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SURGICAL METHODS FOR THE CORRECTION OF RENAL FUNCTION DISORDERS IN CHILDREN

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Abstract

Research objective. To study the results of the development of surgical approaches, improvement of materials for endoscopic correction, and refinement of robotic technologies, which open up prospects for improving the effectiveness of VUR treatment.

Materials and methods. From 2018 to 2025, 120 children with vesicoureteral reflux were examined and treated at the TashPMI clinic. All patients were selected for treatment based on the degree of VUR.

Results. This article reviews modern methods of surgical treatment of VUR, their indications, advantages, and disadvantages.

Modern surgical technologies, including robot-assisted and laparoscopic techniques, reduce the invasiveness of the procedure, shorten the recovery period, and minimise the risk of complications.

Keywords: Vesicoureteral reflux, renal dysfunction, paediatric endourology..

Introduction

Surgical methods for correcting renal dysfunction in children play a key role in preventing chronic renal failure and deterioration in quality of life. Among the common pathologies requiring surgical intervention, particular attention is paid to vesicoureteral reflux (VUR). The article reviews modern surgical methods for treating this pathology, including endoscopic and traditional surgical techniques, such as injections of periurethral fillers and ureteral reimplantation. Assessment of the effectiveness of these methods, as well as their impact on the restoration of kidney function, allows the selection of the optimal treatment depending on the severity of the disease and the patient's condition. The article discusses the results of the postoperative period, the advantages of minimally invasive technologies, and the prospects for further development of surgical treatment.

The continuous development of surgical approaches, improvements in materials for endoscopic correction, and advances in robotic technologies open up prospects for improving the effectiveness of PMR treatment. Future research should focus on optimising treatment tactics, selecting the best correction method for each patient, and minimising side effects.

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Some congenital and acquired kidney diseases in children require surgical intervention to prevent irreversible damage to kidney tissue. One such pathology is vesicoureteral reflux (VUR) – retrograde flow of urine from the bladder into the upper urinary tract, which is often associated with a shortened intramural segment of the ureter.

VUR was first associated with recurrent urinary tract infections (UTIs), renal scarring, and nephropathy in 1960 [10]. The disease occurs in approximately 1% of newborns, with the frequency increasing to 15% in children with prenatally diagnosed hydronephrosis [7]. It is more commonly detected in Caucasian patients and girls, except in cases of antenatal diagnosis, where boys predominate. Up to 40% of children with febrile UTIs suffer from PMR [8].

Genetic predisposition plays a significant role in the development of the disease – up to 30% of cases are detected in siblings. However, routine examination of asymptomatic brothers and sisters with normal renal ultrasound findings is not recommended [28]. PMR can be an isolated pathology or combined with congenital anomalies such as posterior urethral valves, neurogenic bladder, and spina bifida. In severe cases, the disease leads to chronic renal failure and accounts for up to 5% of paediatric kidney transplants [19].

Concomitant bladder and bowel dysfunction (CBD) is particularly common in PMR, especially in girls, increasing the risk of infections and reducing the likelihood of spontaneous resolution. Correction of BMD involves timed voiding, laxatives, pelvic floor muscle therapy, behavioural modifications, and anticholinergic medications [13].

The gold standard for diagnosing VUR is a voiding cystourethrogram (VCUG) [14]. High grades of reflux (III–V) are associated with an increased risk of UTI and renal scarring. Management depends on the child's age, grade of reflux, frequency of infections, and renal status. In infants with low grades, spontaneous regression is possible, whereas in severe forms and in the presence of bladder dysfunction, the likelihood of spontaneous resolution of the pathology is significantly lower [4].

Antibiotic prophylaxis is often used for high degrees of reflux, but its use is associated with the risk of antibiotic resistance. The RIVUR study confirmed its effectiveness in PMR IV–V and concomitant DMPC [18]. Nevertheless, in some cases, surgical correction is required, which can be endoscopic or conventional surgery. This article will discuss modern methods of surgical treatment of PMR, their indications, advantages and disadvantages.

Materials and Methods

From 2018 to 2025, 120 children with PMR were examined and treated at the TashPMI clinic. The first clinical signs of the disease and the results of the therapeutic and diagnostic principle in early and older patients were analysed. At the same time, we assessed the risk factors and aetiological factors of PMR in young children, the nature of the infectious agent, and the presence of aggravating conditions. We mainly observed children under 1 year of age - 36 (36.5%), children from 1 to 3 years of age - 20 (19.3%). Of these, 25 are boys (32%) and 39 are girls (38%). Analysis of the medical records of patients admitted to the urology department showed that 38 (37.3%) patients in the first days of the disease.

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Endoscopic methods

Endoscopic correction of PMR using periureteral fillers was introduced into clinical practice in 1984 and is a minimally invasive treatment for grade I–IV reflux and, in some cases, grade V reflux [17]. This approach demonstrates good results with low morbidity, but requires precise injection technique and correct calculation of the filler volume. Insufficient volume may not eliminate reflux, while excessive volume may lead to obstruction.

The most common fillers include dextranomer-hyaluronic acid gel and polyacrylate-polyol copolymer, which are effective at low degrees of PMR. However, complications are possible, including late recurrence of reflux and ureteral obstruction [20].

There are three main techniques for endoscopic correction:

The STING technique (1981) involves injecting a filler submucosally below the ureteral orifice, which helps to lift and lengthen the vesicoureteral junction (VUJ). A modified version of the method is successful in 91% of cases [22].

HIT technique (2004) – uses hydrostatic pressure to expand the intramural ureter, improving the distribution of the filler. The injection is made into the posterior wall of the ureter, forming a characteristic 'volcano-like' bump that prevents reflux.

The Double-HIT technique is an improved version of the HIT method, involving two intraluminal injections in the proximal and distal parts of the ureteral orifice. This allows its shape to be changed and significantly increases the success rate of the procedure, reaching 93%. In the United States, this technique is the most common endoscopic surgery for PFM, demonstrating an efficacy of 82.5% compared to 71.4% for STING [12, 30].

After endoscopic correction, a follow-up examination is recommended, including an ultrasound examination of the kidneys and MCUG after 3 months [16].

Endoscopic surgery as a first-line treatment. Endoscopic correction of PMR is widely used as the treatment of choice due to its minimal invasiveness, low anaesthesia requirements, and stable results. Increasing the volume of the filler and performing repeat injections can improve effectiveness, especially when treatment is carried out in specialised centres [26].

Prognosis for success. The success of the procedure depends on the degree of reflux:

Grade I – 89%;

Grade II – 83%;

Grade III – 71%;

Grade IV – 59%;

Grade V – 62%.

The degree of PMR is the most significant predictor of treatment effectiveness, as confirmed by meta-analyses [18].

Surgical methods of treating PMR. Historical background. The first antireflux surgery was performed by Hatch in 1952 [11], and by 1960, Hodson and Edwards had linked PMR with recurrent IMP [9]. This led to the development of surgical correction methods aimed at creating a functional antireflux mechanism in the vesicoureteric junction (VUJ).

Classic techniques include:

Leadbetter-Politano (1958) – intravesical reimplantation of the ureter with elongation of the submucosal tunnel to prevent reflux [11].

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Glenn-Anderson (1967) – a modification of the Leadbetter-Politano method that prevents ureteral torsion [5].

Cohen (1975) – transverse trigonal reimplantation, providing reliable protection against reflux but complicating future endoscopic interventions [1].

Open intravesical reimplantation demonstrates an efficacy of >95%, but is an invasive procedure [23]. In the 1960s, an extravesical technique was developed that reduces the risk of postoperative complications. In 2004, robot-assisted reimplantation appeared, which is highly accurate but requires complex technical equipment and is costly [25]. Despite the development of endoscopic methods, traditional surgery remains necessary for severe cases [3].

Surgical techniques. The Leadbetter-Politano method is a complex procedure that preserves the anatomical position of the ureteral orifice, allowing for future ureteroscopy. It involves a Pfannenstiel incision, opening of the bladder dome, and creation of a submucosal tunnel for the relocated ureter [18].

The Glenn-Anderson method is a less complex technique that lengthens the submucosal tunnel without the need to remove the ureter from the bladder, which reduces the risk of twisting. An endoscopic version of this operation has been developed [21].

The Lich-Gregoir method (1964) is an extravesical approach in which the bladder is not opened and the ureter is fixed in the created submucosal tunnel. It is often used in kidney transplantation. There is a laparoscopic version that minimises tissue trauma [24].

Transverse trigonal reimplantation according to Cohen. This method requires a Pfannenstiel incision and opening of the bladder dome. A Denis-Brown retractor is used, and the ureters are pre-stented (5- or 8-French). The ureter is mobilised through the bladder wall, ensuring a working length of at least 8 cm. The opening is closed with absorbable sutures, after which bilateral submucosal tunnels 4 cm long are created. The ureters are split in the cranial direction and fixed with 5-0 chromic sutures. Stenting is indicated for bilateral PMR. Compared to the Cohen technique, the Lich-Gregoir method requires fewer days of hospitalisation and reduces operating time [1][27].

Cohen's vesicoscopic ureteral reimplantation. This laparoscopic transvesical technique is performed through three small incisions above the pubic symphysis for trocar insertion. After initial cystoscopy, a 30° 5-mm cystoscope is inserted and the bladder is filled with gas (≤7 mm Hg). Then, bilateral stenting of the ureters, their circular dissection and mobilisation (at least 4 cm) are performed. After creating a submucosal tunnel, the ureters are fixed in their new position.

A modified version of the operation reduces the risk of postoperative urinary retention in bilateral PMR. In terms of effectiveness, this technique is comparable to the Lich-Gregoir laparoscopic method, but is considered technically simpler [15].

Robot-assisted and laparoscopic extravesical ureteral reimplantation. Preoperative assessment. Routine cystoscopy and retrograde pyelography allow assessment of the ureteral orifices, the length of the posterior wall of the bladder, and identification of anatomical abnormalities. The patient is placed in the Trendelenburg position, and the success of the operation largely depends on the length of the posterior wall of the bladder. If it is insufficiently long, intravesical reimplantation is preferable. Ureterocele is a contraindication to extravesical intervention [18].

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Surgical technique. Stenting of the ureter facilitates its identification, especially during the training phase. A Foley catheter provides hydrodistension of the bladder. After creating a pneumoperitoneum, a 5 mm trocar is inserted, followed by three working ports along the Pfannenstiel line. Particular attention is paid to preventing damage to the vessels and the dome of the bladder. Adhesiolysis is performed to expose the ureter from the bifurcation of the iliac vessels to the bladder while preserving blood supply. The Retzius space is cleared to ensure bladder mobility. The ureter is freed from the PMS with minimal disruption to the periureteral tissues. In males, the peritoneum is dissected below the vas deferens. Babcock forceps or umbilical cord are used to handle the ureter with care. The submucosal tunnel in the detrusor is marked by electrocoagulation with the bladder distended, with a tunnel length to ureter diameter ratio of ≥5:1. A tunnel length of 3 cm is usually sufficient. A 4-0 polypropylene fixation suture secures its formation [2][29].

Detrusor myotomy and tunnel reconstruction. Detrusor myotomy is performed along a pre-marked line, avoiding damage to the mucosa or repairing it if necessary. Protrusion of the mucosa confirms the effectiveness of the detrusor groove, preventing ureteral stenosis. Laparoscopic procedures provide less protrusion due to pneumoperitoneum, so it is important to avoid excessive stretching of the bladder to maintain the working space. Caudal dissection is performed to the level of the PMS in an inverted Y shape, preserving the trigone attachments. The ureter is placed in a submucosal tunnel, after which the detrusor is reconstructed with interrupted absorbable sutures. To prevent ureteral torsion, reconstruction begins at the base of the inverted Y and does not extend beyond it. The final suture is placed at a distance from the ureter, further reducing the risk of torsion [6].

Results and discussion. Endoscopic insertion of periurethral fillers is preferable for low-grade LUTS due to its minimal invasiveness, but its success rate is 10–20% lower than that of surgical reimplantation. Robot-assisted and open surgeries demonstrate high efficacy (98–99%), except for grade V, where the success rate is ~80% [18].

Robot-assisted and extravesical methods avoid opening the bladder, which reduces the likelihood of haematuria, leaks and spasms, speeding up recovery. These approaches also minimise the risk of ureteral obstruction, eliminating the need for stents and drains. The advantages of robot-assisted surgery include reduced pain, less scarring, and shorter hospital stays, but this method is more expensive and slightly less effective.

Persistent PMR after surgery is rare and usually resolves spontaneously. The success of reimplantation depends on adequate mobilisation of the distal ureter, preservation of periureteral tissues, secure fixation with absorbable sutures, and sufficient length of the intramural tunnel. Vesioscopic reimplantation achieves success rates of over 95%.

Postoperative follow-up includes ultrasound examination at 3, 12, and 24 months. MCUG is performed only if symptoms are present or in cases of grade V PMR [6].

Conclusion

Vesicoureteral reflux is a significant pathology that requires a comprehensive approach to treatment. Minimally invasive methods, such as endoscopic insertion of fillers, are effective for low degrees of VUR, but surgical reimplantation remains the gold standard for more severe forms. Modern surgical technologies, including robot-assisted and laparoscopic techniques, reduce the invasiveness of the procedure, shorten the recovery period, and minimise the risk of complications.

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