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REVIEW ARTICLE

Bladder augmentation and urinary diversion in patients with neurogenic bladder: Surgical considerations

Raimund Stein*, **Annette Schröder**, **Joachim W. Thüroff**

Division of Paediatric Urology, Department of Urology, University Medical Center, Johannes Gutenberg University, Langenbeckstrasse 1, 55131 Mainz, Germany

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Abstract In patients with a neurogenic bladder, the primary goal is preservation of renal function and prevention of urinary tract infection, with urinary continence as the secondary goal. After failure of conservative treatment (clean intermittent catheterisation and pharmacotherapy) urinary diversion should be considered. In this review, the surgical options with their advantages and disadvantages are discussed.

In patients with a hyper-reflexive, small-capacity and/or low-compliance bladder with normal upper urinary tract, bladder augmentation (bowel segments/ureter) is an option. To those who are unable to perform clean intermittent catheterisation via urethra, a continent cutaneous stoma can be offered. In patients with irreparable sphincter defects a continent cutaneous diversion is an option. For patients who are not suitable for a continent diversion (incompliant ± chronic renal failure), a colonic conduit for incontinent diversion is preferred.

Surgical complications specific to urinary diversion include: ureterointestinal stenosis, stomal stenosis, stone formation, bladder perforation, and shunt infection and obstruction. Surgical revision is required in around one third of patients. Careful lifelong follow-up of these patients is necessary, as some of these complications can occur late.

* Corresponding author. Tel.: +49 (0)6131 172114; fax: +49 (0)6131 175601.
E-mail address: raimund.stein@unimedizin-mainz.de (R. Stein).

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Introduction

A lesion at any level of the nervous system may result in neurogenic bladder sphincter dysfunction. These patients, whether the lesion is congenital or acquired in early childhood, are a challenge to the urologist. Neural tube defects, including myelomeningocele, lipomeningocele, sacral agenesis and occult spina bifida, are the most common birth defects and the main cause for lesions in this group. Acquired causes such as trauma, spinal cord tumour and myelitis are rare.

The primary goal of treatment is preservation of renal function and prevention of urinary tract infection by providing unobstructed drainage of the upper urinary tract through effective bladder evacuation [1]. Achieving urinary continence is the second goal. Conservative management including clean intermittent catheterisation [2] and pharmacotherapy [3] is the primary approach. Starting early with this regime, surgical intervention can generally be avoided for the long term [4]. Only after failure of all conservative treatment options should the following options for surgical intervention be considered.

Bladder augmentation is a straightforward concept for patients with a hyper-reflexive, small-capacity and/or low-compliance bladder with normal upper urinary tract, and in cases of combined sphincteric incompetence with additional support of the sphincteric function (e.g. by a fascial sling procedure) [1]. However, urinary incontinence remains a problem in 10—30% [5—7]. If deterioration of the upper urinary tract caused by ureteral obstruction or high-grade reflux is a complication of a hyper-reflexive and/or small low-compliance bladder, bladder substitution and ureteral re-implantation are appropriate.

For patients with irreparable sphincter defects and those who are unable to perform transurethral self-catheterisation, continent cutaneous diversion is an option. In patients with chronic renal failure and those who are unable to perform self-catheterisation of a continent stoma, an incontinent type of urinary diversion should be discussed with the patient and caregivers [1]. In such cases and during childhood, colonic conduit diversion is preferable.

The options for urinary diversion should be discussed in an interdisciplinary conference including paediatric nephrologists, neuropaediatricians, neurosurgeons, orthopaedic surgeons and paediatric urologists. The surgical concept is tailored to the physical, mental and psychological condition of the patient and their personal preference.

Factors to be considered prior to surgery

The level of the neurological defect is a crucial aspect. This may determine whether a patient is ambulatory or wheelchair-bound, and whether they are able to adequately perform clean intermittent self-catheterisation (CISC). An important aspect is the transition from the ambulatory state to the wheelchair-bound patient, which may come with age and increasing obesity [8]. At the same time, patient expectations must be considered. Urinary continence during the day and night is usually very important to the patient [9]. As body image gains importance in adolescence, incontinence has a strong negative influence on occupational and social activities, especially sexual relationships.

Bowel

Bowel segments exert contraction in order to milk the bowel contents and furthermore to transport them in an antegrade direction. These contractions are coordinated by nerve and muscle activities. For urinary diversion, two aspects are important: bowel capacity and contractility. The volume of a bowel segment is calculated from the formula of a cylinder increase with the second power of its radius. When comparing ileum with colon, significantly shorter segments of colon are required (Fig. 1) [10]. Many years ago, Frank Hinman demonstrated that reconfiguration of a long thin cylinder into a shorter cylinder with double the circumference results in double the capacity (Fig. 2) [11]. By reconfiguring the bowel from a cylinder to a sphere, the maximum increase in capacity for a given surface area can be achieved. The maximum increase in radius is attained at the expense of cylinder length (cylinder: Volume $= l \cdot \pi \cdot r^2$; sphere: Volume $= 4/3\pi \cdot r^3$). According to Laplace's law $t = (p \cdot r)$ the wall tension of a wall (t) of a reservoir is proportional to the product of the radius (r) and the pressure (p). This means that, for a given wall tension, the greater the radius of the reservoir, the smaller the reservoir pressure. The creation of a high-capacity/low-pressure reservoir is the goal in urinary tract reconstruction, as it avoids incontinence and deterioration of the upper urinary tract.

An intact bowel delivers high-pressure peristaltic contractions intended for milking and transportation of the intestinal contents. Splitting of bowel segments at their antimesenteric border and surgical reconfiguration desynchronise motor activities and lower intraluminal pressures. A reconfigured bowel will continue to contract for several years. However, since contractions do not occur throughout the entire circumference, pressures remain low and fairly constant. Intact ileum produces lower pressure waves as compared to intact caecum [12]. In the caecal reservoir, the number of motor activities remains constant over time. However, the amplitude of the pressure waves decreases, indicating adaptation towards the increasing

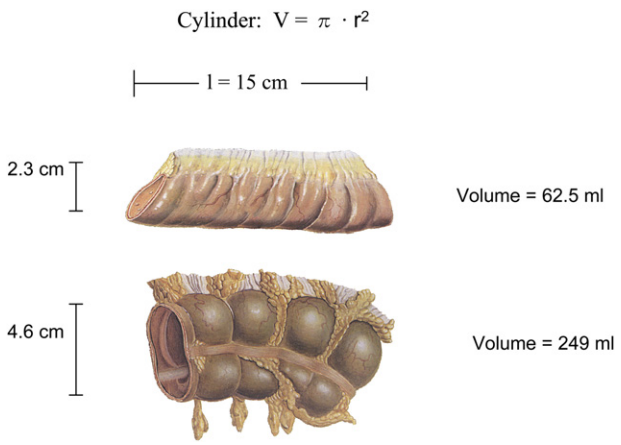

Figure 1 The volume of the bowel differs by the second power of the radius. Using the same length of bowel, a higher capacity is reached with colon.