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Novel Approach to Managing Congenital Posterior Urethral Valves in Premature Infants

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Description

Congenital Posterior Urethral Valves (PUVs) are the most common cause of lower urinary tract obstruction in male infants and represent a significant source of morbidity and mortality due to the potential for bladder and renal damage. These valves are membranous folds that develop abnormally within the posterior urethra, causing partial or complete obstruction of urinary flow. Early diagnosis and effective management are critical to prevent irreversible renal injury and preserve normal urinary tract function [1].

While there is ample research and experience in managing PUVs in full-term neonates and older infants, the treatment of premature infants presents unique challenges. Prematurity is associated with smaller anatomical structures, physiological immaturity, and increased vulnerability to complications related to anesthesia and instrumentation. Standard endoscopic valve ablation can be difficult or even impossible in very low birth weight infants due to these limitations [2]. As a result, novel approaches tailored specifically to the needs and constraints of premature infants have been developed and are gaining traction.

The pathophysiology of PUV involves obstruction of the posterior urethra, resulting in elevated bladder pressures, vesicoureteral reflux, hydronephrosis, and progressive renal parenchymal injury. In premature infants, these processes are often worsened by immature renal function and compromised immune and respiratory systems. These factors contribute to an increased risk of complications during both diagnosis and treatment [3-5]. The small size of the urethra restricts the use of standard endoscopic instruments, while the fragility of tissues makes them prone to injury during procedures. Additionally, physiological instability-such as immature lung function and cardiovascular fragility-raises the stakes of anesthesia and surgical intervention, and the heightened risk of infection adds further complexity.

Traditionally, the standard treatment for PUV is transurethral valve ablation performed within the first few days or weeks of life. This is achieved using a cold knife or electrocautery via cystoscopy. The diagnosis is confirmed by Voiding Cystourethrogram (VCUG), which also helps evaluate the severity of obstruction [6]. However, in premature infants, the insertion of endoscopic instruments may be unsafe or technically impossible due to the small caliber of the urethra and associated comorbidities. These limitations sometimes necessitate initial urinary diversion procedures such as vesicostomy or percutaneous nephrostomy to decompress the urinary tract, deferring definitive treatment until the infant is more stable. While diversion can stabilize the infant, it is associated with complications such as stomal issues, recurrent infections, and delays in definitive valve ablation [7].

To address these challenges, advances in diagnostic imaging have improved the early identification

and assessment of PUV in premature infants while minimizing invasive procedures. High-resolution prenatal and postnatal ultrasound allows detailed evaluation of bladder wall thickness, ureteral dilation, and renal parenchymal changes. Magnetic Resonance Urography (MRU) provides anatomic and functional information without exposing infants to radiation, making it a valuable tool in complex cases or when VCUG is contraindicated [8]. Although VCUG remains the gold standard for diagnosing PUV, newer catheters and smaller contrast volumes reduce the risk of trauma during the procedure in premature infants.

Technological progress has led to the development of miniaturized endoscopic instruments specifically designed for neonates and premature infants. These include ultra-miniature flexible cystoscopes with external diameters less than 5 French, as well as micro-instruments for precise valve ablation [9]. These small-caliber tools facilitate minimally invasive transurethral valve ablation in infants with low birth weight, reducing the need for open surgery or prolonged urinary diversion.

Postoperative care of premature infants undergoing PUV treatment involves meticulous monitoring of urine output, renal function, and electrolyte balance. Serial ultrasonography is employed to track the resolution of hydronephrosis and assess bladder morphology. Antibiotic prophylaxis is often administered to reduce the risk of urinary tract infections. When feasible, urodynamic studies help evaluate bladder function and guide ongoing management [10]. Long-term follow-up is essential to detect and manage complications such as bladder dysfunction, chronic kidney disease, recurrent infections, and urethral strictures.

A clinical case illustrates the novel approach well: a male infant born at 28 weeks gestation was diagnosed prenatally with bilateral hydronephrosis and thickened bladder wall. After birth, confirmatory imaging revealed PUV causing high-grade obstruction. Given the infant's low birth weight (1.1 kg) and respiratory instability, immediate endoscopic valve ablation was considered too risky. A temporary vesicostomy was performed to decompress the urinary tract. After six weeks, when the infant had gained weight and stabilized, valve ablation was performed using a miniaturized flexible cystoscope and laser ablation under careful anesthesia. The procedure was successful without complications. Postoperative imaging showed significant improvement, and the vesicostomy was closed after three months, achieving definitive treatment with minimal morbidity.

Conclusion

Congenital posterior urethral valves in premature infants require a carefully balanced approach that relieves obstruction promptly while minimizing procedural risks associated with prematurity. Novel strategies such as the use of miniaturized endoscopes, laser ablation, and staged management with temporary urinary diversion have improved outcomes by tailoring treatment to the fragile physiology and anatomy of these infants. Multidisciplinary collaboration and advances in imaging and surgical technology are critical to optimizing care. With ongoing research and technological innovation, the prognosis for premature infants with PUV continues to improve, offering hope for better preservation of renal function and quality of life.

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