Surgical treatment of ureteropelvic junction obstructions in pediatrics

Background
Ureteropelvic junction obstruction (UPJO) is one of the most common congenital abnormalities seen by pediatric urologists. Asymptomatic antenatal hydronephrosis has become the most common presentation of UPJO in newborns. Older children most often present with symptoms of urinary tract infection, sepsis, pain, nausea and vomiting. The etiology of a UPJO can be from a congenital anatomic obstruction, poor kidney function or a lower pole crossing vessel causing secondary extrinsic obstruction.

Open pyeloplasty, more specifically the Anderson-Hynes method, has been the gold standard of treatment for UPJO in adults and children since 1949. This technique involves removal of the abnormal segment of tissue and then anastomosis of the spatulated ureter to the most dependent portion of the renal pelvis. Other less invasive techniques emerged in the 1980s with the endopyelotomy. This method is used in specific cases in adults, but rarely in children due to its low success rates (62-70%)\(^1\). The advantages and popularity of less invasive procedures led to the fine-tuning of laparoscopic techniques in 1993, and the introduction of robot-assisted techniques in 1999\(^1\). In this article we will discuss open, laparoscopic and robot-assisted pyeloplasties in pediatric patients.

Open Pyeloplasties
Open pyeloplasty is a proven method with a 93-99% success rate\(^2\). There are two approaches to open incision: the flank approach and the dorsal lumbotomy approach. The flank incision, which involves transecting three layers of muscle on the anterior abdominal wall close to the 12th rib, has the cosmetic drawback of leaving a significant scar in a very visible location. The dorsal lumbotomy is a retroperitoneal procedure with a smaller incision made at the midpoint between the 12th rib and iliac crest. Muscle transection is not required with this approach, making recovery quicker and less painful for children. Although the dorsal lumbotomy approach creates a smaller working space and is therefore more laborious for the surgical team, recovery time is usually much shorter with this technique than it is with the flank approach.

At CHKD, both approaches are used. The dorsal lumbotomy approach is my preferred choice for UPJO identified from antenatal hydronephrosis in children younger than five. To correct obstructions caused by crossing vessels, the flank approach is preferred because it gives better access to the crossing vessels. The flank approach is also the preferred approach for kidneys with malrotation anomalies such as horseshoe kidneys. Disadvantages of open flank pyeloplasty reported in the literature include a higher level of invasiveness, longer hospital

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Laparoscopic Pyeloplasties

Laparoscopic procedures have been shown to exhibit comparable success rates to the open pyeloplasty. Although the procedure is slowly being adopted in the pediatric sector, the extent of intra-corporeal suturing required has limited its widespread use; depending on the experience of the surgeon, the procedure can take two to three hours longer than an open pyeloplasty. However, with greater experience, surgeons have demonstrated operative times comparable to those of open pyeloplasty. Post-operative benefits of this procedure include shorter hospital stays and lower narcotic usage. However, only the most experienced laparoscopic surgeons are able to perform this type of procedure due to the difficulty of intra-corporeal suturing. The advent of robot-assisted pyeloplasty has aided in lessening this learning curve.

da Vinci® Pyeloplasty

Pyeloplasty is the most common procedure performed with the da Vinci® robot in pediatric urology. This system provides 3-D vision, motion scaling and tremor filtering, easing the technical demands of the less invasive procedure for the surgeon. These features, along with the improved facilitation of intra-corporeal anastomosis offered by the da Vinci® robot, significantly increase the number of surgeons who can offer minimally invasive pyeloplasties. Traditional pyeloplasties and those performed with the da Vinci® robot result in similar blood loss, length of postoperative hospitalization, narcotic use, complication rates and success rates.1 More experienced surgeons have shorter operating times with both procedures.4 Because children provide limited working space, most surgeons use a transperitoneal approach for pediatric robot-assisted pyeloplasties.1 The da Vinci® robot is not part of every pediatric urologist’s armamentarium. I have been using it since 2000 and reserve its use for children who weigh more than 100 pounds. The patients are instructed to consume a clear liquid diet for the 24 hours prior to surgery. Magnesium citrate bowel prep is done at home the day prior to surgery. We use three to four ports. The camera is used in a 12 mm port at the belly button, and two 10 mm working ports are placed approximately 10 cm apart. The optional fourth port is used either for suction or with smaller sites, for retraction. The improved dexterity provided by the da Vinci® robot makes the surgery as easy as an open procedure. The patients recover as quickly as my younger, smaller patients do after a dorsal lumboflap surgery. They are typically discharged home in 23 hours and return to school in two or three days. At CHKD, our success rate with the da Vinci® robot-assisted pyeloplasty has been over 95%, which is comparable to open results.5

There are pediatric urologists nationally who now choose to do a da Vinci® robot-assisted pyeloplasty for neonates and infants less than a year old. The concern here is that the dorsal lumboflap approach has such a small incision that it is difficult to justify the robot-assisted approach. The da Vinci® robot-assisted pyeloplasty needs to be in the armamentarium of treatment choices for UPJO, but we have to be wise about when to use it. It is not the best choice in all cases. It is the appropriate first choice for teenagers and older children for whom the alternative is a flank incision pyeloplasty. Here at CHKD we have surgeons credentialed to use the da Vinci® robot who utilize this approach when indicated with excellent success rates.

Dr. Upadhyay is a board-certified pediatric urologist at CHKD.

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Advances in Pediatric Chest Wall Reconstruction

Nuss Procedure Outcomes, Adaptations

Nuss Procedure Outcomes

CHKD’s surgeons first published the minimally invasive Nuss Procedure to correct pectus excavatum in 1997, based on our experience with 42 patients. Since then, we have performed more than 1,000 additional Nuss Procedures, continually measuring our outcomes and reﬁning our techniques in response to them.

Last December, we published our results with 1,215 Nuss Procedure patients over the last 21 years in Annals of Surgery. Although I served as lead author on the study, much credit goes to our colleagues and fellow authors: CHKD surgeons Michael Goetzky, MD; Robert Oehlert, MD; and Ann Kuhn, MD; surgical fellow Richard Reddlinger, MD; and of course, to CHKD surgeon-in-chief emeritus, Donald Nuss, MD, CHB.

Over two decades, we have made signiﬁcant progress establishing objective criteria for surgical intervention using computed tomography (CT) scans of the chest, resting pulmonary function studies (spirometry and/or plethysmography) and cardiology evaluations including echocardiograms and electrocardiograms.

We recommend surgical correction when patients are symptomatic, have a severe pectus excavatum on a clinical basis and fulﬁll two or more of the following criteria:
• CT index greater than 3.25
• Evidence of cardiac or pulmonary compression on CT or echocardiogram
• Mitral valve prolapse
• Arrhythmia
• Restrictive lung disease

In 21 years, we evaluated 2,378 patients and performed repairs on 1,215 (51%). The mean Haller CT index was 5.15 ± 2.32 (mean ± SD). Pulmonary function studies performed in 739 patients showed that FVC, FEV1, and FEF25–75 values were decreased by a mean of 15% below predicted value. Mitral valve prolapse was present in 18% (216) of 1,215 patients and arhythmias in 16% (194).

Of patients who underwent surgery, 2.3% (35 patients) had genetically conﬁrmed Marfan syndrome and an additional 17.0% (232 patients) had physical features suggestive of Marfan syndrome. Scoliosis was noted in 28% (340).

Complications decreased markedly over 21 years. In primary operation patients, the bar displacement rate requiring surgical repositioning decreased from 12% in the ﬁrst decade to 1% in the second decade, due in large part to reﬁnements in the construction and placement of the stabilizers that hold the bar in place.

Allergy to nickel was identiﬁed in 2.8% (35 patients) of whom 22 identiﬁed preoperatively received a titanium bar. Ten patients were treated successfully with prednisone, and three required bar removal (two had a titanium bar inserted and one required no further treatment). Wound infection occurred in 1.4% (17 patients), of whom four required surgical drainage (0.4% of the total). Hemor- rhax occurred in 0.6% (eight patients).

In reviewing the pectus excavatum surgeries performed since 1987, the authors determined that 95.8 percent of patients who had the surgery had a “good to excellent anatomic result.” Since that time, new instruments were developed. These include:

• a stronger and more streamlined bar
• an instrument specially designed to improve substernal tunnel creation
• a stabilizer to prevent bar displacement
• titanium bars for patients with metal allergies

New surgical techniques were also developed to minimize risk when dissecting between the heart and the sternum in an extremely deep defect. These include:
• dissecting two tunnels, one higher than the deepest part of the depression, and using the ﬁrst tunnel to elevate the lowest part of the defect before the bar is inserted
• use of a chest suction cup to elevate the sternum
• introduction of a high resolution thoracic camera into the chest as the procedure is performed

We also detail a radical revision of CHKD’s post-operative pain management and post-operative therapies such as deep breathing exercises patients should perform.

Since the acceptance and publication of the 21-year study, we also have established new protocols for anesthesia during bar placement surgery.

Any time new surgical techniques are developed, it is essential to review outcomes and reﬁne techniques periodically so that others can beneﬁt from our experience. With minimally invasive repair of pectus excavatum ﬁrmly established as a worldwide standard of care, we hoped to demonstrate that this procedure can be performed both safely and effectively and to highlight techniques that have resulted in improved surgical outcomes.

New Treatments for Pectus Carinatum

CHKD surgeons performed the nation’s ﬁrst minimally invasive surgeries to correct pectus carinatum in 2006. In pectus carinatum, the chest wall deformity protrudes outward like the breast of a bird. Pectus carinatum patients can suffer from chest pain, difﬁculty exercising and negative body image.

The new procedure, based on the Nuss Procedure, uses the patented Nuss bar to brace the chest in the correct position for two to three years so the bones can harden in their proper positions. In the Nuss Procedure, the curved bar is tunnelled through the chest cavity and under the sternum to prop it up. In the carinatum surgery, the bar goes under the muscles of the chest wall and over the sternum to press it down.

Prior to the advent of this surgery, correcting pectus carinatum involved opening the chest, removing rib cartilage and often fracturing the sternum to rebuild the chest.

In addition to the surgery, CHKD’s Center for Chest Wall Deformities is offering pectus carinatum patients treatment with a new external brace. Bracing has long been used as an alternative to surgery for milder cases of carinatum, but patient compliance is typically a challenge to success. Many braces can be painful and must be worn during most hours of the day to be effective.

The new brace, which was developed in South America where pectus carinatum is more prevalent, has a feature that allows us to calibrate the pressure it applies to the deformity very precisely, minimizing discomfort and complications such as skin irritation. We have ﬁtted more than 80 patients over the last two years, with excellent results.

Dr. Kelly is a board certiﬁed pediatric sur- geon at CHKD, and also serves as chief of the Department of Surgery.

New Surgeons Join CHKD Practices

Cardiac Surgery
Dr. Felix Tari
Dr. Tsai arrived in May from Children’s Menor- rimm Health Hospital in Houston, Texas, where he was a pediatric heart surgeon. He was also assistant professor of pediatric surgery at the University of Texas Southwestern Medical School at Dallas. Dr. Tsai comes to the practice from Children’s Memorial Hermann Hospital in Houston, Texas, where he was pediatric heart surgeon. He was also assistant professor of pediatric surgery at the University of Texas Southwestern Medical School. He received his cardiothoracic surgical training at the University of Texas Southwestern Medical School and was a fellow in pediatric cardiothoracic surgery at the Medical University of South Carolina. He is a founding member of the World Society for Pediatric and Congenital Heart Surgery and is board-certiﬁed in surgery and thoracic surgery. To reach Dr. Tsai, please call (757) 660-7703.

Pediatric Surgery
Dr. Michele Lombardo
A board-certified surgeon, Dr. Lombardo completed a fellowship in pediatric surgery at Brown University/Hasbro Children’s Hospital and was an instructor in surgery at Brown University. She trained at Brown University/Rhode Island Hospital, where she was executive chief resident, earned medical degree at Boston University School of Medicine and is a graduate of Simmons College in Boston. She joined CHKD Pediatric Surgery practice in July. To reach Dr. Lombardo, please call (757) 660-8850.

Orthopedic Surgery
Dr. Cara Novick
Pediatric orthopedic surgeon Cara D. Novick will join CHKD Orthopedic Surgery and Sports Medicine practice in October. Board-certified in orthopedic surgery, Dr. Novick comes to the practice from Joe DiMaggio Children’s Hospital in Florida. She completed a fellowship in pediatric orthopedic surgery at the Naval Medical Center in San Diego and a residency in orthopedic surgery at the Naval Medical Center in San Diego. After graduating from Yale University, Dr. Novick earned her medical degree at New York University School of Medicine.

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