

Sequential Treatment of Duplex Kidney with Pyonephrosis: Case Reports and Analysis

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Abstract

This case report is designed to investigate sequential treatment principles, the appropriate timing for nephrostomy and radical nephrectomy, and the merits and demerits of laparoscopic and open surgical procedures in the context of a duplex kidney accompanied by pyonephrosis. Through a meticulous analysis of two representative cases and a comprehensive review of pertinent literature, the report offers a valuable reference for clinical practice. This enables the optimization of treatment strategies for patients afflicted with a duplex kidney and pyonephrosis, leading to enhanced treatment efficacy and a reduction in potential complications.

Keywords duplex kidney; pyonephrosis; nephrostomy; nephrectomy; sequential treatment

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1 Introduction

Duplex kidney is a relatively common congenital anomaly of the urinary tract, with an incidence of approximately 0.8%. When a duplex kidney is accompanied by pyonephrosis, the pathological state becomes notably more complex. Inadequate management may give rise to severe complications, including the dissemination of infection, deterioration of renal function, and even

life-threatening septicemia. Consequently, devising a rational sequential treatment regimen, precisely determining the optimal timing for nephrostomy and radical nephrectomy, and selecting the appropriate surgical approach (either laparoscopic or open surgery) are of paramount importance in enhancing the prognostic outlook for patients.

2 Case Reports

2.1 Case One

A one-year-old female toddler was hospitalized due to “an eight-day fever accompanied by a three-day oliguria episode.” Upon admission, her body temperature was recorded at 38.8°C. She was in a lethargic state, with a 24-hour urine output of approximately 150 ml, which was substantially lower than that of her peers. Mild eyelid edema was also observable. The parents informed that the child had occasionally cried during urination in the past.

Following a thorough diagnostic evaluation, the urinary system ultrasound revealed a left duplex kidney complicated by pyonephrosis, severe hydronephrosis of the upper renal pole, a tortuous and dilated ureter, and a left ureterocele. CTU (CT urography) further elucidated the abnormal anatomical configuration and the extent of the lesion.

Subsequent to a multidisciplinary evaluation and after comprehensive preoperative preparations such as anti-infective therapy and measures to enhance renal function, a laparoscopic one-stage left duplex nephrectomy was carried out. During the surgical procedure, it was discovered that the upper pole of the left duplex kidney had massive hydronephrosis, measuring approximately 8 × 7 × 3 cm. The renal parenchyma of the upper pole was extremely thin, and there was significant perirenal inflammatory adhesion. The left duplex ureter was a megaureter, with a diameter of 1.5 cm, while the diameter of the ureter of the lower pole of the kidney was around 0.4 cm.

Owing to the close adhesion between the renal pelvis and the surrounding tissues, laparoscopic dissection proved to be arduous. After intraoperative consultation with the family and obtaining their consent, the surgical approach was converted to an open procedure. The duplex renal artery and vein were successfully severed, and the duplex kidney along with its associated ureter was entirely resected. A drainage tube was then inserted.

Postoperatively, anti-infective and nutritional support therapies were administered. The urine volume and renal function were meticulously monitored. The patient made a favorable recovery, with her body temperature returning to normal and the urine volume progressively reaching the normal range. No abnormalities were detected during follow-up after discharge.

2.2 Case Two

Another one-year-old girl was admitted to the hospital due to “recurrent fever lasting for eight days accompanied by diarrhea for two days.” Her body temperature fluctuated within the range of 38°C to 39°C, and she had diarrhea 4 – 5 times a day, with watery stools. At the same time, it

was noticed that the frequency of her urination decreased and the color of her urine was dark.

After color Doppler ultrasonography, she was diagnosed with left duplex kidney accompanied by pyonephrosis, end-stage hydronephrosis of the upper pole of the kidney, severe hydronephrosis of the lower pole of the kidney, and slightly elevated creatinine and urea nitrogen levels in the renal function indices. Considering the severe infection and her poor general condition, direct resection surgery was deemed inappropriate at that moment.

Consequently, a percutaneous nephrostomy of the upper pole of the left duplex kidney was initially carried out, and a substantial amount of purulent urine was drained. After the operation, active anti-infection measures and correction of water and electrolyte imbalances were implemented. Due to the need for long-term infusion, an external jugular vein catheter was indwelled.

With effective infection control and improvement in the child's overall condition, a left duplex nephrectomy was scheduled two weeks after the nephrostomy. The operation proceeded smoothly, and the patient recovered well. The renal function was normal upon reexamination, and she was discharged as scheduled. The subsequent follow-up indicated normal growth and development.

3 Treatment Process

3.1 Treatment Process of Case One

3.1.1 Initial Anti-infection

Immediately upon admission, intravenous administration of broad-spectrum antibiotics (Ceftriaxone Sodium and Sulbactam Sodium 0.3 g, q8h) was initiated for the purpose of combating the infection. Simultaneously, a comprehensive set of routine admission examinations was carried out. Additionally, measures such as urine alkalinization, fluid resuscitation, and nutritional support interventions were implemented.

3.1.2 One-stage Radical Nephrectomy

After two weeks of intensive antibiotic therapy, the patient's infection symptoms were fully controlled. Follow-up blood and urine tests showed largely normal results, and serum creatinine remained stable at $110 \mu\text{mol/L}$. At this time, a comprehensive assessment of the patient was conducted, including color Doppler ultrasound and CT urography, which confirmed that the upper pole of the kidney had no functional preservation value. Preoperative preparations were completed, and no surgical contraindications were identified.

To minimize surgical trauma and postoperative complications, laparoscopic radical resection of the upper pole of the left duplex kidney was selected. However, due to severe adhesions and an unclear anatomical structure, the operation was converted to an open procedure. During surgery, the adhesions were meticulously dissected. The connection between the megaureter and the renal pelvis was successfully transected while preserving the renal pedicle vessels. The

estimated intraoperative blood loss was approximately 50 mL, and the operation lasted about 180 minutes.

Postoperatively, the patient's body temperature gradually normalized, infection indices improved, and no significant complications were observed. The patient was discharged on the sixth postoperative day.

3.2 Treatment Process of Case Two

3.2.1 Anti-infection and Nephrostomy Decision

Upon admission, while continuously monitoring the patient's vital signs, an empirical antibiotic regimen (Piperacillin Tazobactam 1.0 g, q8h) was initiated. Given the initial stability of the patient's condition, the decision was made not to proceed immediately with nephrostomy. Instead, the medical team closely monitored the patient and completed a series of relevant examinations.

However, on the third day post-admission, the patient's febrile symptoms worsened. Subsequent urine analysis revealed a significant increase in white blood cells. Owing to the patient's young age and limited cooperation, it was determined that a percutaneous nephrostomy of the upper pole of the left duplex kidney under general anesthesia in the operating room was necessary. Following the procedure, a substantial volume of purulent urine was successfully drained, leading to a gradual resolution of the fever and a progressive decrease in white blood cell count and neutrophil ratio.

3.2.2 Implementation of Radical Nephrectomy

Two weeks after the nephrostomy, the patient's urinary tract infection was effectively controlled, and preoperative evaluations revealed no significant abnormalities. Plans were thus made to conduct a radical duplex nephrectomy.

Due to the chronic nature of the child's illness, which had resulted in dense adhesions between the renal pelvis and surrounding perirenal tissues, an open surgical approach was chosen. During the operation, the surgical team meticulously dissected the adherent tissues and achieved complete resection of the upper left kidney and its associated ureter. The estimated intraoperative blood loss was approximately 20 mL, and the operation lasted around 180 minutes.

Postoperatively, the patient exhibited a favorable recovery without any significant complications and was discharged on the fifth postoperative day.

4 Discussion

4.1 Sequential Treatment Principles of Duplex Kidney with Pyonephrosis

The duplex renal collecting system represents one of the most prevalent congenital anomalies within the urinary system^[1]. A duplex kidney is characterized as a kidney unit comprising two pelvicalyceal systems and is among the common congenital urinary tract anomalies^[1,2]. In general, ureteral duplication was noted in one out of 125 (0.8%) cases within the autopsy series. The

majority of duplex abnormalities are asymptomatic^[3]. Duplex kidneys appear symptomatically only when associated with complications and associated anomalies^[4,5].

The unique anatomical structure of duplicated kidney and ureteral malformation, along with ureteral stenosis and poor urine drainage, is prone to fluid reflux and urinary tract infections^[6,7]. Luo et al. reported that urinary tract infection was the most prevalent symptom (46%), followed by incontinence (20%) and antenatal or postnatal diagnosis (18%)^[8].

The therapeutic guideline for duplex kidney complicated by pyonephrosis is to initially manage the infection, safeguard renal function, and subsequently decide on the necessity of radical surgery based on the assessment of renal function^[9]. During the acute stage of infection, broad-spectrum antibiotics ought to be actively employed for anti-infective therapy^[10,11]. Concurrently, in light of the patient's specific circumstances, timely nephrostomy drainage should be implemented to alleviate the pressure within the renal pelvis, impede the further dissemination of the infection, and foster the regression of inflammation. Once the infection has been effectively managed, a comprehensive evaluation of renal function is conducted. For a duplex kidney with non-functional or severely compromised function and a healthy contralateral kidney, radical nephrectomy can be taken into account.

4.2 Timing of Nephrostomy

The timing of nephrostomy holds a vital position in the treatment of duplex kidney accompanied by pyonephrosis^[12]. Generally, when the patient exhibits severe infection manifestations like high fever, chills, and indications of septicemia (such as hypotension, tachycardia, etc.), and the antibiotic anti-infection treatment proves ineffective, along with imaging investigations revealing conspicuous renal abscess and a substantial quantity of purulent fluid accumulation, percutaneous nephrostomy ought to be carried out emergently. This is because the prompt drainage of purulent fluid can diminish the pressure within the renal pelvis and preclude the further propagation of the infection, constituting an essential step to rescue the patient's life^[13].

In the scenario of scheduled nephrostomy, if the patient's infection symptoms are relatively mild, and a certain degree of alleviation is achieved following antibiotic treatment, yet there remains persistent low-grade fever, lumbar pain, and no evident reduction in the size of the abscess, percutaneous nephrostomy can also be contemplated within a defined time frame under vigilant observation. This can ameliorate the patient's symptoms and afford an opportunity for further assessment and treatment^[14].

4.3 Timing of Radical Nephrectomy

After infection control, radical nephrectomy should ideally be carried out subsequent to the infection being fundamentally under control^[15,16]. This typically demands a phase of antibiotic therapy and/or drainage (such as nephrostomy drainage). When the patient's body temperature becomes normal, the white blood cell count and neutrophil proportion in the blood routine revert to normal or approach normal levels, and the systemic infection symptoms vanish, then the

option of surgery can be entertained. Conducting surgery during the active period of infection will augment the surgical risks, including intraoperative hemorrhage and the dissemination of infection.

After sufficient assessment of renal function, it is essential to ascertain the functionality of the residual portion of the affected kidney via examinations such as radionuclide renogram and intravenous urography^[17]. If the other segment of the affected kidney (in the context of a duplex kidney) functions well and the contralateral kidney function is within the normal range, and following a comprehensive evaluation, it is determined that the excision of the diseased part will not precipitate renal failure, then radical resection can be contemplated^[18,19].

4.4 Advantages and Disadvantages of Laparoscopic and Open Surgeries

Laparoscopic surgery merely necessitates a few small incisions (ordinarily approximately 0.5 - 1.5 cm) in the abdomen. In contrast to the extensive incision of open surgery, the postoperative pain is considerably alleviated, and the patient experiences a swifter recovery^[20,21]. For instance, patients who undergo laparoscopic nephrectomy might be capable of getting out of bed and commencing ambulation 1 - 2 days after the operation, whereas patients who undergo open surgery could potentially require 3 - 5 days.

Laparoscopic surgery is capable of magnifying the surgical field of view by means of a camera, facilitating a more distinct visualization of the anatomical configuration of the kidney and the adjacent tissues. Particularly when addressing complex anatomical structures like the duplex kidney, it can more precisely dissect blood vessels and ureters, thereby diminishing the incidence of intraoperative damage^[8].

Laparoscopic surgery requires the surgeon to have proficient laparoscopic operation skills, and the cooperation requirements of the surgical team are also high^[22]. Moreover, when dealing with complex adhesion situations such as adhesions that may occur after duplex kidney with infection, the operation difficulty will further increase.

Laparoscopic surgery requires the use of special instruments and equipment, such as laparoscopic systems and ultrasonic scalpels. The high cost of these equipment leads to a relatively higher surgical cost compared with open surgery.

In cases where complex anatomical configurations and severe adhesions are present, open surgery endows the doctor with the ability to directly make contact with the tissues by hand. This tactile interaction empowers them to more precisely assess the scope and nature of the pathological lesion. During the process of radical nephrectomy, it becomes more expedient to manage large blood vessels, thereby effectively curtailing the risk of intraoperative bleeding.

Open surgery predominantly makes utilization of conventional surgical apparatuses, and the corresponding technology has reached a relatively advanced level of maturity. The vast majority of surgeons in hospitals are capable of attaining a high level of proficiency in performing such operations and do not necessitate specialized training to master the intricate techniques associated with laparoscopic procedures^[23].

Open surgery requires a relatively large incision, usually about 5 - 10 cm, to expose the kidney.

The postoperative pain is severe, and the recovery time is long. The probability of patients having complications such as wound infection and dehiscence is relatively high.

Although the surgical field of view can be exposed with the help of surgical retractors and other tools, compared with the magnified visual field of laparoscopic surgery, it is slightly insufficient in observing fine anatomical structures and may increase the risk of intraoperative damage to surrounding tissues.

5 Conclusion

In the case of patients with duplex kidney accompanied by pyonephrosis, personalized treatment regimens ought to be devised in light of specific circumstances. Throughout the treatment course, it is crucial to accurately determine the optimal timing for performing nephrostomy and radical nephrectomy and make appropriate surgical choices, thereby enhancing the therapeutic efficacy and diminishing the incidence of complications. Simultaneously, it is essential to further intensify research on duplex kidney with pyonephrosis, with the aim of providing a more reliable foundation for clinical treatment^[24].

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