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Surgical treatment of hydronephrosis in children: a single-centre study

Leczenie operacyjne wodonercza u dzieci – doświadczenia jednego ośrodka

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Abstract

Introduction: Hydronephrosis is one of the most commonly diagnosed urinary tract defects in children. It is characterised by various degrees of dilation of the renal pelvis and calyces with concomitant thinning of the renal parenchyma. The dilation is caused by a ureteropelvic junction defect obstructing the outflow of urine from the kidney. Extreme hydronephrosis can lead to a complete lack of function of the affected kidney. The treatment of hydronephrosis involves restoring normal urine outflow from the kidney and depends on the cause of the condition. The decision to perform surgery depends on the rate of progression of abnormalities observed in the renal parenchyma, among other aspects. **Aim of the study:** The paper presents the experiences of a single centre in the surgical treatment of hydronephrosis in children aged up to 18 years. **Materials and methods:** In 2016–2020, 77 children underwent surgery for hydronephrosis at the present authors' department. In 40% of cases, hydronephrosis was diagnosed on antenatal screening, in 31% it was observed on abdominal ultrasound performed due to abdominal pain, in 17% the condition was detected incidentally when the causes of other diseases were being investigated, in 9% urinary tract infection led to the discovery of hydronephrosis and in 3% of cases abdominal trauma was the reason the patient was examined in the first place. In 58% of the subjects, the cause of hydronephrosis was intramural stenosis of the ureteropelvic junction, in 22% it was the presence of accessory vessels and in 20% various other causes were found. In all patients, Anderson–Hynes ureteropyeloplasty was performed. **Results:** Surgical outcomes were assessed 12 months after the procedure, and in 97.4% of cases they were considered good. A repeat operation was performed in only 2 cases due to a lack of improvement after the original hydronephrosis surgery. **Conclusions:** Surgical treatment of hydronephrosis caused by ureteropelvic obstruction is an effective and safe method with a low risk of early and late complications.

Keywords: hydronephrosis, children, ureteropyeloplasty

Streszczenie

Wstęp: Wodonercze jest jedną z najczęściej rozpoznawanych wad układu moczowego u dzieci. Charakteryzuje się różnego stopnia poszerzeniem miedniczki nerkowej i kielichów z równoczasowym ścieńczeniem warstwy miąższowej nerki. Poszerzenie spowodowane jest niewydolnością połączenia miedniczkowo-moczowodowego powodującą utrudnienie odpływu moczu z nerki. Skrajne wodonercze może doprowadzić do całkowitego braku funkcji chorej nerki. Leczenie wodonercza polega na przywróceniu prawidłowego odpływu moczu z nerki i zależy od przyczyny. Decyzja o leczeniu operacyjnym jest uwarunkowana między innymi szybkością progresji zmian obserwowanych w miąższu nerki. **Cel:** Praca ma na celu przedstawienie doświadczeń jednego ośrodka w leczeniu operacyjnym wodonercza u dzieci do 18. roku życia. **Materiał i metody:** W latach 2016–2020 w Klinice autorek operowano z powodu wodonercza 77 dzieci. W 40% przypadków wodonercze rozpoznano na podstawie badań prenatalnych, u 31% dzieci w trakcie badania ultrasonograficznego jamy brzusznej wykonywanego z powodu bólów brzucha, w 17% przypadków wodonercze wykryto podczas diagnozowania innych chorób, w 9% wskutek zakażenia układu moczowego, a w 3% przyczyną diagnostyki był uraz brzucha. W 58% przypadków przyczyną wodonercza było śródścienne zwężenie połączenia miedniczkowo-moczowodowego, w 22% obecność naczyń dodatkowych, a w 20% stwierdzono różne inne przyczyny. U wszystkich pacjentów wykonano zabieg plastyki miedniczkowo-moczowodowej sposobem Hynesa–Andersona. **Wyniki:** Wyniki operacji oceniano po upływie 12 miesięcy od zabiegu i w 97,4% uznano je za dobre. Tylko w 2 przypadkach wykonano reoperację wodonercza z powodu braku poprawy po operacji pierwotnej. **Wnioski:** Leczenie operacyjne wodonercza spowodowanego przeszkodą w połączeniu miedniczkowo-moczowodowym jest metodą skuteczną i bezpieczną, obarczoną niskim odsetkiem wczesnych i późnych powikłań.

Słowa kluczowe: wodonercze, dzieci, plastyka miedniczkowo-moczowodowa

INTRODUCTION

Hydronephrosis is one of the most commonly diagnosed urinary tract defects in children[1,2]. It is characterised by various degrees of dilation of the renal pelvis and calyces with concomitant thinning of the renal parenchyma. The dilation is caused by a ureteropelvic junction defect obstructing the outflow of urine from the kidney. Impaired urine flow leads to a number of morphological and functional changes referred to as obstructive uropathy (Figs. 1, 2). Extreme hydronephrosis can lead to a complete lack of function of the affected kidney.

The causes of hydronephrosis can be divided into three groups:

- Intramural: abnormalities in peristaltic wave progression (adynamic segment). These include: anatomical defects – circumferential muscle layer hypertrophy (or fibrosis) with an increased amount of collagen or functional impairment – abnormal expression and function of Cajal cells. As a result of collagen and fibroblast proliferation at the expense of smooth muscle cells, progressive motor impairment is observed in the urinary outflow tract[3,4].
- External: the presence of accessory vessels leading to the inferior pole of the kidney (Fig. 3). The vessels cross with the ureter, compressing the ureteropelvic junction[5,6]. A similar mechanism is found in nephroptosis, which involves periodic crossing of the ureter with vessels. External compression can also be the result of extraperitoneal inflammation that impairs urine flow[7,8].
- Internal: urolithiasis – a concrement lodged in the ureteropelvic junction impedes urine flow from the kidney and additionally causes local inflammation; ureteral valve or polyp (very rare abnormalities)[9].

Regardless of its causes, a ureteropelvic junction defect always results in similar consequences. Hydronephrosis deteriorates when the balance between the amount of urine produced and the ability to transport it to the lower sections of the urinary tract is compromised. The pressure inside the renal pelvis increases to >5–25 cm H_2O, which leads to nephron damage and decreased glomerular filtration rate; as a result, urine production decreases[1].

Hydronephrosis that originates and progresses slowly may be asymptomatic. Sometimes the first symptom is a palpable abdominal mass. However, rapidly progressing urinary stasis is characterised by the following symptoms: abdominal pain, asthenia, nausea, lack of appetite, sometimes haematuria, and urinary tract infection.

The treatment of hydronephrosis involves restoring normal urine outflow from the kidney and depends on the cause of the condition. The decision to perform surgery depends on many factors, including, among other aspects, the patient's age, hydronephrosis progression observation time, ultrasound scanning results, scintigraphy results, clinical symptoms and the rate of hydronephrosis progression. In doubtful cases, diagnostic imaging procedures are additionally performed such as urography and contrast-enhanced computed tomography.

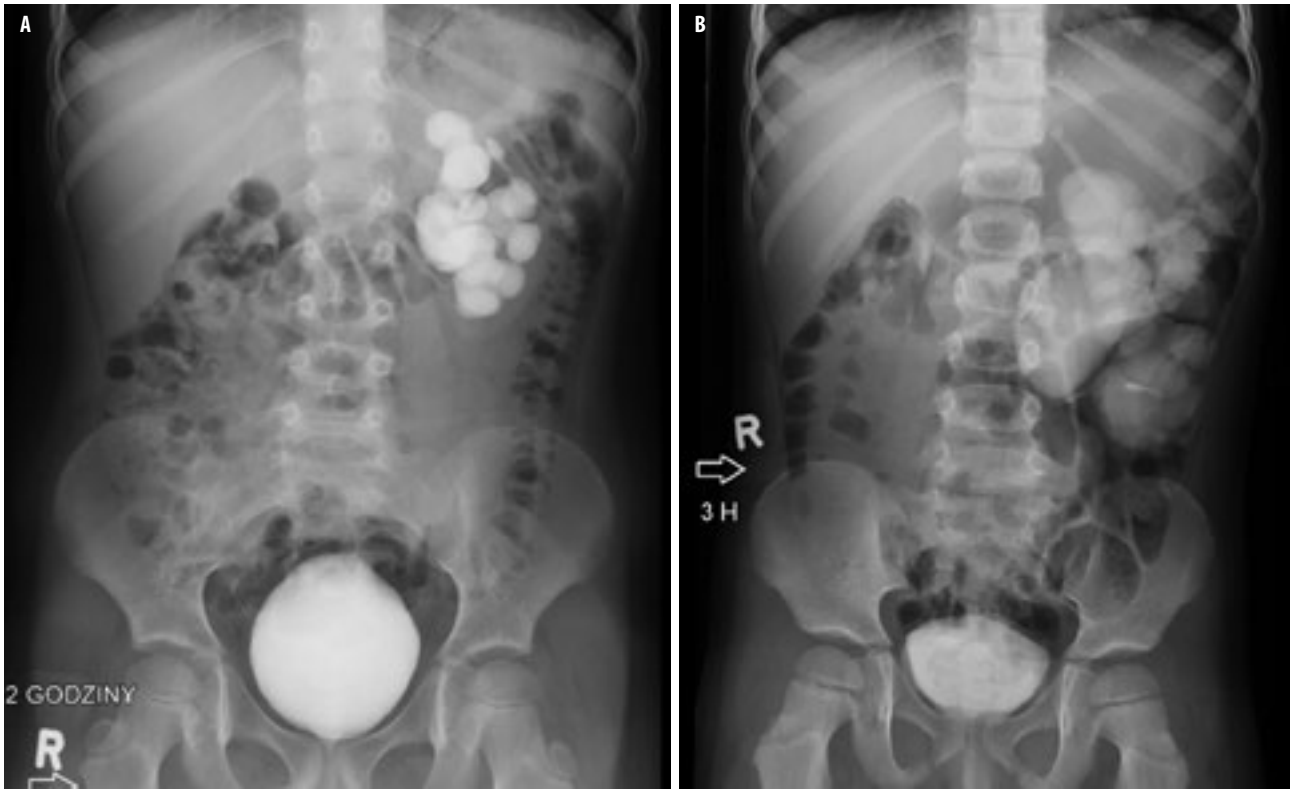

Fig. 1. Left-sided hydronephrosis: urography

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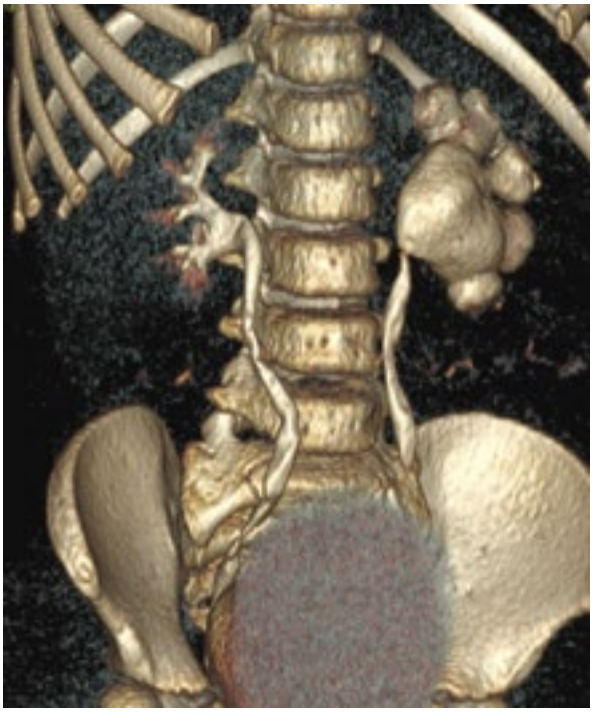

Fig. 2. Left-sided hydronephrosis: CT urography, 3D reconstruction

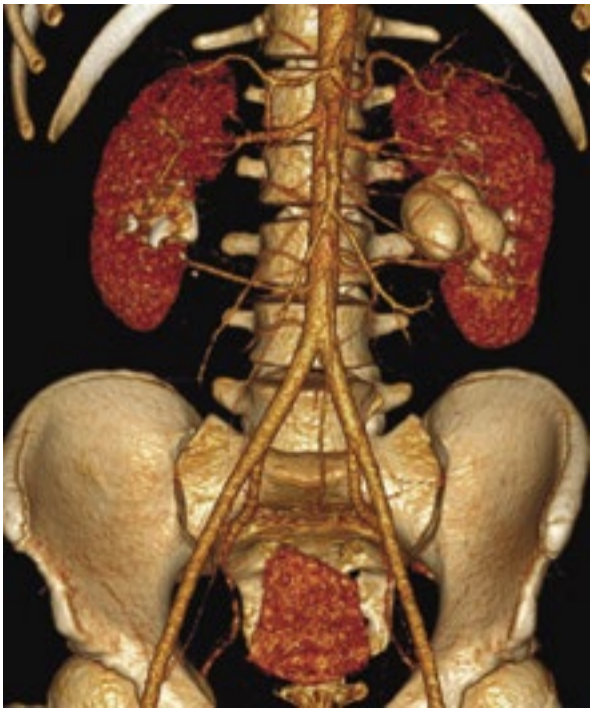

Fig. 3. Left-sided hydronephrosis caused by the presence of an accessory vessel (3D reconstruction)

Surgery is indicated when:

- clinical symptoms are present: pain, palpable abdominal mass;
- the renal pelvis becomes enlarged on ultrasound up to >20 mm in the anterior-posterior (AP) dimension;
- follow-up scintigraphy shows impaired urine excretion and decreased renal filtration function;
- the contrast agent lingers in the pelvicalyceal system for more than 2 hours on imaging studies;
- the patient has recurrent urinary tract infections;
- the patient develops hypertension.

The most common procedure performed in children with hydronephrosis is Anderson–Hynes ureteropyeloplasty. It involves the excision of the stenotic area and the construction of a wide anastomosis between the renal pelvis and the ureter. This procedure is characterised by a high efficacy rate (approximately 98%) and a low number of complications. Other methods used to treat the type of hydronephrosis described in the present paper include: Foley, Fender, Culp–De Weerd and Scardino–Prince procedures. All of these procedures lead to the widening of the ureteropelvic junction. Upon surgeon's discretion, it is possible to apply various types of catheters supporting the anastomosis: nephrostomy (a catheter which is inserted through the skin to the kidney and then to the ureter below the anastomosis) or a JJ stent inserted to the renal pelvis and the urinary bladder. The anastomosis can also be performed without a supporting stent[10]. Laparoscopy is being increasingly used to treat hydronephrosis, which is a less extensive procedure. Laparoscopy leaves a smaller postoperative trauma in the patient. At the same time, it provides a better view of all structures of the ureteropelvic junction, allowing one to resect the affected segment in a precise fashion. There are two laparoscopic approaches to the kidney: transperitoneal and extraperitoneal. In both approaches, 3–4 trocars are used. Based on the present authors' experiences, the extraperitoneal approach is more difficult in small patients. It prolongs surgery time due to a smaller operation area, and the smaller distance between the trocars makes instrument manoeuvring difficult[11–13].

During the postoperative period, complications are observed both directly after the procedure and at a later time. The complications that occur directly after surgery include lack of ureteropelvic junction integrity (characterised by urine leakage through a perirenal drain), urinary tract infection and postoperative wound inflammation. Long-term complications are lack of kidney function improvement, recurrence of hydronephrosis progression and the need to perform pyeloplasty again[14,15].

AIM OF THE STUDY

The study presents the authors' own experiences in the surgical treatment of children diagnosed with progressive hydronephrosis with renal impairment.

MATERIALS AND METHODS

In 2016–2020, 77 children aged from 0 to 18 years underwent surgery for hydronephrosis at the Department of Paediatric Surgery and Paediatric Urology of the Centre of Postgraduate Medical Education (CMKP) in Dziekanów

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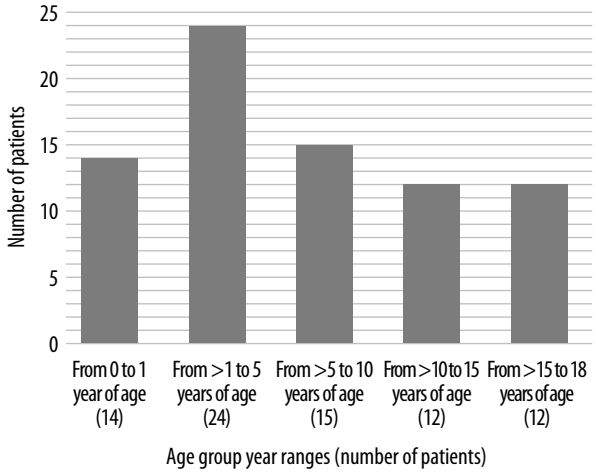

Fig. 4. Patients undergoing surgery broken down by age group

Leśny, Poland. The study group included 44 boys (57%) and 33 girls (43%). Left-sided hydronephrosis was found in 50 patients (65%) and right-sided one in 27 subjects (35%). Fig. 4 presents age distribution in the patients. There were 24 children aged 1–5 years, who accounted for 31% of all patients undergoing surgery.

In 47 patients (61%), hydronephrosis was caused by intramural stenosis of the ureteropelvic junction and in 16 cases (21%) by the presence of accessory vessels (Fig. 5). Among the children undergoing surgery, 25 (32%) had been monitored at the Department of Paediatric Surgery and Paediatric Urology of CMKP since the neonatal period, while other patients were referred for surgery from various other paediatric nephrology centres.

In the study, ultrasound was used to make a preliminary diagnosis of hydronephrosis. In 31 patients (40%), hydronephrosis was revealed on antenatal screening, in 24 children (31%), ultrasound performed due to abdominal pain revealed the condition, in 13 cases (17%), hydronephrosis was detected incidentally when the causes of other diseases were being investigated, in 6 patients (8%), it was urinary tract infection that led to the discovery of hydronephrosis, in 1 patient it was urosepsis, and in 2 cases abdominal trauma. Pelvicalyceal system dilation was diagnosed early, already in the antenatal period, in 40% of children. This made it possible to provide postnatal care to these children, both in the field of urology and nephrology. Follow-up ultrasound examination was conducted every 3 months and dynamic scintigraphy every 6 months. Urinalysis was performed at regular intervals. If kidney function deteriorated and the renal pelvis dilated further with partial blockage of urine flow being visualised in the study subjects, diagnostic imaging was performed that was suitable for the clinical situation: contrast-enhanced computed tomography, urography or ascending pyelography. Diagnostic imaging was used to assess the degree of kidney damage, pelvicalyceal system dilation and the time in which the contrast agent drained from the kidney. Contrast agent lingering for more than 2 hours was the sign of obstructed urine flow.

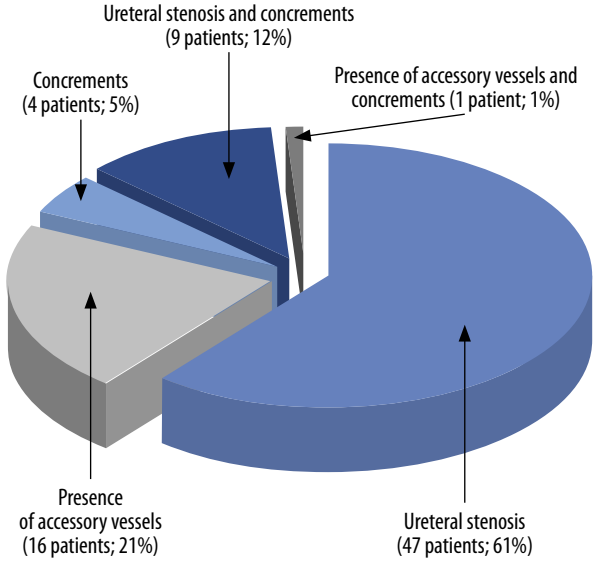

Fig. 5. Causes of hydronephrosis in the study group

Based on examination findings, including gradual deterioration of kidney function observed on dynamic scintigraphy, a decision was made to perform ureteropyeloplasty. The procedure was performed using the classic method with Anderson–Hynes technique. The procedure lasted between 40 minutes and 2.5 hours. The anastomosis was supported with a JJ stent, which was removed endoscopically 2–3 weeks later under short-term general anaesthesia. In addition, a drain was placed in the kidney bed, which was removed on day 4 after the procedure on average. The patients received second-generation cephalosporins at 50 mg/kg/day for 5 days as antibiotic cover. Subsequently, furazidine was administered at 4 mg/kg/day until the JJ stent was removed. After the procedure, all children were followed up according to a pre-established protocol. Urinalysis was performed initially once a week (until the JJ stent was removed) and then every 2 weeks. Follow-up ultrasound examination was performed one week after the JJ stent was removed and then once a month, up to 6 months after the procedure. Follow-up dynamic scintigraphy was conducted 6 and 12 months post surgery.

Reduction of AP pelvic dilation to ≤10 mm (≥20 mm before the procedure) and a lack of difficulty in the excretion of the tracer from the kidney on renoscintigraphy (with the flow being slower or completely blocked before surgery) were considered a good outcome.

RESULTS

Surgical outcomes were assessed 12 months after the procedure, and in 97.4% of cases they were considered good. A repeat operation was performed (with a good outcome) in 2 cases due to a lack of improvement after the original hydronephrosis surgery. In one of these cases, the cause of progressive hydronephrosis was the bending of a too long ureter in the subpelvic area. In the other case, postoperative adhesions compressed the ureter and compromised urine

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flow from the kidney. In 2 cases, urine leakage through the anastomosis was observed. In one of these cases, the leakage resolved on its own on day 10 after the procedure, and in the other case it did on day 8. Neither case required repeat operation. No urinary tract infection was found in any of the patients after hydronephrosis surgery.

DISCUSSION

Hydronephrosis develops as a result of impaired urine flow from the kidney and is a relatively early diagnosed urinary tract defect. The prevalence of hydronephrosis in the paediatric population is 0.5–1%. Currently, due to the fact that ultrasound scanning has become widely available, the majority of hydronephrosis cases are diagnosed in the antenatal period and early childhood. Renal pelvis dilation is the most common defect that can be diagnosed already at week 16 of foetal development. Due to the fact that obstructive defects diagnosed during the antenatal period are the main cause of chronic kidney disease later in life, neonates with hydronephrosis require thorough nephrological and urological care[15]. After birth, ultrasound scanning and isotopic imaging are performed to determine whether urine flow impairment is significant enough to require surgery or whether it can be observed and treated conservatively. The main examination procedure that doctors use when making therapeutic decisions is dynamic renoscintigraphy, which shows the degree of renal parenchymal damage and of urine flow impairment. Currently, there is an ongoing debate on the indications for ureteropyeloplasty in children diagnosed with pelvicalyceal dilation[5]. Some authors believe that children with an estimated hydronephrotic kidney function of >35% do not require surgical correction, since the results of long-term observation studies show no functional deterioration in the affected kidney despite persistent signs of obstructive uropathy[3]. However, others believe that a child with significant pelvicalyceal dilation on ultrasound, a decreased kidney filtration share of <40% and blocked urine outflow on renoscintigraphy should undergo surgery[9,16].

Indications for ureteropyeloplasty include kidney function deterioration and increasing pelvicalyceal dilation. Periodic follow-up examinations are performed such as ultrasound, which is initially repeated once month and then every 3 months, and renoscintigraphy, which is repeated every 3 months in infants and every year in older children. In doubtful cases, contrast-enhanced computed tomography can be performed, since it shows precisely what kind of obstacle is compromising urine flow[16,17].

Conservative management involves periodic follow-up to determine kidney function and the degree of renal parenchymal damage. In order to improve urine flow, alpha-blockers can be used, which have a long-lasting effect on the muscle tissue of the ureteropelvic junction. In the case of hydronephrosis caused by ureteropelvic junction muscle hypertrophy, the administration of doxazosin can cause urinary stasis to resolve and kidney function to improve.

One needs to remember about the apparent hyperfunction of a hydronephrotic kidney (referred to as "supranormal" kidney in the literature). Kidney function exceeding 55% on renoscintigraphy may be a sign of substantial stasis and impaired tracer excretion from the dilated pelvicalyceal system[18–20].

There are a number of possible surgical procedures. In a patient with AP pelvic dilation of >5 mm, calyceal dilation and renal cortical thinning, one can perform primary surgery, i.e. Anderson–Hynes ureteropyeloplasty in order to obtain good urine flow from the kidney. Such patient management is accepted and warranted. However, the majority of paediatric surgeons and urologists who operate on patients with hydronephrosis make different decisions. In patients with pelvic dilation, initially, kidney decompression procedures can be performed such as nephrostomy or JJ stent placement in the kidney. This makes it possible to assess the actual filtration share of the decompressed kidney. A repair procedure can be postponed without detriment to the function and filtration rate of the hydronephrotic kidney.

If hydronephrosis is accompanied by additional signs and symptoms such as recurrent urinary tract infections, nephrolithiasis, arterial hypertension or lumbar pain, and kidney function is relatively good, a repair procedure should be performed earlier[21]. However, if kidney function accounts for <10% of the total filtration process, nephrectomy should be performed[22].

After the procedure, patients should be followed up. Ultrasound examination is performed initially once a month and subsequently every 3 months. The first follow-up scintigraphy should be conducted 6 months after surgery and then it should be repeated every year. Following pyeloplasty, scintigraphic kidney function and ultrasound examination findings usually improve and patients report their clinical symptoms to have resolved. There is a widespread view in the available literature that the majority of complications develop within 2 years from the operation; nevertheless, long-term follow-up should be continued[23,24].

The present authors believe that the current indications for surgical treatment of hydronephrosis are well-defined. In patients with impaired urine flow and deteriorating filtration function of the kidney, hydronephrosis surgery is the right course of action to take. The procedure involves obstruction removal and ureteropyeloplasty. The Anderson–Hynes technique, which is used at the Department of Paediatric Surgery and Paediatric Urology of CMKP, is a simple and safe method with good postoperative outcomes. Conservative treatment of hydronephrosis with doxazosin should be limited to patients with no visible symptom progression, to children with a small dilation of the pelvicalyceal system and with no evident parenchymal atrophy in the affected kidney.

CONCLUSIONS

Surgical treatment of hydronephrosis caused by ureteropelvic obstruction is an effective and safe method with a low risk of early and late complications.

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Conflict of interest

The authors do not report any financial or personal affiliations to persons or organisations that could adversely affect the content of or claim to have rights to this publication.

References

1. Gawłowska A, Niedzielski J: Uropatia zaporowa u dzieci – wybrane aspekty. Przegl Pediatr 2003; 33: 282–285.
2. Apoznański W: Wodonercze. In: Bagłaj M, Kaliciński P (eds.): Chirurgia dziecięca. PZWL, Warszawa 2016: 748–756.
3. Krakós M, Kobos J, Andrzejewska E: Badanie unerwienia ściany moczowodu w zwężeniu połączenia miedniczkowo-moczowodowego u dzieci z wodonerczem wrodzonym. Urol Pol 2004; 57: 71–76.
4. Zięba I: Badania nad mechanizmami fibrogenezy w drogach moczowych u dzieci z wrodzonym wodonerczem. Praca magisterska, Repozytorium Uniwersytetu Jagiellońskiego, 2017.
5. Świerc A, Ciecierska A, Zielińska K et al.: [Clinical and ultrasound characteristics and results of the treatment of congenital hydronephrosis in neonates]. Pediatr Pol 2016; 91: 20–25.
6. Stern JM, Park S, Anderson JK et al.: Functional assessment of crossing vessels as etiology of ureteropelvic junction obstruction. Urology 2007; 69: 1022–1024.
7. Szedel A, Życzkowski M, Potyka A et al.: Laparoskopia w przypadkach nienowotworowych schorzeń układu moczowo-płciowego. Urol Pol 2008; 61 Suppl 1. Available from: http://www.urologiapolska.pl/artykul.php?3158.
8. Drelich-Zbroja A: Standardy badań ultrasonograficznych Polskiego Towarzystwa Ultrasonograficznego – aktualizacja. Badanie ultrasonograficzne tętnic nerkowych. J Ultrason 2014; 14: 297–305.
9. Szmigielska A, Krzemień G, Bombińska M et al.: Wodonercze czy kielichonercze – diagnostyka różnicowa zastoju moczu w układzie moczowym. Ann Acad Med Siles 2017; 71: 62–65.
10. Apoznański W, Chrzan R, Rysiakiewicz K et al.: Wpływ szynowania moczowodów na przeciekanie moczu u dzieci poddanych operacji zwężenia miedniczkowo-moczowodowego. Adv Clin Exp Med 2005; 14: 765–770.
11. Penn HA, Gatti JM, Hoestje SM et al.: Laparoscopic versus open pyeloplasty in children: preliminary report of a prospective randomized trial. J Urol 2010; 184: 690–695.
12. Szydełko T, Kasprzak J, Niezgoda T et al.: Laparoskopowa, przezotrzewnowa plastyka przejścia miedniczkowo-moczowodowego – doświadczenia własne na podstawie pierwszych 20 przypadków. Urol Pol 2003; 56: 33–35.
13. Janetschek G, Peschel R, Frauscher F: Laparoscopic pyeloplasty. Urol Clin North Am 2000; 27: 695–704.
14. O'Reilly PH, Brooman PJ, Mak S et al.: The long-term results of Anderson–Hynes pyeloplasty. BJU Int 2001; 87: 287–289.
15. Sahito RA, Soomro BA, Qureshi MA: An experience of open Anderson–Hynes pyeloplasty. J Surg Pak 2013; 18: 135–138.
16. Czarniak P, Żurowska A, Szcześniak P et al.: Wstępne wyniki programu wczesnej opieki nefro-urologicznej nad dziećmi z wrodzonym wodonerczem. Pol Merkur Lekarski 2009; 26: 322–324.
17. Krzemień G, Szmigielska A, Bombiński P et al.: Extreme hydronephrosis due to uretropelvic junction obstruction in infant (case report). Dev Period Med 2016; 20: 139–142.
18. Nocuń A, Kornaś A, Nóżka-Kozik M et al.: Zjawisko podwyższonej funkcji względnej nerki u dzieci z rozpoznaniem jednostronnego wodonercza w renoscyntygrafii ^{99m}Tc-EC. Pediatr Pol 2011; 86: 247–249.
19. Lichosik M, Placzyńska M, Jobs K et al.: Porównanie aktualnych metod oznaczania estymacyjnego przesączania kłębuszkowego u dzieci. Pediatr Med Rodz 2013; 9: 154–159.
20. Eskild-Jensen A, Gordon I, Piepsz A et al.: Interpretation of the renogram: problems and pitfalls in hydronephrosis in children. BJU Int 2004; 94: 887–892.
21. Bochniewska V, Jung A, Jurkiewicz B et al.: Metody zabiegowe w leczeniu kamicy układu moczowego u dzieci. Pediatr Med Rodz 2010; 6: 309–314.
22. Harper JD, Shah SK, Baldwin DD et al.: Laparoscopic nephrectomy for pediatric giant hydronephrosis. Urology 2007; 70: 153–156.
23. Polok M, Apoznański W: Anderson–Hynes pyeloplasty in children – long-term outcomes, how long follow up is necessary? Cent European J Urol 2017; 70: 434–438.
24. Paradysz A, Behrendt J, Życzkowski M et al.: Usefulness of ultrasound examination in diagnosis and follow-up after surgical treatment of pyeloureteral stricture in neonates. Pol J Radiol 2006; 71: 58–61.

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