Dialogues in Pediatric Urology

CONTRIBUTORS

Update and Controversies in Laparoscopic Paediatric Urology - Part II

Orchiopexy and Upper Tract

FROM THE GUEST EDITOR

Pedro Jose-Lopez, MD
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Dear Friends and Colleagues;

Hopefully you truly enjoy Part One of this series "*Update and Controversies in Laparoscopic Paediatric Urology*". As you know, this current issue contains information about more common MIS issues in Paediatric Urology including orchidopexy and upper tract, where we can find nephrectomies, tumoural resective surgery and pyeloplasty.

As we all know, there are many ways of approaching each of this procedures….. maybe too many in some cases. Therefore, this issue is more about those **controversies** that we face every day. We have invited experts in each technique to "expose and defend" their own method, leaving the final decision regarding the best option for your patient, to you.

As the articles of this 2nd part are based on the authors own experience (with technical details and expectantly useful tips) the main goal of this issue is to encourage you and your team to take a moment to discuss the analysed topics and get some valuable messages. Furthermore, these messages could either guide you to start more complicated MIS in paediatric urology or reinforce your current practice. Or, after questioning your present method, be persuaded to change to a new one that could better serve you and your team.

We would like to invite you to enjoy this second issue of the series "*Update and Controversies in Laparoscopic Paediatric Urology.*" I encourage you to make time in your crazy schedule to discuss and share these articles with your team, as that will untimately benefit your own patients.

FROM THE EDITOR

Elizabeth B. Yerkes, MD

After finding some inspiration to be a better teacher or learner in Part I of this series, I now encourage you to feast upon Part II with its focus on laparoscopic orchiopexy and upper tract ablative and reconstructive procedures. Part III will round out the series with lower tract surgery and reconstructive procedures.

While many of the procedures in Part II would be considered first-tier accessible for minimally invasive pediatric urologic surgery, nearly everyone will find some surprising technical nuance or viewpoint in Part II to ponder and to share with associates, residents and fellows.

The unifying message is that there are multiple approaches, incorporating both small and large variations, to achieve an excellent surgical outcome. While it can be demonstrated in many cases that MIS has some distinct advantages over traditional open procedures, it will be very difficult to demonstrate superiority of one MIS approach over another. It is really surgeon experience and the complexity of the pathology that should dictate the surgical approach— what a relief that an open surgical approach can still be the right answer! We can however snatch up technical pearls from each other to modify our own approach. Just to highlight a few in Part II: entertaining two-stage laparoscopic orchiopexy for redo orchiopexy, facilitating intra-renal dissection in heminephrectomy, finding your way retroperitoneoscopically, establishing a protocol for your team *and* taking the time to periodically reassess for enhancements.

Whether you are continuing to build your MIS repertoire or already highly polished in one approach, Parts II and III are ready to be your pocket mentor. Many thanks to all of the contributors for their expertise, algorithms and candor!

APPROACHES TO LAPAROSCOPIC ORCHIOPEXY

Single-Stage Laparoscopic Orchidopexy

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A 7 month old male presenting for evaluation and management of a non-palpable left testis since birth is a common clinical scenario for pediatric urologists. 3.7% of all newborn males are born cryptorchid and 0.9% will remain so by 1 year of age. While approximately 80% of cryptorchid testes are palpable, about 3/4 of the remaining 20% of non-palpable testes are found intra-abdominally and the remaining 1/4 will be monorchid. The clinical questions are simple: how should the presence of a testis best be ascertained, and how should orchidopexy best be performed? The answer is simple – laparoscopically.

Surgical Technique

After induction of general anesthesia, a Foley catheter and a nasogastric tube are placed. Open insertion of a 5 mm trocar into the abdomen is performed through an infra-umbilical or trans-umbilical incision and 6-10 mm Hg of CO_2 pneumoperitoneum is obtained. Two working 5-mm trocars are placed under direct vision at each lateral rectus margin at the umbilical level. (Figure 1) The position of the testis is assessed as well as the vasculature to the testis. A single-stage approach is deemed appropriate if the testis is below the iliac vessels and if the vasal vessels appear satisfactory. The lines of peritoneal incision are: (1) parallel and lateral to the gonadal vessels from the internal inguinal ring cephalad as high as possible, (2) caudad to the vas deferens from the internal ring proceeding medially crossing the obliterated umbilical ligament, and (3) across the gubernaculum, when present, as caudally as possible so it can be used as a handle during mobilization of this triangular pedicle off of the posterior abdominal wall.

Figure 1. Port placement for laparoscopic orchiopexy – the camera port is placed umbilical (either infra or trans) and two working ports are placed at each lateral rectus edge at or just below the level of the umbilicus. The fourth port is placed through the scrotum to bring the testis into position.

Single-Stage Laparoscopic Orchidopexy *(continued from previous page)*

One way to determine if sufficient length of dissection has been achieved is to draw the testis towards the contralateral internal inguinal ring. If the testis does not easily reach the ring, it is simple to further incise the peritoneum lateral to the vessels and provide further mobilization. To gain additional length, one can incise across the peritoneum covering the triangular pedicle.

A "neo ring" is created lateral to the bladder and medial to the obliterated umbilical ligament. A pointed-tipped laparoscopic instrument is passed into the neohiatus, over the pubic symphysis, and into the ipsilateral hemiscrotum while being careful to avoid injuring the bladder. A fourth 5-mm trocar is passed into the abdomen through the subdartos scrotal pouch over the pointed tipped instrument. Via this last trocar, the gubernaculum is grasped with a toothed forceps, securing proper cord orientation, and passed into the ipsilateral hemiscrotum. The pneumoperitoneum is released to better assess the position of the testis. If additional length is still needed, and the peritoneum over the triangular pedicle can be incised, or even the Fowler-Stephens procedure can be performed, if necessary. (Figure 2)

Pneumoperitoneum is continued while fascial closure of the working ports is performed, under direct laparoscopic vision, to prevent visceral herniation or injury to an intra-abdominal structure. The abdomen is deflated, the camera port removed, and the umbilical port is closed. The skin incisions are closed with subcuticular absorbable monofilament suture.

Deciding on the Fowler-Stephens Maneuver

The intent of the Fowler-Stephens maneuver is to gain additional length of the cord facilitating a more dependent placement of the testis. Transection of the internal spermatic vessels is achieved after ligating the vessels with surgical clips. The intraoperative points at which this decision can be made are: (1) initially, when assessing the distance of the testis from the verge of the inguinal canal and the nature of the vessels; (2) after mobilizing the triangular pedicle; or (3) after incising the peritoneum across the triangular pedicle. The viability of the testis will be predicated on the viability of the vasal and other accessory vessels, and this is best accomplished when there is minimal dissection. Thus, the best time to make this decision is at inspection.

Fowler-Stephens Technique

After deciding upon performing the Fowler-Stephens maneuver after initial inspection, the peritoneum overlying the internal spermatic vessels is opened and the vessels ligated and then divided (Figure 3). Whether Fowler-Stephens maneuver is performed at that time (one-stage) or about 4-6 months later (two-stage), the dissection and remaining steps of the surgery are as described as above. If the Fowler-Stephens maneuver is performed at either of the other two time points [2 or 3 listed above], the dissection has already been performed, and testis is relocated to the scrotum as described above.

Argument for Single-Stage Non-Fowler-Stephens Procedure

Since Jordan described laparoscopic orchidopexy in 1992[1] and laparoscopic staged Fowler-Stephens procedure in 1994[2], many series have reported success rates that surpass those of open orchidopexy. A meta-analysis conducted by Docimo[3] of open orchidopexy for intra-abdominal testes found an overall success rate of 76.1%: transabdominal (81%), single-stage Fowler-Stephens (67%), two-stage Fowler-Stephens orchidopexy (73%). In contrast, a multi-institutional study of laparoscopic orchidopexy[4] found higher success for all analogous laparoscopic orchiopexies: single-stage non-Fowler-Stephens (97.2%), one-stage Fowler-Stephens (74.1%), two-stage Fowler-Stephens orchidopexy (87.9). The atrophy rate was 6.1% for all cases; 2% for single-staged non-Fowler-Stephens cases, 22% after single-stage Fowler-Stephens and 10% after two-stage Fowler-Stephens cases. Surgical success should be defined as a viable testis, located dependently in the scrotum to allow for subsequent physical examination. Unfortunately, viability is generally deemed by the author and there are sparse reports of long-term experiences. Esposito[5] reported on 12 patients with at least 10 year follow up who underwent two-stage laparoscopic Fowler-Stephens procedure. The operated testis was always smaller than the normal testis, despite good vascularization on Doppler ultrasound in 10 testes (83.3%); 2 (16.7%) testes were atrophic.
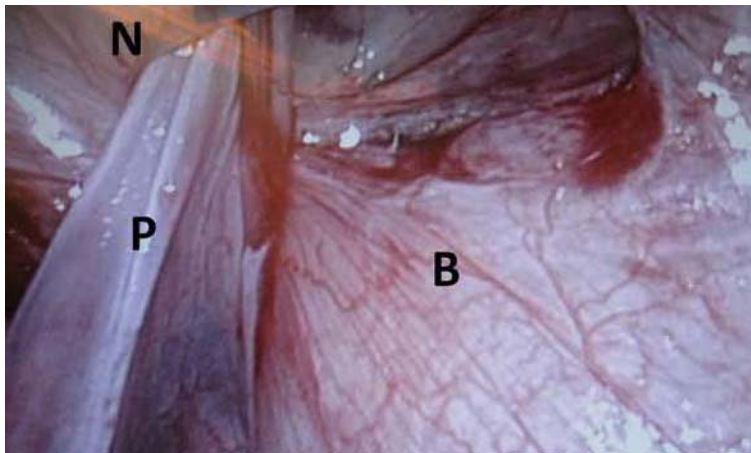
Figure 2. Intraoperative photograph of the abdomen after the testis has been delivered into the scrotum through the neohiatus (N) lateral to the bladder (B) demonstrating the pedicle of vessels under the intact peritoneum (P).
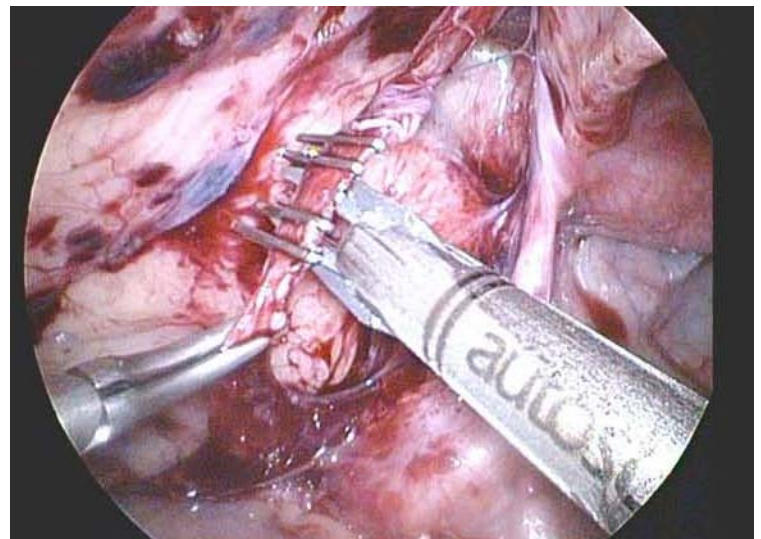

Figure 3. Intraoperative photograph of internal spermatic vessels soon to be divided between two sets of clips. The Fowler-Stephens maneuver was performed in this case after delivering the testis into the scrotum without dividing the triangle of peritoneum and determining that there was excessive tension on the testis

Single-Stage Laparoscopic Orchidopexy *(continued from previous page)*

These collective experiences support performing a single-stage non-Fowler-Stephens procedure, but the surgeon's own experience should drive that decision. Our most recent published experience of 203 testes found that 70.5% of the testes were amenable to a non-Fowler-Stephens procedure and there was 100% postoperative viability.[6] Four testes required secondary surgery to improve their position, but all were high testes that in retrospect should have undergone a Fowler-Stephens procedure; three of these revisions were performed early in our experience. We attributed the high success rate to minimal manipulation of the testicle during dissection, maintaining a wider peritoneal window, and sparse use of electrocautery.

Single-Stage vs. Two-Stage Fowler-Stephens Procedure

Clearly there would be greater security for surgeons to stage the repair until a comfort level is gained in performing the procedure, and more importantly, comfort in judging early whether division of the spermatic vessels was needed.

Deciding to divide the vessels after skeletonization of the vessels, after significant vasal dissection, after enthusiastic use of electrocautery, or after recognition of inadequate pedicle length may compromise the viability of the collateral vasculature and increase the likelihood of atrophy. Similarly, atrophy can be caused by excess tension on the testis after fixation where the surgeon is appropriately reluctant to divide the vessels at that point. However, deciding at inspection, or very early in the dissection, that the Fowler-Stephens maneuver is needed should allow the surgeon to maintain a wide peritoneal area with the associated vessels that should improve gonadal survival.

It is sometimes vague from the literature regarding the success rates of Fowler-Stephens procedures (single-or two-staged) at what point the decision to divide the vessels was really made. Baker's[3] multi-institutional study indicates superiority in the two-stage procedure. In our own series, Lindgren[7] reported our early experience with Fowler-Stephens laparoscopic orchidopexy; the success rate was 89% among 18 testes. Since our case volume was low, an issue with all series, one needs to be careful in assessing which procedure is superior, as there was only one failure in each procedure: 1/13 (92%) one-stage vs. 1/5 (80%) two-stage procedure. Chang[8] reported an overall 85% success rate for all Fowler-Stephens procedures (23 of 27) and a 4% atrophy rate. Of the 20 one-stage Fowler-Stephens orchidopexies, 17 testes were successfully placed in the scrotum without atrophy. These results continued in Samadi's[6] updated series.

Bilateral intra-abdominal testes

Chang reported that among intra-abdominal testes, 25% were bilateral.[8] In 2008, we reported on a single-surgeon experience with bilateral laparoscopic orchidopexy (BLO) in 21 boys.[9] A single-setting BLO was attempted for all 42 testes and was completed in 36 testes (18 boys). A physical examination to assess testicular viability and position was performed at 14 days, 6 months and 1 year postoperatively. Four of the 42 cases (9.5%) underwent laparoscopic Fowler-Stephens orchidopexy: 2 in a one-stage and 2 in a two-stage procedure. These latter 2 cases account for 2 of the 3 boys whose orchidopexies were not completed in a single setting; however, both boys had bilateral viable intrascrotal testes at 1 year follow-up. The position of the testes following laparoscopic orchidopexy was mid-lower scrotum (38), upper scrotum (3), and inferior pubic/superior scrotal (1). Viable testes were noted in 40 of 42 testes (19/21 boys) on 6-month follow-up. The atrophic testes followed one single-stage and one two-staged Fowler-Stephens procedures. Nineteen of 21 boys (91%) ultimately achieved bilateral viable intrascrotal testes.

Summary

Laparoscopy has revolutionized the management of the non-palpable testis both diagnostically and therapeutically as the laparoscopic orchidopexy provides more successful repositioning of a viable testis from the abdomen to the scrotum than analogous open surgery. The surgeon should begin each case anticipating that a single stage repair, with or without Fowler-Stephens maneuver, will take place and then make that decision as early as feasible based on the position of the testis below the iliac vessels and the perceived adequacy of the vasal vasculature. If this decision is delayed until dissection has started, then the assessment of adequacy of the mobilization of the pedicle should be made before incising the overlying peritoneum. The surgery is then either completed (with or without sparing the internal spermatic vessels) or the surgeon proceeds with a two-stage procedure.

There are several conclusions from the literature and from personal experience regarding single-stage laparoscopic orchidopexy:

1. A single-stage approach can be considered for most intra-abdominal testes.
2. A single-stage repair obviates the risks associated with a second Anestheticand with operating in a previously operated field.
3. A two-stage repair should be reserved for testes that are high in the abdomen, perhaps using the iliac vessels as a landmark, or it is used when the surgeon has trepidation and prefers a two-stage approach.
4. The decision to proceed with a single-stage repair should be made early in the surgery, optimally at the time of laparoscopic inspection.
5. Technical aspects that may increase testis viability include minimal testicular manipulation during dissection, maintaining a wide peritoneal window, and using electrocautery sparingly.
6. Single-stage bilateral laparoscopic orchidopexy represents a natural progressive step in properly selected patients and yields comparable outcomes to those of unilateral laparoscopic orchidopexy.
7. The first orchidopexy should be performed on the "easier" side. If the intraoperative outcome appears to be successful, the surgeon should proceed to the contralateral testis.
8. The same considerations made during a unilateral laparoscopic orchidopexy (position, vasculature, Fowler-Stephens, technical factors) should be made to each of the two intra-abdominal testes.

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Laparoscopic Two-Stage Fowler-Stephens Procedure For Undecended Testis – A Personal Perspective

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Introduction

This article features the personal perspective of a specialist paediatric urologist, with more than 10 years experience in minimally invasive surgery, on the subject of the undescended testis. The comments are mostly based on his considerable personal experience, rather than on published data. Sometimes we can learn more from our instincts and lively debate than from the written word.

Background

An undescended testis occurs in approximately 0.8-1% of 1 year old boys, and in about 20% of cases the testis will be in a non-palpable location (NPT).[1-3] Half of the patients with a NPT will have an intra-abdominal or high inguinal ('peeping') testicle.[2,4] The surgical management of this group of patients can be challenging and is controversial. In 1959, Fowler and Stephens described an open single-stage inguinal technique in which the testicular vessels were isolated and divided to facilitate the mobilization of the testis to the scrotum.[5] Almost 30 years later this technique was modified by Ransley, describing a staged open approach for the treatment of the intra-abdominal testicle in patients with Prune Belly syndrome.[6]

Laparoscopy as a Diagnostic and Therapeutic Tool

For the assessment of NPT, laparoscopy is widely practiced. In general, there is no place for radiological imaging for the NPT due to a lack of sensitivity and specificity.[1,2] The only role for radiological imaging is when laparoscopy has demonstrated a vas entering a closed internal ring without any evidence of the testicular vessels. In these patients an abdominal MRI is recommended after puberty to elucidate the possibility of testicular tissue adjacent to the lower pole of the kidney.

At Great Ormond Street Hospital for Children (GOSH) when a child presents with a NPT, we would perform a diagnostic laparoscopy and if this demonstrates an intra-abdominal testis, we would proceed to a two-stage laparoscopic Fowler-Stephens orchidopexy. The ideal age is around 6 months of age, with a 6-month interval between the 2 stages. However, if a testis remains non-palpable at 3 months of age, it is unlikely to become palpable by waiting another 3 months. Therefore, in our view, diagnostic laparoscopy should be considered from 3 months of age.

Technical Aspects of Staged Laparoscopic Orchidopexy

1. Laparoscopic First Stage Fowler-Stephens Orchidopexy:

In most cases only two trocars are required: an umbilical open Hasson trocar (5mm 30° camera) and 1 instrument trocar (5 or 3 mm.). After dividing the peritoneum you create a window, mobilize the vessels and then either clip or diathermy the vessels. Of course you will need a 5 mm port if you are using endoclips. We generally avoid dividing the vessels at the first stage. In addition we perform minimal division of the peritoneum. The main reason for this is to avoid reducing the width of the pedicle suspending the testicle and in this way minimizing the theoretical possibility of testicular atrophy from a torsion event. To date we have not experienced testicular atrophy following the first stage Fowler-Stephens orchidopexy with this approach.

2. Laparoscopic Second Stage Fowler-Stephens Orchidopexy:

For the second stage we wait a minimum interval of 6 months. Once again we use an umbilical open Hasson trocar (5mm 30° camera), and 2 instrument trocars are used to mobilize the testicle. Initially, the previously ligated testicular vessels are divided. The vas is then mobilized with a wide strip of peritoneum, taking care to avoid handling the vessels surrounding the vas. As the dissection proceeds into the pelvis, the ureter should be identified. After we have mobilized the testicle, we have found useful the test to bring the testis up to the opposite internal ring to see if there is an adequate length.

For the orchidopexy, using a laparoscopic Kelly forceps we go down into the natural inguinal canal. We run that instrument down, coming into the external ring and then into the scrotum. You should do this very carefully, remembering that your femoral vessels are very close. Once in the scrotum, you make your incision and sub Dartos pouch. After that, with a small piece of suture, one end in an artery forceps and the other end in the laparoscopic Kelly forceps with the two tips of the instruments touching, and you go backwards into the peritoneal cavity. Next, you should open the jaws of your artery forceps just to widen the canal you have made and then grasp the testis and pull it down along his natural route. After that, we put the testis into a sub Dartos pouch with one or two stitches.

Laparoscopic Two-Stage Fowler-Stephens Orchidopexy for the 'Peeping' Testis

The high palpable testicle, what some people call the 'peeping' testis, is a case where the testis is essentially an intra-abdominal testicle with a patent proximal inguinal canal. The testis can move in and out of the abdominal cavity, and sometimes with very careful manipulation one can milk the testicle into the proximal inguinal canal. However, it is usually not possible to manipulate the testis into the scrotum, due to the fact that the main underlying problem is short testicular vessels. For this reason, even with the best surgical technique and a high inguinal approach, it is usually not possible to position the testicle in the base of the scrotum. We believe that with a two-stage laparoscopic approach, one can achieve a more desirable position in the base of the scrotum with a similar atrophy rate. It is important to have the testicle in the more natural position, not only for fertility or endocrine function, but also for the cosmetic outcome and to facilitate testicular self-examination in adult life.

Laparoscopic Two-Stage Fowler-Stephens Technique for Redo Orchidopexy

There is a place for considering the two-stage Fowler-Stephens orchidopexy in redo cases. In order to understand if the patient is suitable for this approach, one must first review the original presentation, examination findings and the operative record. If the child had a classical undescended testis and a straightforward orchidopexy that has failed, then we would perform an open redo orchidopexy. The reason behind this is that the most likely reasons for failure are either inad-

Laparoscopic Two-Stage Fowler-Stephens Procedure *(continued from previous page)*

equate mobilization of the testicular vessels or the testis becoming displaced back into the groin. However, there are those cases where the testis was in a proximal inguinal position or a 'peeping' testis where the child had a difficult orchidopexy and the testis was placed in the scrotum but under tension. In this group of patients we believe there is a place for considering a laparoscopic two-stage Fowler-Stephens redo orchidopexy. The risk of testicular atrophy is likely to be somewhat higher in these redo cases, but by adopting the staged approach we feel that one can achieve a more desirable position of the testis in the scrotum.

Outcomes of the Laparoscopic Two-Stage Fowler-Stephens Orchidopexy

The experience at GOSH with this approach has been very encouraging. A recent review of boys treated from 2000 to 2009 with the laparoscopic two- stage Fowler-Stephens orchidopexy included 109 testes in 89 boys. The documented atrophy rate is 12% (unpublished data). We identified a clear association between wound infection and higher atrophy rate.

There is extensive literature available that compares different approaches. Baker et al documented a much higher atrophy rate with a single stage Fowler-Stephens orchidopexy (22%) compared with a two-stage approach (10%) in 85 patients.1 More recent publications have shown success rates between 66% and 100% for the single-stage laparoscopic Fowler-Stephens approach.[1-4]

In 2010 Elyas et al published a systematic review that summarized all of the current evidence.[7] This article included 16 articles and more than 950 patients. The findings of this meta-analysis concluded that the two- stage approach had higher success rate (85%), when compared with the single-stage Fowler-Stephens (80%). No difference was found between the open and laparoscopic technique.

A topic of potential controversy is the management of a long loop vas. From the group of Toronto, they reported a higher atrophy rate in patients with this anatomic variant.[8] This scenario has been rarely encountered in our patients, but it is conceivable that the dissection re-quired to mobilize the vas from within the inguinal canal may lead to a higher atrophy rate. Based on the above mentioned, because of the higher association with structural abnormalities of the testicle and epididymis in this group, it may be reasonable to consider removing the testis provided that the contralateral testis is completely normal. [Ed: Dave et al.[8] noted 83% atrophy after second-stage laparoscopic Fowler-Stephens in setting of long loop vas. Both groups were small due to this unusual scenario, but there was not atrophy when the second stage was completed open. They recommend an open second stage.]

Summary

We believe that the two-stage Fowler-Stephens orchidopexy achieves a more desirable scrotal position with a comparable atrophy rate when compared to the single-stage open approach. In addition we would recommend this approach for the 'peeping' testis and for select redo orchidopexy cases.

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APPROACHES TO NEPHRECTOMY AND NEPHROURETERECTOMY

Retroperitoneoscopic Nephrectomy and Nephroureterectomy

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The first cases of laparoscopic total and partial nephrectomies have been reported in the early 1990s in adults and children. Most total and partial nephrectomies in children are performed for non-functioning symptomatic kidneys or moieties, secondary to renal dysplasia, obstructive uropathy, or vesicoureteric reflux. Symptoms supporting the indication include infections, hypertension, stones, and loin pain.

Whether the kidney should be approached by transperitoneal or retroperitoneal laparoscopy has been an endless debate among pediatric urologists, as both approaches have specific advantages and drawbacks.

The Retroperitoneal Approach

Main Concepts and Positioning

The retroperitoneal area is a virtual space, thus the creation of an adequate working volume is an essential phase of every retroperitoneoscopic procedure. This first step, potentially problematic for beginners in terms of orientation and creation of an adequate space for the size of the child, may have slowed up the diffusion of the technique. There is a significant learning curve for mastery.

The creation of the working space can be achieved either under direct vision, with repeated movements of the laparoscope, or blindly with the inflation of a balloon. A balloon of appropriate size is inserted percutaneously (a home-made balloon can easily be manufactured using one finger of a surgical glove secured at the tip of a large catheter). When using a balloon, the ideal site for percutaneous insertion may not be at the tip of the 12th rib, due to the high risk of transperitoneal insertion and subsequent pneumoperitoneum, but more along the lateral edge of the lumbosacral muscles. (Fig 1). This site will eventually be the location of the most medial operative port.

A thoughtful positioning of the child is also of outstanding importance, considering the limited space between the iliac crest and the 12th rib in young children. Every effort should be made to enlarge this space, by using a flexible operative table or bolsters while installing the patient.

In retroperitoneoscopy, the orientation of the surgeon in such an unusual space may be confusing, and actually relies on one major landmark: the psoas muscle, which should be constantly kept in a fixed position, usually at the bottom of the field of view.

An important point is the necessity of mobilizing the kidney itself as little as possible until complete control of the vascular structures is achieved. Indeed, the natural peritoneal attachments of the kidney will help the exposure, avoiding the need for additional ports that are sometimes difficult to introduce into the limited space.

Lateral position

The lateral position has been the historical route for retroperitoneal access (Fig 2). The child is placed in full lateral decubitus, bent on a bolster or by flexion of the table, in order to enlarge the space between the rib and the iliac crest as much as possible. The laparoscope is introduced at the tip of the 12th rib, after the fascia has been opened through a split-muscle blunt incision. The working space is created with combined movements of the laparoscope, gas insufflation, and early insertion of the posterior operating instrument. Additional ports will be introduced under direct control vision, one posteriorly at

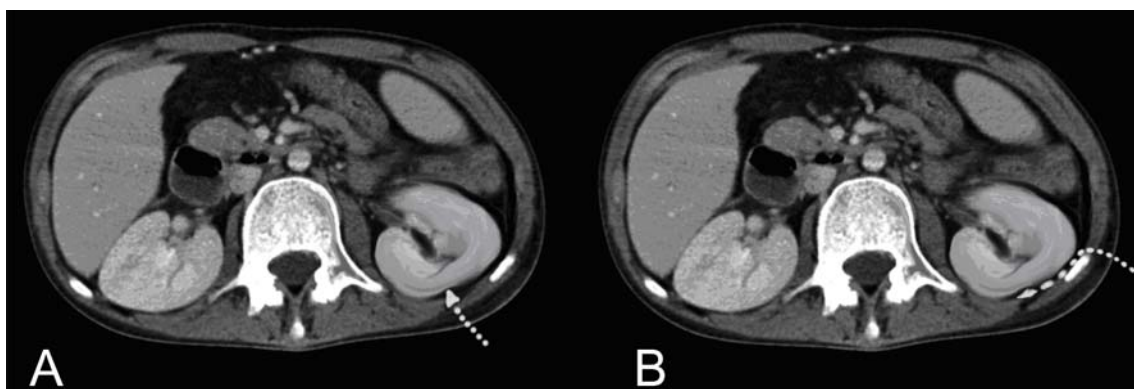*Figure 2 - Right flank lateral position: retroperitoneoscopic approach*

Figure 1 - Schematic view of abdominal CT-scan, showing point of entry of the first trocar.
A : arrow shows the path of a balloon inserted along the lateral edge of the sacrospinalis muscle.
B : arrow shows the path of the approach at the tip of the 12th rib. Note the presence of the peritoneal lateral cul-de-sac

Retroperitoneoscopic Nephroureterectomies *(continued from previous page)*

the costovertebral angle, and another one anteriorly, along the iliac crest. The latter cannot be inserted securely before sufficient working space has been created, pushing away the peritoneum attachments to the abdominal wall. Attention should be paid to provide adequate tri-angulation, but also to not restrict the freedom of movements of this anterior instrument by inappropriate insertion excessively close to the iliac crest. A key point to success in this approach is to open the Gerota's fascia posteriorly close to the psoas muscle, and to avoid any dissection between the kidney and the peritoneum. These tricks will allow the kidney to be fixed on the top of the field without an extra instrument to hold it up.[1]

Prone position

The prone position for posterior retroperitoneoscopic approach[2] has raised recent interest among pediatric urologists. The patient is placed in a fully prone position, with rolls placed under the chest and the pelvis to allow the abdominal contents to fall away in a dependent position.[3] The indicated side of the child is brought close to the edge of the table, to allow maximum freedom of mobility for the most dependent operating port. The patient should also be positioned to enlarge the space between the iliac crest and the 12th rib (Fig 3).

A transverse skin incision is made along the lateral edge of the sacro-lumbar muscles, and a home-made balloon is introduced percutaneously in the retroperitoneum after the fascias have been punctured. The retroperitoneal working space is then fully developed by inflation of the balloon, posterior and lateral to the kidney, outside of the Gerota's fascia. A 5-mm trocar is placed through the incision, and the retroperitoneum is insufflated. Additional ports (Fig 4) will be inserted under direct vision: at the tip of the 12th rib for the laparoscope, and a lateral operating port as lateral and anterior as possible. Great care should be taken to avoid insertion through the peritoneum.

*Figure 3 - **Prone installation for a left retroperitoneoscopic approach.** Note that the infant is placed along the edge of the operating table to facilitate the movements of the most lateral and dependent trocar. Note also the slightly curved installation of the patient, to enlarge the space between the 12th rib and the iliac crest.*

Prone vs. Lateral Approach

The kidney can be approached retroperitoneoscopically with both approaches, with comparable difficulties and similar learning curves. The lateral approach has been the historical and logical route for retroperitoneoscopy, analogous to the conventional access for open renal surgery. However, the prone posterior approach offers undeniable advantages, like direct and early access to the renal pedicle. In the lateral position, it is often necessary to retract and hold the kidney at the "ceiling" of the working space to maintain access to the renal vessels. The prone position allows direct access to the vessels, without the need for an instrument to maintain this space. The benefit of gravity permitted by prone installation also provides a larger working space, without the need for excessive CO2 insufflation. The posterior route is a very versatile approach, especially in small infants in whom the limited working space may be critical. In our opinion, this approach is superior to the conventional lateral route when meticulous and prolonged dissection of the renal hilum is necessary (partial nephrectomies), and for bilateral cases, as it avoids the need for changing the installation. The main drawbacks are the time needed for urgent open conversion if major vascular injury occurs, and a somewhat limited access to the deep pelvis after 5-7 years of age.[2] When complete resection of the lower ureter is mandatory in older patients, the lateral approach may allow dissection of the ureter beyond the division of the iliac vessels.
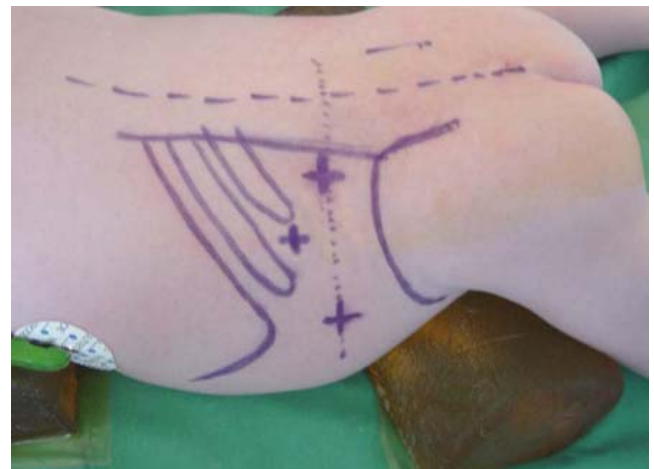
*Figure 4 - **Prone left retroperitoneoscopy.** Ports are inserted along the sacrospinalis musculature at mid-distance between the iliac crest and the last rib, at the tip of the last rib, and laterally as low and lateral as possible.*

Retroperitoneoscopic Nephroureterectomies *(continued from previous page)*

Total Nephrectomy

Although indications remain rare, total nephrectomy is the procedure of choice to acquire and develop experience with retroperitoneoscopy. Main indications are symptomatic non-functioning kidneys secondary to reflux or obstructive uropathy. In the first series reported almost 20 years ago by the pioneers of pediatric laparoscopy, multicystic dysplastic kidneys represented a significant proportion of the cases performed. It is now generally accepted that most of theses cases actually do not require any form of intervention. Preliminary series reporting on the initial experience of consecutive cases show an acceptable learning curve with operative time of approximately 100 min.[4,5] Factors influencing the learning curve are the indications elected, the size of the kidney, and the mentorship.

Nephrectomy may also be indicated before transplantation in children with end-stage renal failure (ESRF), when the underlying renal disease is associated with significant morbidity such as hypertension. In rare cases such as severe congenital nephrotic syndrome or WT1 mutations associated with ESRF, bilateral nephrectomy can be indicated early in life. In these cases, the retroperitoneal laparoscopic approach will be particularly beneficial. For pre-transplant cases, the kidney should be introduced in an endoscopic bag for specimen retrieval, in order to minimize postoperative retroperitoneal adhesions.

Total radical nephrectomy for renal tumor, mainly Wilms' tumors, represents a highly specific and controversial indication. Only limited volume tumors, without any doubt regarding preoperative rupture, hemorrhage, necrosis, or vascular thrombus, may be indicated, and only after neo-adjuvant chemotherapy.[Ed: Recognize regional differences in management philosophy and protocol, with a mutual goal of improved survival.] When a minimally-invasive approach is considered, the transperitoneal approach should be elected to comply with the oncological standards of treatment with retroperitoneal lymph node sampling.

Partial Nephrectomy

Laparoscopic partial nephrectomy is technically more demanding than total nephrectomy. Main indications are represented by non-functioning upper moieties secondary to obstructive uropathy (ureterocele, ectopic ureter), or lower moieties affected by reflux or PUJ obstruction.

Upper-pole nephrectomy represents the majority of indications. The main technical difficulty for retroperitoneoscopy may be the limited working space in small infants with massively dilated upper tract.[6,7] Lower-pole nephrectomies are usually performed in older children and involve less dilated upper tract. The procedure, however, may remain difficult due to the size of the moiety to resect and due to deep involvement of the lower calyces in the upper moiety. The main difficulty of both procedures relies on clear identification of the vascular anatomy. A safer identification of the urinary tract anatomy is helped by a retrograde insertion of a ureteral catheter to allow methylene blue injection. Some experienced teams advocate early ligature of the pathological ureter at the beginning of the procedure to maintain dilation of the system and to facilitate further dissection of the moiety.[8]

The step of parenchymal section is now greatly facilitated by the use of modern sealing devices (Harmonic® scalpel, Ligasure®). It is important that the remaining moiety is kept attached to the peritoneum and mobilized as little as possible to avoid vascular injury caused by intra-operative traction and also accidental postoperative torsion. The risk of functional loss of the remaining moiety is well established at approximately 5%, which seems comparable to open conventional surgery.[9]

Retroperitoneoscopy: Pros and Cons

Pros

The choice for transperitoneal or retroperitoneal laparoscopy for renal access is an on-going debate among pediatric urologists. One of the major arguments for the retroperitoneal access is that it reproduces exactly what had been previously performed and advocated over decades for renal surgery. The risk of bowel adhesions is not theoretical, and may have been underestimated, especially in the procedures that will involve some urine leakage. One has to keep this hazard in mind when planning a laparoscopic procedure, considering the long life span of pediatric patients.

In children with ESRF already under peritoneal dialysis, the retroperitoneoscopic approach is certainly superior to transperitoneal laparoscopy, as it has been clearly shown that it allows faster return to dialysis. Bilateral procedures, although uncommon, will be best approached through prone posterior access without the need for changing the installation.

Cons

The small working volume and the difficulties of orientation of the surgeon's mind in this unusual space represent significant limitations that have hindered the widespread adoption of the technique. Mentored learning is especially recommended, and standardization of the procedures helps to reduce complications.

Summary

It is obvious in the pediatric literature that, with the development of minimally-invasive techniques, a shift can be observed from retroperitoneal open surgery toward transperitoneal laparoscopic procedures, especially for the most technically challenging indications (heminephrectomies, pyeloplasties, adrenalectomies). However, this trend may be viewed as a devious effect: experienced groups have extensively shown the feasibility of all these procedures through retroperitoneoscopy after adequate teaching for a safe learning curve.

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Transperitoneal Laparoscopic Approach for Nephrectomy and Nephroureterectomy

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The laparoscopic approach to renal surgery in the pediatric population has gained popularity since Ehrlich reported the first pediatric laparoscopic nephrectomy in 1991 and Figneshau reported the first pediatric nephroureterectomy in 1994. [Ed: See also Jordan GH, Winslow BH. Laparoendoscopic upper pole partial nephrectomy with ureterectomy. *J Urol 1993;150(3):940–3*.] Advantages of the laparoscopic approach over open surgery include less postoperative pain, shorter hospital stay, better cosmetic results and a quicker return to activity. At that time Guillonneau et al reported a small retrospective series comparing 10 transperitoneal and 10 retroperitoneal pediatric nephrectomies. His group found that the transperitoneal approach had a shorter operative time but similar complications and length of stay.[1] Since that time the advantages and disadvantages of both approaches have been frequently debated.

Indications

The majority of our laparoscopic nephrectomies are performed for benign disease. Indications for nephrectomy include nonfunctioning kidney, a symptomatic or enlarging multicystic dysplastic kidney, single-system ectopic ureter, recurrent infections in children with a poorly functioning kidney, and pediatric kidney recipients. Due to the potential for a refluxing ureteral stump, our practice is to take the ureter as close to the bladder as possible for nephrectomy and heminephrectomy. When a stump remains, some series have reported re-operation rates as high as 8%.[2]

Technique

Our surgical technique for the transperitoneal approach uses a 5–10 mm umbilical camera port and two secondary 3–5 mm instrument ports. The child is placed in a 60-degree lateral position with a bump under the kidney. Occasionally, for right sided surgeries, a liver retractor is required. Normally the colon is mobilized so that the kidney and vessels can be visualized; occasionally though it is possible to approach the kidney transmesenteric. Specimen retrieval is through the camera port incision. For the majority of pediatric kidneys, a sponge holder or hemostat is used to remove the kidney piecemeal. If an intact specimen is required, an endocatch system is used to remove the kidney en bloc.

Outcomes

Outcomes between retroperitoneal and transperitoneal approaches appear to be similar. In a 2009 systematic review comparing the two approaches, no statistical difference was found between hospital stay and overall complications, although there was a trend towards longer operating times with the transperitoneal approach. The comparison groups were not matched and did not take into account the indication for surgery or the difficulty of the cases.[3]

Similarly, in one of the largest series in the literature, there was no significant advantage of one approach over another for 100 consecutive cases in terms of analgesic requirements, length of hospital stay or complication rates. Operating time was statistically significant and favored the retroperitoneal approach, although this result should be viewed with caution as these two approaches were performed by separate surgeons.[4] In our experience, outcomes have been directly dependent upon surgeon experience with a given technique and the patient-specific anatomical challenges.

Advantages

As compared to the retroperitoneal approach, the transperitoneal approach offers the unique benefit of a larger working space in the peritoneal cavity. This leads to improved visualization and allows for laparoscopic transperitoneal nephrectomy to be the preferred technique for complex cases such as horseshoe kidney and multicystic dysplastic kidney. In fact, traversing the peritoneum allows laparoscopic nephrectomy to be performed in infants less than a year of age and less than 10 kg.[5] Bilateral cases can also be performed successfully through the one access.

In addition, intraperitoneal landmarks are likely more familiar to the surgeon since urological training routinely includes laparoscopic and robotic transperitoneal approaches to the prostate and kidneys. Due to the access afforded by the transperitoneal approach, the ureter may be accessed in its entirety. The retroperitoneal approach, conversely, often requires a second incision in the lower abdomen, especially for children older than 5 years of age.[6]

Disadvantages

While beneficial in many cases, the transperitoneal approach also has its drawbacks. Postoperative adhesions can make redo or salvage surgeries difficult. However, most adhesions are clinically insignificant. Nonetheless, for patients who have had multiple intrabdominal operations, the retroperitoneal approach may be superior. In our institution we avoid the transperitoneal approach for patients with dense adhesions and instead favor the posterior retroperitoneal approach for nephrectomy and for nephroureterectomy.

Bowel injury is also a potential complication of the transperitoneal approach, although it is possible to damage the bowel via the retroperitoneum if excess cautery is used. Access to the retroperitoneum requires dissection of the colon off the sidewall prior to locating the renal hilum. Kocherization of the colon risks injury to both the large and small bowel. In addition, an increased rate of ileus formation may occur as compared to the retroperitoneal approach.

For patients with a ventriculperitoneal (VP) shunt, there have been concerns that the transperitoneal approach may potentially increase infection and shunt malfunction due to the breach of the peritoneal integrity. For this reason we perform the majority of our nephrectomies for patients with VP shunts in the posterior retroperitoneal fashion. Evidence is building, however, that the transperitoneal approach is safe for these patients and dialysis may be performed within 24 hours of surgery.[7] While we favor the retroperitoneal approach for bilateral nephrectomy in the end stage renal failure patient requiring dialysis, we have not had peritoneal dialysis problems when the peritoneum was entered thus supporting the argument that the transperitoneal approach is an acceptable alternative.

Transperitoneal Laparoscopic Approach *(continued from previous page)*

Future Indications

Laparoscopic surgery for Wilms tumor has been successfully reported in the literature using a laparoscopic transperitoneal approach. This may be especially possible for small lesions or where preoperative chemotherapy has been used.[8]

The transperitoneal approach uniquely lends itself to the adoption of newer technologies such as laparoendoscopic single site surgery (LESS) and robotic-assisted surgery. In the pediatric population the first LESS nephroureterectomy was reported in 2009 by Bayazit and the first LESS partial nephrectomy was reported in 2010 by Jeon. Both were performed in a transperitoneal fashion and have the cosmetic benefit of a smaller surgical scar. Further reports have confirmed excellent outcomes for LESS nephrectomy, but randomized studies are lacking and the overall risk to benefit ratio has yet to be determined.[9]

Conclusion

The transperitoneal approach to laparoscopic renal surgery offers distinct advantages over other approaches: increased working space and familiarity with the technique. Overall outcomes, however, do not favor one approach over another and instead favor surgeon experience.

Pediatric urological surgeons should be well versed in all approaches and choose the one that best fits the patient anatomy and preferences.

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LAPAROSCOPIC NEPHRECTOMY AND ADRENALECTOMY FOR TUMORS

Laparoscopic Approach For Kidney Tumors

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Although the benefits of laparoscopy are recognized and the technique extended for the treatment of benign urological diseases in children, the standard treatment for kidney tumors in this age group is the open radical nephrectomy. Laparoscopic radical nephrectomy (LRN) is the state-of-the-art procedure for kidney tumors in adults, but its role in children, particularly for Wilms tumor (WT), is to be defined.[1,2]

WT is the most frequent kidney malignancy in childhood, with incidence of 7 cases per million under 15 years of age, and peak incidence between 30-47 months of age. The majority are sporadic, although familial transmission is noted in 1% to 2%. WT is usually asymptomatic, being palpated in the abdomen by the family or physician. Abdominal ultrasonography differentiates the tumor from hydronephrosis, and the CT scan is necessary to define its location and extent, including vascular involvement, contralateral disease or metastases.[1,2]

Its management is based on the complete surgical resection of the tumor, as well as chemotherapy for all patients and radiotherapy for selected individuals. The National Wilms Tumor Study Group recommends primary resection, in order to provide an accurate assessment of histology, genetics and tumor extent[3], followed by adjuvant chemotherapy. On the other hand, the International Society of Pediatric Oncology (SIOP) favours neoadjuvant chemotherapy in patients with presumptive WT, with or without a biopsy, depending on the individual's age. This is followed by nephrectomy and further chemotherapy.[4] Despite this dual approach, the end results of overall and disease-free survival are similar in both groups.[1,2,4]

Open surgery is the traditional procedure for WT resection and includes a complete inspection of the abdominal cavity, lymph node sampling and radical nephrectomy. Exploration of the contralateral kidney is not deemed necessary, since minor contralateral lesions not seen in the CT image do not interfere in the long-term outcome of the treatment.[5] Tumoral rupture and neoplastic cell spillage are to be avoided by gentle manipulation, in order to prevent upstaging the disease or local recurrence. Neoadjuvant chemotherapy plays an important role in this aspect, as it decreases the tumor size and induces the formation of a pseudocapsule that reduces the risk of rupture, enabling a safer surgical resection.[4]
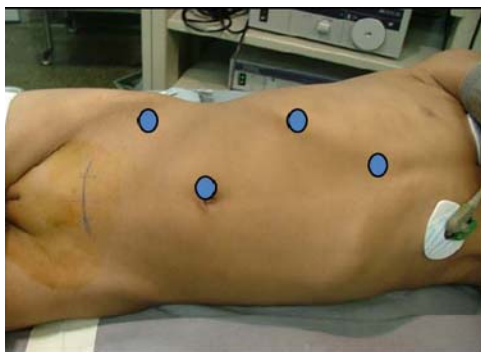

Figure 1: A. Position of the trocars for a right sided LRN (site of Pfannenstiel incision demarcated) B. Trocars inserted

Laparoscopic Approach For Kidney Tumors *(continued from previous page)*

Since almost 90% of WT patients achieve cure, the current objective is to minimize morbidity of the treatment without impairing the cure rates.[1,2] The Brazilian WT Cooperative Group is committed to the SIOP protocol, and therefore our patients receive neoadjuvant chemotherapy as a four-week schedule of vincristine and actinomycin-D. This provided us the opportunity to utilize LRN in selected cases of unilateral WT, extending the advantages of minimally invasive procedures.

Surgical Technique

Our patients are operated through a transperitoneal approach. They are positioned in extended 30 degree lateral position, under general anesthesia, with bladder and orogastric catheters. Pneumoperitoneum is insufflated to 12-14 mmHg pressure. A 5 or 10 mm trocar is placed at the umbilicus for the camera, and a 3 mm trocar is placed at the xyphoid. Two trocars are placed at the anterior axillary line, one in the iliac region and another subcostal.One of these is 10mm for the harmonic scalpel and the hemostatic clamp (Fig 1).
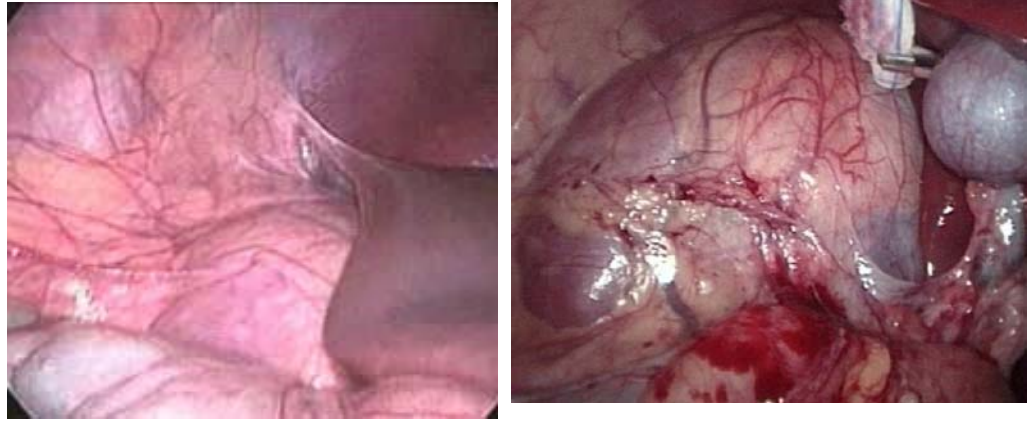

Figure 2: A. Right kidney with WT bulging in retroperitoneum B. Tumor exposed after mobilization of liver and colon

Figure 3: Tumor being removed through Pfannenstiel incision

Figure 4: Final aspect after closure of ports and incision

The abdominal cavity is evaluated in search of other intra-abdominal abnormalities. Intraperitoneal adherences are eliminated to adequately expose the ipsilateral lumbar region. After mobilization of the colon and displacement of the liver or spleen, the tumoral kidney is seen in the retroperitoneum, covered by the perinephric fascia and the fibrous pseudocapsule resulting from chemotherapy (Fig 2). Dissection is initiated in the hilar region, in the search of the vessels. On the right side, this begins in the lateral aspect of the vena cava, while on the left, medial to the confluence of the gonadal and renal veins. The renal vein is isolated and retracted to expose the renal artery, which is ligated with polymer clips and sectioned. Secondary arteries must also be identified and ligated. The renal vein is then clipped and sectioned. The gonadal and adrenal veins, as well as the ureter, are also sectioned. The kidney and its perirenal fat, including the tumor and its pseudocapsule, are dissected "en bloc" and mobilized. Lack of tactile sensation requires careful mobilization of the tumor. The adrenal must be included in the dissection when the tumor affects the upper pole. Particular care is needed in the ligature and section of the adrenal veins in the right side. Adherences to the lumbar musculature, diaphragm, liver or spleen require careful dissection with the harmonic scalpel to separate the mass from these structures without injuring them.

After complete dissection of the specimen, it is left in the lumbar fossa. A limited lymphadenectomy is performed to obtain periaortic or pericaval lymph node samples necessary for adequate staging of the disease. These are removed through the largest trocar. A Pfannenstiel incision is prepared and a trocar with a retrieval bag is inserted without deflating the pneumoperitoneum. After the entrapment, the specimen is carefully removed intact through this incision (Fig 3). Morcellation is contraindicated to ensure correct pathological analysis and staging of the tumor. After review of the cavity, the trocars are removed and the incision and ports closed without drains (Fig 4). The bladder and orogastric catheters are removed after the procedure.

Results

Twenty children with WT (11 girls and 6 boys) that presented with decrease in tumor size were submitted to LRN. Median age was 47.2 months (range 10- 108mos.). Fourteen children had tumor on the right kidney and 6 on the left. Operative time varied from 107 to 210 minutes (mean147 min). Four patients had significant adherences to the

Laparoscopic Approach For Kidney Tumors *(continued from previous page)*

lumbar or diaphragmatic musculature, three to the liver and one to the spleen. Lymph nodes were obtained in all cases (3 to 12 lymph nodes). The mean weight of specimens was 125 g (range 55-234g). All specimens were removed intact, without rupture. No conversions occurred. Blood loss was minimal (30-50 ml). There were no postoperative complications in our patients except prolonged ileus in one. Feeding was possible in the first postoperative day in most children, and they were discharged in the second or third postoperative day, completing chemotherapy according to the SIOP protocol.

Histopathological analysis revealed viable tumor cells in the perirenal fat, with incomplete resection (stage III disease) in two patients, while 13 patients had stage I disease (tumor within the kidney, completely excised) and 5 stage II (tumor outside the capsule, but completely removed). Four patients received adjuvant radiotherapy, one in the abdomen due to stage III disease and three in the thorax due to lung metastases. After follow-up of 12-108 months (mean 53mos.), no patient had any complication related to the procedure nor port site recurrence. Only one patient with stage III disease, treated without adjuvant radiotherapy, presented local recurrence, requiring further chemotherapy with complete remission of the disease. The aesthetical results were excellent in all patients, to the great satisfaction of the parents (Fig 4).
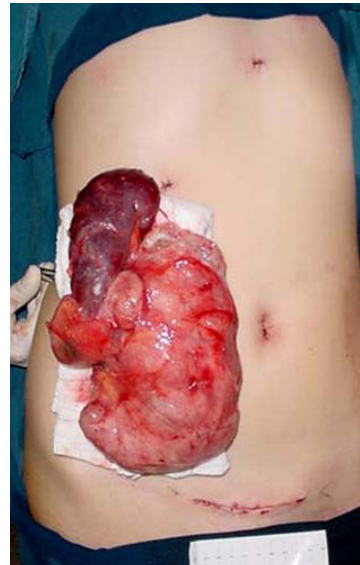
Three children with other renal tumors were also treated with LRN. Two patients were diagnosed initially as WT without biopsy and treated with neoadjuvant chemotherapy. Despite minimal response in size reduction of the tumor, LRN was performed in both, due to the moderate size of the lesions. The procedure was uneventful in a 4 year old boy with right tumor whose pathology disclosed neuroblastoma. The other, a 9 year old girl with tumor in the upper pole of the left kidney, had a diaphragmatic laceration at the end of the dissection due to adherences to the tumor. Instead of a Pfannenstiel incision, a subcostal incision was made for repair of the diaphragmatic tear and removal of the specimen. Pathology disclosed a renal adenocarcinoma. The third patient, a 13 year old girl had a biopsy-proven right cystic nephroma. A successful LRN was performed despite the size of the tumor, and the only difficulty was to entrap the specimen in the retrieval bag due to its size (Fig 5). In all three patients, the tumors were removed completely with free margins and without rupture, and all had uneventful postoperative recovery. Only the patient with neuroblastoma received adjuvant chemotherapy, and all three are alive and disease-free after 1-8 years.

Figure 5: Right cystic nephroma removed laparoscopically in a 13 years-old girl

Summary

In our hands, LRN in selected pediatric patients could not be considered more difficult than a nephrectomy for an inflammatory kidney. The real limitation of the procedure is the volume of the tumor relative to the size of the patient. WT has the obvious advantage of tumor size reduction and formation of a pseudocapsule due to neoadjuvant chemotherapy, which facilitates the procedure and decreases the risk of rupture. As shown in our limited experience with only three cases, children with other less frequent benign or malignant renal tumors may be also submitted to LRN, with equally good oncological results.

A retrospective analysis of our WT patients showed that the largest diameter of the laparoscopically resected specimens was always equal or less than 10% of the patient's height. This can be a useful index to take into account when considering the LRN. Tumors that remain significantly large after chemotherapy or have extensive adherences to the liver, spleen, diaphragm or great vessels are best treated by open surgery. Despite the report of successful LRN in WT without neoadjuvant chemotherapy[6], we do not perform it even if the tumor is small, mainly because all our patients with suspected or biopsy-proven WT follow the SIOP protocol. Nevertheless, as in adult LRN, extensive intraperitoneal adhesions, as well as associated pulmonary disease or uncontrolled coagulopathy may be contraindications for a laparoscopic procedure.

Shared by other reports[7,8], our positive pioneer experience with LRN for WT after chemotherapy, as well as for other renal tumors, confirms the role of this minimally invasive procedure in the armamentarium for the treatment of renal tumors in children.[9,10]

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Laparoscopic Adrenalectomy In Children:
Is It The Gold Standard?

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Introduction

After the publication of the first laparoscopic adrenalectomy two decades ago, the number of surgical procedures performed by this approach has increased considerably. Many studies were performed comparing the open and the laparoscopic approaches to determine which would bring greater therapeutic benefits at short and long term. Thus, several morbidity parameters were assessed, including the ones inherent to the procedure and those on short- and long-term follow-up.

The results were quite satisfactory for the laparoscopic procedure, which took the lead over the open approach in various situations, with less intraoperative bleeding, reduced transfusion rate, less postoperative pain, less inflammatory response, reduced hospital stay, better cosmesis and reduced need for redo surgery.[1-7] Initially, the steep learning curve showed longer surgical time. Nowadays, in larger series, this approach revealed shorter operative time compared to the open procedure.

Although these results are quite significant in adults, caution is needed when applying to children. Although the laparoscopic procedure in children seems to share the same benefits observed in adults, few studies in pediatric patients have been described. With the small number of individuals evaluated in groups, it is hard to assert that the same benefits of the laparoscopic approach in adults apply to younger individuals.

Laparoscopic Approaches

There are three main techniques for performing laparoscopic adrenalectomy in children, each presenting its own peculiarities.[8]

1. Lateral Transperitoneal Adrenalectomy

The first and most widely used technique is the lateral transperitoneal adrenalectomy. The child is placed in lateral decubitus position over a flank lift to allow a slight lateral flexion of the spine, ensuring a better spacing between the costal margin and the iliac crest. The first trocar is inserted in the umbilical scar. A second trocar is inserted laterally, at the middle clavicular line, and a third trocar is inserted in the middle clavicular line, near the costal margin.

In the case of right adrenalectomy, the liver is lifted and the peritoneum is incised along the inferior vena cava, and the main adrenal vein is located, ligated and sectioned. The dissection of the adrenal gland is made from medial to lateral, and the small veins are cauterized using any preferred source of energy. The adrenal gland is removed intact in a bag, allowing better assessment of pathology.

In the left adrenalectomy the colon, spleen and pancreas are mobilized medially, with the renal and splenic veins used as anatomical reference. The main adrenal vein is ligated and sectioned. After that, the adrenal gland is removed the same way as in the right adrenalectomy.

The main advantages of this technique consist of ample space for the procedure, with a good exposure of the gland and good lymph node dissection. Thus, this approach allows performing safe and efficacious procedures also in combination with other procedures, like liver biopsy.[8]

2. Lateral Retroperitoneal Adrenalectomy

The child is placed in a position similar to the lateral transperitoneal adrenalectomy at lateral decubitus over a flank lift for slight lateral flexion of the spine. The insertion of the first trocar is placed at the end of the last rib. The second trocar is inserted along the paravertebral muscle edge in the angle below the 12th rib. The third trocar is placed at the anterior iliac crest.

The first dissection plane is between the perirenal fat and Gerota's fascia, locating the adrenal gland. Despite the similar position with the lateral transperitoneal adrenalectomy, access is less direct, there is less space to perform the procedure. It is not possible to perform a bilateral approach without changing the installation of the equipment.[8]

3. Prone Retroperitoneal Adrenalectomy

The child is placed in prone position with the thorax and pelvis slightly elevated for the better abdominal release. A trocar for the insertion of the optic is introduced at the midpoint between the last rib and the iliac crest. The second trocar is inserted at the end of the last rib, and the third trocar is inserted between the other two trocars.

For right adrenalectomy, the main reference point remains the inferior vena cava, while the left adrenalectomy uses the left renal vein and the splenic vein as anatomic reference.

This method is more complex, with less space for approach and a higher learning curve. However, this method is very valuable when bilateral adrenalectomy is needed, because the change of the installation equipment is not needed.[8]

Robotic-Assisted Approach

The robotic-assisted approach in children is a safe procedure and can be performed without major difficulties. However, due to the peculiarities of these patients, the robotic procedure has some specific difficulties: the disproportionate size of the robotic equipment and the size of the patient. In addition, higher cost and longer operative time are also observed in pediatric patients. Thus, the robotic approach in pediatric patients can be used safely, although it does not seem to have advantages over the laparoscopic approach for low complexity procedures.[9]

Indications

Neuroblastoma is the most common abdominal tumor in children. It is a malignant tumor and is the leading cause of adrenalectomy in children. The laparoscopic approach may be indicated after attention to tumor location. There should be no evidence of invasion of adjacent organs, since this fact increases the conversion rate to an open procedure and increases postoperative morbidity.[10]

Pheochromocytoma is a catecholamine-secreting tumor that can be benign or malignant. Hereditary pheochromocytoma cases occur in von Hippel-Lindau syndrome, multiple endocrine neoplasia type 2, neurofibromatosis type 1 and mutation of the succinate dehydrogenase gene, appearing bilaterally and often malignant. The removal of the tumor is a key element of treatment, and the laparoscopic approach is an option.[8]

Laparoscopic Adrenalectomy In Children *(continued from previous page)*

Adrenocortical carcinoma is a malignant tumor of adrenal gland cortex. Although some authors prefer the open approach for adrenocortical carcinoma because of the lower risk of peritoneal carcinomatosis in adult patients, there is no evidence of higher risk of this complication in children when the laparoscopic approach is performed. This difference may be related to the different origin of this tumor in the adult and child patient.

Benign adrenal tumors are rare and include ganglioneuromas, adenomas and cysts. They are good indications for the laparoscopic approach, paying attention to cases where there is suspicion of surrounding tissue invasion.[8]

Although controversial, tumor size is a parameter often considered during evaluation for a laparoscopic procedure. In children, this factor does not appear very important, as the conversion rates for tumors of different sizes are not statistically different. Similarly, the rates of conversion to open in children do not seem to be related to the age, weight or body mass index of the patient.[10]

Another possible indication is congenital adrenal hyperplasia. Although it is a rare situation, bilateral adrenalectomy is a therapeutic option for congenital adrenal hyperplasia refractory to medical management.

At our institution there have been 19 laparoscopic adrenalectomies, performed between 1998-2011, with a mean age of 3.9 years.[1] All procedures were performed transperitoneally and showed to be a safe and efficacious procedure with a single transfusion and no conversion. Our outcomes are similar to other results described in the literature (Table 1).

Summary

Laparoscopic adrenalectomy is a viable and promising procedure, with good results for the main indications for adrenalectomy in children. It seems to also have the same benefits as in adults, with decreased postoperative morbidity regardless of age, weight, body mass index and tumor size. However, in cases of invasion of surrounding tissues by the tumor, the laparoscopic approach should be selected with care, since it has a higher rate of conversion to open procedure. Although the lateral transperitoneal approach is the easiest one, the procedure should be determined according to the surgeon's familiarity.

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Table 1 – Outcomes of the main publication on laparoscopic adrenalectomy in children.

Author	Year	Journal	N	Mean Age (ys)	Operative Time (min.)	Transf.	Complic.
Lopes et. al.	2011	J.Ped.Urol	17	3.9	138.5	5%	0
St. Peter et. al.	2011	J. of Lap. & Adv. Surg. Tech.	140	8.8	130.2	2.8%	9.9%
Sukumar et al	2011	J. Min. Inv. Acc. Surg.	7	9.6	111	0	14.2%
Nerli et al	2011	J. Ped. Urol.	18	5.8	95	0	0
Laje et al	2009	J. of Lap. & Adv. Surg. Tech.	8	14.5	99	0	0
Kadamba et al	2004	J. Ped Surg.	10	4	141	0	20%

Minimally Invasive Pyeloplasty in Children: Three Approaches

Assisted Laparoscopic Surgery For Pyeloplasty

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The first laparoscopic pyeloplasty in a child was described by Peters et al in 1995[1], but the technique took many years to become popular among paediatric urologists; it requires excellent laparoscopic suturing skills, it is time-consuming and it has a long learning curve. Furthermore, the true potential advantages of laparoscopic over open pyeloplasty, particularly in infants and young children, still remain controversial.[2]

Robotic-assisted laparoscopic pyeloplasty with the aid of the da Vinci Surgical System®, thanks to the three dimensional viewing and the full range articulation of the robotic arms, may obviate the long learning curve and the difficulties of the intracorporeal suturing of conventional laparoscopy.[3] However issues such as high costs, the need for a dedicated operative room and team make robotic pyeloplasty still limited to very selected centers.

Figure 1 - With the patient in full lateral position, landmarks for retroperitoneoscopy are marked. A 1.5 cm incision in performed at the apex of the XII rib.

In order to overcome the difficulties of conventional laparoscopic pyeloplasty, a technique for a laparoscopic- assisted pyeloplasty was described in five children by El Ghoary in 2004.[4] The procedure was performed transperitoneally with three trocars. After mobilizing the colon, the UPJ was dissected free and exteriorized through the incision of a 10 mm port. This port was placed as close as possible to the UPJ on the anterior abdominal wall.

A similar technique, performed with three trocars (5 mm + 3 mm) through a retroperitoneoscopic approach, was then described by Farhat et al[5]: in 11 patients aged 4.5 to 11.9 years. They reported an average operative time of 160 min, hospital stay less than 36 hours and the need for conversion in 2 of 11patients.

Far from being codified, the technique of laparoscopic-assisted pyeloplasty was reported in only scattered papers over the last years.[6,7] Tong et al[8] performed a retroperitoneoscopic-assisted pyeloplasty with three trocars in 23 children aged 2-11 months. Despite longer operative time, they reported smaller incisions, faster recovery and shorter postoperative hospital stay compared to open dismembered pyeloplasty.

Eventually, in 2007, Lima et al[9] proposed a simplified video-assisted pyeloplasty using only one trocar. An operative 10 mm telescope with a 5 mm operative channel inserted through a single 10 mm port in the retroperitoneum allowed easy dissection of the UPJ and its exteri-

orization at the skin level for pyeloplasty. They performed this technique in 16 children aged 2 to 18 months with one transient complication (urinary leakage). Ultrasonographic improvement of the dilatation was seen in all cases with excellent cosmetic results.

The appealing perspectives of this one-port technique led us, since January 2008, to propose one port retroperitoneoscopic-assisted pyeloplasty to all patients < 5 years of age with a UPJ obstruction requiring surgery.

The operative technique is as follows. After induction with general endotracheal anesthesia, the patient is placed in full flank position. Prophylactic antibiotics are given at induction and the bladder is filled with methylene blue solution through a Foley catheter. Skin landmarks for retroperitoneoscopy are marked and a single 15 mm incision   is performed at the apex of the XII rib (Fig 1). Muscle fibers are gently split, and the fascia is reached and opened. A 10 mm balloon trocar is placed in the retroperitoneum and CO2 pneumoretroperitoneum is established at 9 mm Hg pressure. The 10 mm telescope with a 5 mm straight operative channel (Fig 2) is then inserted and the working space is created by blunt dissection with the tip of the scope or with the aid of a peanut. The kidney is generally approached posteriorly, the renal pelvis, proximal ureter and UPJ are identified, and any crossing vessel carefully looked for. The UPJ is gently dissected free, the pelvis widely mobilized and the proximal ureter mobilized as necessary (Fig 3). In cases of giant hydronephrosis, percutaneous needle aspiration of the pelvis under vision will allow easier mobilization. The UPJ is hitched onto a vessel loop (Fig.3), then the trocar and the scope are carefully removed and the retropneumoperitoneum deflated, in order for the UPJ to be exteriorized at the skin level.

Once the UPJ is exteriorized, 5/0 stay sutures are place on the pelvis and the proximal ureter to avoid any torsion. The UPJ is transected, the proximal ureter spatulated, any redundant pelvis resected and Anderson-Hynes dismembered pyeloplasty performed using 6/0 or 7/0 polydioxanone suture and magnifying loupes 2.5x. After completing the anterior side of the anastomosis, a 4.7 Fr double J stent of adequate length is placed in the bladder in antegrade fashion. Methyl-
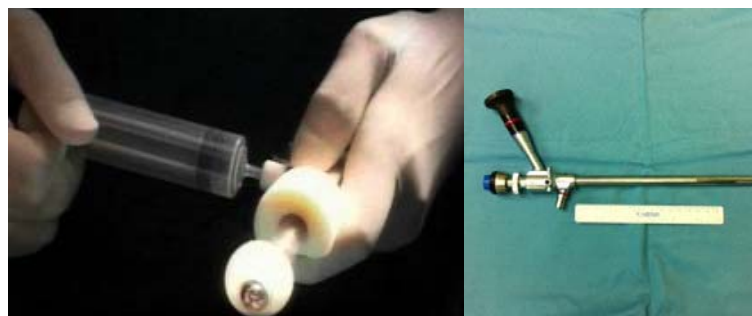
Figure 2 - Tricks for the one port retroperitoenoscopic assisted pyeloplasty: a 10 mm balloon trocar and a 10 mm short operative optic.

Assisted Laparoscopic Surgery For Pyeloplasty *(continued from previous page)*

Figure 3 - Retroperitoneoscopic view: the kidney is approached posteriorly. With the aid of a peanut the UPJ, proximal ureter and pelvis are dissected free, then the UPJ is mobilized on a loop.

ene blue dripping from the stent will confirm the correct position of the distal curl in the bladder. The posterior side of the pyeloureteric anastomosis is then completed. CO2 retropneumoperitoneum is re-established and the reconstructed UPJ is checked. The port wound is closed without any perirenal drain. Oral fluids are started 2 hours and solid food 4 hours after surgery. The Foley catheter is removed after 24-48 hours and the child is discharged home after spontaneous voiding when comfortable. Postoperative pain is periodically assessed by ward nurses using FLACC or VAS scale. Paracetamol, with codeine if needed, generally provide adequate analgesia. At discharge patients are placed on antibiotic prophylaxis until the double J stent is removed endoscopically, at 4 to 6 weeks after surgery.

Followup protocol include urine test every 2 - 4 weeks, urinary ultrasound at 3, 6 and 12 months and MAG3 nuclear scan for functional evaluation at 6-12 months after surgery.

The results of our preliminary experience on the first 28 consecutive cases of one-trocar retroperitoneoscopic assisted pyeloplasty were previously reported[10] and compared with a cohort of 25 children operated in an open fashion by the same surgeon. Inclusion criteria for surgery were symptoms (UTI, pain), pelvis AP diameter at ultrasonography 20 mm or greater and progressively increasing, impaired split renal function 40% or less at MAG3 renal scan with obstructed furosemide test washout parameters (t ½ > 20 min).

Out of the 28 cases, the only severe complication was a transient urinoma due to early double J dislodgement. The results of our preliminary experience were definitely encouraging. Success rate was not different from open pyeloplasty. Despite slightly longer operative time, the one-port retroperitoneoscopic-assisted pyeloplasty led to significant reduction in the requirement for analgesics, reduced hospital stay, reduced length of the scar and better cosmetic outcome compared with open pyeloplasty (Table 1).

We have now reached a series of 100 consecutive one-port retroperitoneoscopic pyeloplasty, since the technique was offered unselectively to all patients before pubertal age requiring correction of UPJ obstruction. 72 were males, 68 on the left side, 60% had a prenatal diagnosis. Age at surgery was from 4 to 144 months (median 18 months). One patient required conversion (UPJ obstruction secondary to previously operated UVJ obstruction with recurrent pyelonephritis), 99 were completed, with 14 presenting aberrant vessels. Operative time was 70-175 mins (median 100), hospital stay was from 2 to 4 days (median 2). Early dislodgement of the double J in 6 cases did not have any consequence. 3 patients required reoperation: 1 had a bifid pelvis with hydronephrosis of the lower moiety, 2 had very hypoplastic ureter, which would accommodate only a 3 Fr double J and pre-

sented with postoperative pyelonephritis and hydropyonephrosis. Out of the 68 patients who have completed the one year followup, 64 (94%) have stable or improved split function at MAG3 scan and all have normalization of transit time with t ½ < 20 mins.

After 100 consecutive procedures, some considerations are worth noting. Mobilization of the UPJ was excellent in infants and young children. In our experience the use of the operative optic made the exteriorization of the UPJ easy and straightforward. However, we cannot deny that, as an alternative, the procedure could also be accomplished as a three-trocar technique as described by Farhat. The presence of aberrant crossing vessels did not impede the procedure: after wide mobilization from the vessels, the pelvis and the UPJ could always be exteriorized at the skin level. The technique was feasible also in older children; through a more posterior incision beneath the XII rib, and only obesity or intrarenal pelvis were contraindication to the laparoscopic-assisted procedure. The coaxial movements of the camera and the instrument may sometimes be bothersome and impend the view, but in case of important peripyelitic adhesions or aberrant vessels the use of adjunctive 3 mm instruments, which we did in one case, allows easier dissection without the need of conversion. Torsion of the UPJ is prevented by stay suture placed soon after exteriorization of the pelvis, and according to us in not an issue. Antegrade placement of double J stent was not more difficult than in open pyeloplasty and the correct position of the stent in the bladder was always verified with methylene blue dripping from the stent. Extracorporeal suturing over-

Figure 4 - The UPJ is mobilized at the skin level. Stay sutures are placed in order to avoid any torsion. The resection of the UPJ and the suture of the pyeloplasty are then performed extracorporeally.

Assisted Laparoscopic Surgery For Pyeloplasty *(continued from previous page)*

Table 1 - *Preliminary experience in 28 one-port retroperitonescopic assisted pyeloplasty (OPRAP). Demographic data and results are compared with a cohort of 25 open pyeloplasty. Age, operative time, hospital stay and scar length are expressed as mean.*

	#pts	Age (mths)	Left / Right	Polar vessel	Op time	Hosp stay	Pain <24 h	Complic	MAG3	Scar (cm)
Oprap	28	18	17/11	4	95	3.4	4	1	1 obst	19
open	25	19	15/10	5	72	6.5	6.8	0	1 obst	43
p	ns	ns	ns	ns	<0.05	<0.05	<0.05	ns	ns	<0.05

comes the long learning curve of conventional laparoscopy, allows precise technique and reduction pyeloplasty in case of giant hydronephrosis. Operative time, despite longer than open pyeloplasty, was as average 100 mins, and therefore much shorter than any conventional laparoscopic pyeloplasty. Costs were low due to the short operative time, short hospital stay and not expensive laparoscopic material. Patient recovery was absolutely quick, with most patients discharged at 48 hours, and the cosmetic results were excellent.

Laparoscopic assisted pyeloplasty is an appealing hybrid technique combining advantages of both open and laparoscopic pyeloplasty. It is easy to teach and learn, with a short learning curve, and it is an optimal training to the retroperitoneoscopic approach for the young laparoscopist. It is also suitable for the expert laparoscopist when faced with conversion in a technically difficult laparoscopic pyeloplasty. Feasible in all age groups until prepubertal age, it provides excellent results in infants and young children, which are the majority of patients with UPJ obstruction, due to the ease of PUJ mobilization, significantly shorter operative time compared to conventional laparoscopy, reduced pain, short hospital stay and excellent cosmetic results. Despite being unknown to many paediatric urologists, laparoscopic-assisted pyeloplasty provides a successful additional technique to open or conventional laparoscopic pyeloplasty for the correction of PUJ obstruction.

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Pyeloplasty: Retroperitoneal Approach

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Retroperitoneoscopy has expanded much more slowly than other minimal access surgical techniques in natural cavity, like peritoneal or pleural cavity.[1] In classical open pediatric urology the renal and ureteral approach realized along a retroperitonal path (except for WILM's tumor and trauma) is the gold standard. At the beginning of minimally invasive surgery, pediatric surgeons embarking on this new access preferred the transperitoneal approach because of the well-known and wide peritoneal chamber. Progressively some surgeons,[2] in order to reproduce the same procedure as with open surgery, have developed the retroperitoneal access, first in lateral position, then in prone position. The details of technique, positioning, creation of the working space, and port placement have been already described.[2,10] Usually only 3 trocars are needed: one 5 mm for a zero degree telescope is introduced under visual control at the tip of 11th or 12th rib, the second 3 mm is placed in the costo-vertebral angle , the third 3 mm above the iliac crest.

Both techniques, retro or transperitoneoscopic pyeloplasty, are technically demanding and require advanced laparoscopic skills for meticulous pelvic ureteric anastomosis with freehand intracorporeal suture techniques. Many tricks have to be learned to mobilize the ureter and pelvis (without compromising the vascular supply) to present them in a correct position for suturing without tension. In my mind the two key points are to present and stabilize both the pelvis and the upper end of the ureter using stay sutures and to use a camera holder to get a stable image. I prefer to fix the junction to the psoas muscle, to incise partially pelvis and ureter and to divide them only when the first half of the anastomosis is completed. In all cases I recommend inserting a JJ stent in antegrade fashion. If passing in the bladder proves to be difficult, the distal part of the stent is shortened and left in the ureter. The proximal part is exteriorized through the pelvis (using externalized JJ stent allows to remove it without anesthesia). Operative time is still long even after the learning curve. This long time of intense concentration and the debatable ergonomic position for the surgeon explain why minimal access pyeloplasty is a tiring surgery when performed without robotic assistance. (If possible, don't do two pyeloplasties on the same day because the needed concentration for suturing the urinary tract in a watertight fashion is much higher than with open surgery!)

Compared with the transabdominal approach, drawbacks to retroperitoneoscopic access include the steep learning curve to create the working space, the limited working space, and the limited area for port placement.[1] Whatever the position of the patient, lateral or prone, the most common complication is the accidental peritoneal perforation, which induces pneumopritoneum and can further reduce the retroperitoneal working space and visibility. The risk of peritoneal tear is particularly high in smaller children where the peritoneum is thinner and less protected by fat. As for each surgical access, visual control represents the best guarantee against visceral and peritoneal injury.

But, even if no superiority is proven at this time according to the EBM criteria, the retroperitoneoscopic approach offers several potential advantages:

- It reproduces the Gold-standard open procedure.
- It offers a more direct and rapid exposure without peritoneal cavity transgression and without dissection and handling of intraperitoneal structures which could be injured during these maneuvers. (A case of unnoticed accidental perforation of the sigmoid bowel has been reported by Szavay[4] leading to nephrectomy.) The working space is not obscured by intestinal loops, therefore the risk of post operative paralytic ileus, shoulder pain, omental evisceration and intestinal adhesions is eliminated.
- It uses fewer trocars. Only 3 trocars are needed; the transperitoneal approach uses at least 4 trocars.
- In case of anastomotic leakage, the consequences could be much more serious in case of transperitoneal access because the peritoneal cavity is more difficult to properly drain than a small retroperitoneal space. A second operation is often required, even if a JJ stent is in place.
- The retroperitoneal approach can be performed even after previous transperitoneal surgery.

Is retroperitoneoscopic access suitable to any age? To any patient size?

Even if the dissection is easier in small patients, the limited working space could make retroperitoneal suturing particularly challenging. At the beginning of our experience as other authors[5,6] we excluded patients under 2 years of age. Today we propose this access from 4 months of age (around 6 kg) and we have not noted increased complications or conversion rates in this age group. This fact is confirmed by some published papers.[7,8] However in small children with massive pelvic calyceal dilatation, the retroperitoneoscopic approach can be difficult with the risk of pelvic perforation when introducing the trocars. In such cases it is advisable to decompress the kidney (by puncture) at the beginning of the procedure or to opt for a transperitoneal or open access. However in small children with massive pelvic calyceal dilatation, the retroperitoneoscopic approach can be difficult with the risk of pelvic perforation when introducing the trocars. In such cases it is advisable to decompress the kidney (by puncture) at the beginning of the procedure or to opt for a transperitoneal or open access.

Is retroperitonoscopic access suitable for any case?

No, there are some contra indications:
- In the case of previous retroperitoneal surgery or previous percutaneous nephrostomy for drainage it seems logical to use a transperitoneal approach; that is also the case for redopyeloplasty.
- In case of ectopic kidney, horse-shoe kidney and some malrotated kidney, after having acquired a clear understanding of the anatomy by CT scan transperitoneal access is usually recommended.
- In case of obstruction due to an aberrant polar vessel, especially if a simple vascular hitch is considered, again an anterior approach will make the procedure easier. The same advice in case of retrocaval ureter even if the cure is possible by retroperitoneoscopy. In my experience these contra indications for using retroperitonal approach represent 10% to 15% of cases.

Pyeloplasty : Retroperitoneal Approach *(continued from previous page)*

Concerning the results, several papers have emphasized the true effectiveness and potential advantages of that technique.[9] Since our first report of 45 cases in 2009[10] we have operated on 80 cases more and we can confirm these results with a success rate of 97% with a mean follow-up of 3.5 years (very long term follow-up are still lacking). But our mean operative time is still around 2.5 hours. Our conversion rate is 3%.

In conclusion, the goals of minimally invasive surgery are to maintain the principles of open procedure, and that is the case with retroperitoneoscopic pyeloplasty, while minimizing morbidity for young patient. But today minimally invasive dismembered peyloplasty is not validated as the gold-standard procedure. Retro versus transperitoneal access for UPJ surgery is an old and theoretical debate, even if I remain still convinced of the advantages of the former. Each surgeon must use the technique he feels comfortable with. The true discussion is to choose between the others possibilities described in this issue and elsewhere: lap assisted technique, lap single site surgery, robot assisted technique, endopyelotomy, balloon dilatation and also watchful waiting and open surgery.

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Transperitoneal Laparoscopic Pyeloplasty: More Room, More Feasibility

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Introduction

The first laparoscopic pyeloplasty in children was described seventeen years ago in 1995 by Peters et al.[1] Since then, this technique has been widely applied and has become [our] approach of choice in the treatment of ureteropelvic junction obstruction (UPJO).

The advantages of laparoscopic pyeloplasty are essentially less postoperative pain, shorter hospital stay and better cosmetic value.[2,3] However, it has been claimed that laparoscopic reconstructive urological procedures have longer surgical time and longer learning curve, both major disadvantages of this kind of minimally invasive approach.

Surgical times decline as more experience is gained; initial series showed an average time of 278 minutes, decreasing to 90 minutes after 16 cases.[4] Nowadays the 82-100% success rate described with this technique is comparable to classic open pyeloplasty.[4,5]

Technique

There are two main minimally invasive approaches to the ureteropelvic junction: retroperitoneal, as the traditional urologic approach, and transperitoneal..

Figure 1: Patient position

Figure 2: Port places where 1st port is umbilical

Transperitoneal Laparoscopic Pyeloplasty *(continued from previous page)*

Figure 3 Trans - mesocolonic Approach

Figure 4: Hitch stitch and ureteropelvic junction

As described by Tan in 1999[6], our unit commonly uses the transperitoneal approach, because it provides more working space and wider vision field, facilitating suturing and knotting, which are the most complex steps in this surgery. This approach provides defined anatomical references, making the renal vessels and the hilum easily approachable. Additionally, as laparoscopy is the first approach for the paediatric surgeon during their training period and is widely used for other procedures, most surgeons are more familiar with this approach.

Under general anesthesia the patient is placed in a lateral position, with the affected kidney on top. The authors' preference is to have the child in a 75° position (Figure 1). The patient is secured with adhesive tapes. A 5mm trocar is inserted with open technique after a vertical transumbilical incision. A 30-degree camera is preferred. Pneumoperitoneum is placed according to age and weight, starting flow at 1 liter/min to 4 liter/min to maintain pressure between 10-12 mmHg. Two additional trocars of 3-5 mm are placed under direct vision: one below the costal margin on mammary line and another at iliac fossa, with ergonomic criteria [triangulation]. A fourth 3mm trocar is placed at top flank (Figure 2). In the right UPJO cases, a complete mobilization of colon is done. For the left side it can be done either by mobilizing the colon or by approaching the ureteropelvic junction through a window in the colon mesentery (Figure 3).
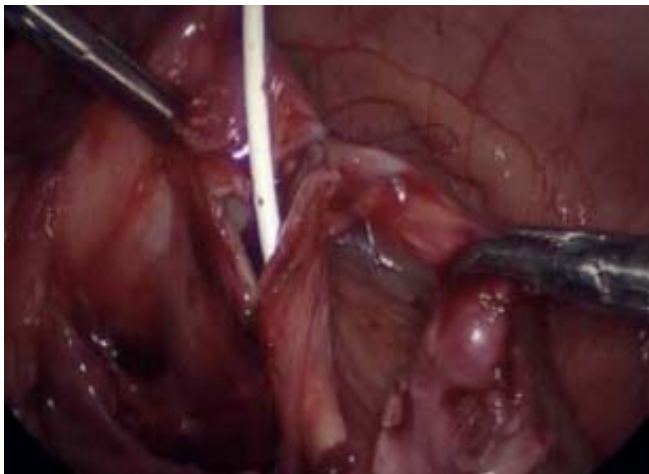
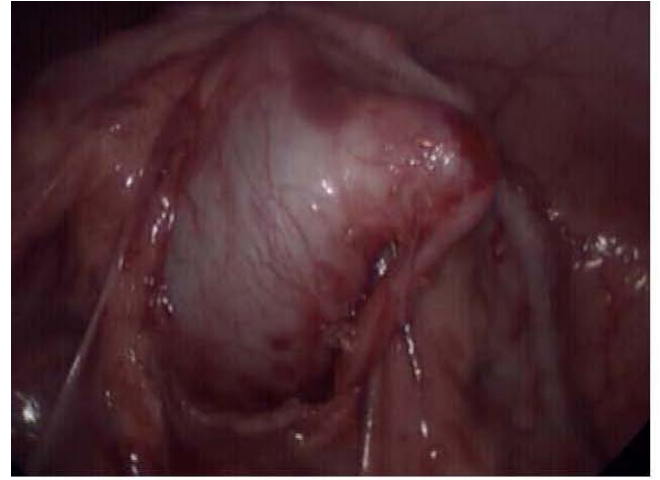After Gerota's fascia is incised and the ureter and ureteropelvic junction have been located, a hitch stitch for fixation and presentation of the renal pelvis is used. This stitch is exteriorized or tacked by the 3 mm flank port (Figure 4).

A traditional Anderson-Hynes dismembered pyeloplasty is done, starting with one interrupted suture (8-10cm long) and then running sutures on each side (12cm long), with 5-0 poliglecaprone 25 (Monocryl®).

It is recommended to start with the posterior side and then the anterior side, finishing on the wall closer to the surgeon. When the anterior side is half way complete, a double-J stent is inserted anterograde by the 3 mm flank port (Figure 5).

When a crossing vessel is present, the pyeloplasty must be done anterior to the vessel. This technical point is easily detected and performed by the transperitoneal approach.

No kidney drain is left but a bladder catheter, inserted at the beginning of surgery, is used for 3-5 days. Patient is discharged the next morning with oral antibiotics and analgesia as required.

The double-J stent is removed 4-6 weeks later.

Comments

After doing both retro- and transperitoneal pyeloplasties for some time, nowadays our first approach for UPJO is the transperitoneal approach.

To support the "feeling" that in our hands the transperitoneal approach was easier, a prospective study was carried out from November 2009 to May 2010. Prior to the study, we developed a step-by-step surgical protocol and explained it to the whole surgical team, including the surgeons, surgical assistants and scrub nurses. The patient sample included 12 patients > 5 kg with UPJO, as diagnosed via ultrasound and dynamic renal scintigraphy. All needed a pyeloplasty. Two surgeons with advanced urological laparoscopic experience of at least 5 years performed all operations alternately.

Once the protocol was developed and explained to the entire surgical team, the patients were divided into two groups. After performing the surgery on the first 6 patients, protocol steps were reviewed to determine how the surgery itself and the time of surgery could be optimized. The protocol was revised, re-explained to the entire surgical team, and performed on the second group of 6 patients.

Figure 5: Introduction of Double-J

Transperitoneal Laparoscopic Pyeloplasty *(continued from previous page)*

Changes made to the surgical protocol were suture replacement of polydioxanone (PDS) with poliglecaprone 25 (Monocryl®); standardization of the number and length of sutures; the standard use of a fourth trocar; initiation of the suture from the posterior wall of the anastomosis; standardization of the introduction of the double J stent;and introducing the bladder catheter at the beginning of the surgery to avoid the double J stent coming out by the urethra.

Using the above mentioned protocol, we reduced the operative time by 18%, from 171,2 min to 141,7 min in group A and B respectively. We have also seen this decrease in the surgical time of our fellows, achieving an average time of their first 6 patients at 160 minutes, less than the curves initially described in the literature and in our original group (171 min).

In our opinion, there are 3 facts that allowed reducing the operative time. The main factor is the consolidation of the surgical team, doing faster and harmonious surgery. Second, the installation of a fourth trocar in the flank, which facilitates both the placement of a double-J in anterograde and the use of an extra instrument that helps fix the pelvis or the ureter during the spatulation and suturing process. Lastly, standardizing the length of the sutures, which results in a easy developed anastomosis and avoids unwanted knots,and changing polydioxanone (PDS) for poliglecaprone 25 5-0 (Monocryl ®). We found that the new choice does not curl or break, and it slides easily though tissues.

As the transperitoneal approach increases the working space and maneuverability of laparoscopic instruments, we have no problems performing this surgery in children under one year, including patients from 5 kg in our series, as it has already been described by other groups.[7,8] Up until this time we have no complications, such as visceral injury, postoperative ileus, collections or hernias, related to this access. After 12months follow-up with US and dynamic scintigram, we have a 100% success rate.

Conclusions

For all our patients, transabdominal laparoscopic pyeloplasty is the usual approach and the first choice for ureteropelvic junction obstruction in our center, independent of age or degree of dilatation. With this approach we feel more comfortable and secure in a surgery which is already difficult by itself. Besides, this technique allows us to transfer our experience easily and faster to the residents, decreasing their learning curve. Furthermore, the transperitoneal approach allows us a safer approach to complex situations in UPJO, as double systems, crossing vessels, redo pyeloplasty, and horseshoe kidneys.

We conclude that laparoscopic pyeloplasty is the gold standard for all children over 5 kg. Also, we are currently investigating whether the use of this surgical protocol can also improve performance and reduce surgical times for medical residents without extensive laparoscopic experience and who may be less familiar with the steps involved.

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