed hydronephrosis due to CV presenting a useful alternative to AHDP in the management of symptomatic children where CV are deemed the sole aetiology. We recommend careful patient selection based on preoperative clinical and radiologic findings that are diagnostic of extrinsic-UPJO, combined with intraoperative-DT to confirm the appropriate selection of corrective procedure.

Acknowledgements

None.

Footnote

Conflicts of interest: The authors have no conflicts of interest to declare.

Ethical statement: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Being our

study retrospective, formal consent is not required.

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Cite this article as: Esposito C, Bleve C, Escolino M, Caione P, Gerocarni Nappo S, Farina A, Caprio MG, Cerulo M, La Manna A, Chiarenza SF. Laparoscopic transposition of lower pole crossing vessels (vascular hitch) in children with pelviureteric junction obstruction. *Transl Pediatr* 2016;5(4):256-261. doi:10.21037/tp.2016.09.08