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Effects of intravesical electrical stimulation therapy on urodynamic patterns for children with spina bifida: A 10-year experience

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Abstract *Objective:* Intravesical electrical stimulation (IVES) has been performed for various purposes in children with a neurogenic bladder. We evaluated the results of IVES on urodynamic study parameters in children with spina bifida.
Methods: We retrospectively analyzed the cases of 88 children who received IVES between August 1999 and May 2010 and whose comparative urodynamic data were available before and after treatment. According to the pre-IVES urodynamic study, children were divided into 3 groups: detrusor overactivity, detrusor underactivity and acontractile detrusor. We investigated the changes in detrusor function, bladder capacity and detrusor-sphincter dyssynergia.
Results: In the group showing detrusor overactivity, the bladder had a synergic pattern in 41.7%, and normal detrusor function was observed in 16.7% of them. Bladder capacity increased after IVES therapy, especially in those who started therapy before 18 months of age ($p = 0.019$). Detrusor-sphincter dyssynergia was resolved in 55.6%. In the acontractile detrusor group, detrusor contraction ability increased in 48%, but bladder capacity did not.
Conclusions: Appropriate candidates for this treatment need to be carefully selected.

Abbreviations: CIC, clean intermittent catheterization; DSD, detrusor-sphincter dyssynergia; ICCS, International Children's Continence Society; IVES, intravesical electrical stimulation; SCI, spinal cord injury; UDS, urodynamic study.

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Introduction

The incidence of spina bifida worldwide still ranges from 0.3 to 4.5 per 1000 births [1]. Most children with spina bifida have complex problems that require multidisciplinary lifelong care. More than 90% of patients with spina bifida have lower urinary tract dysfunction [2]. The primary goals of treatment are to preserve renal function and social continence [3]. Many patients are universally treated with anticholinergics and clean intermittent catheterization (CIC). However, in some patients this prophylactic therapy is unsatisfactory in preventing upper urinary tract deterioration and incontinence [2]. In those who fail to respond to medical treatment, bladder augmentation procedures might be needed [4]. However, the risks of bladder augmentation are well documented [5,6]. Therefore, more aggressive strategies such as intravesical electrical stimulation (IVES) might be useful for preventing upper urinary tract damage and secondarily for gaining continence, and improving the quality of life and social interactions.

The first IVES trials can be traced back to 1878 when Saxtorph treated patients with urinary retention by transurethral bladder stimulation. This technique was reintroduced by Katona as a treatment for neurogenic voiding disorders [7]. Although the effects of IVES are controversial, several studies have shown beneficial bladder stimulation, if not a majority of the patients treated using this method [3,8—12].

At our center, for the last 10 years, IVES has been performed for various purposes in children with spina bifida. In this long-term study, we evaluated the results of IVES on urodynamic study (UDS) parameters in children with spina bifida.

Materials and methods

There were 88 children with spina bifida who received more than 4 cycles of IVES between August 1999 and May 2010 at our institute. For these cases comparative urodynamic data before and after the IVES treatment were available. According to the pre-IVES UDS, children were divided into 3 groups: detrusor overactivity, detrusor underactivity and acontractile detrusor. We investigated the changes in detrusor function, bladder capacity and detrusor-sphincter dyssynergia. The post-IVES UDS was taken at 3 months after the last IVES treatment cycle. Oral anticholinergics were discontinued in all children at least 3 days prior to each UDS and IVES treatment.

In accordance with the International Children's Continence Society (ICCS) [13] detrusor overactivity was defined as a urodynamic observation characterized by involuntary detrusor contractions that were spontaneous or provoked during the filling phase, involving a detrusor pressure increase of greater than 15 cm H_2O above baseline. A detrusor underactivity was contraction of decreased strength and/or duration, resulting in prolonged bladder emptying and/or failure to achieve complete bladder emptying within a normal time span. An acontractile detrusor demonstrated no contractions whatsoever during urodynamic studies. Detrusor-sphincter dyssynergia, which is applicable in patients with neurogenic bladder disturbance, was the cystometric observation of a detrusor voiding contraction concurrent with an involuntary contraction of the urethra and/or periurethral striated muscle.

Bladder compliance was defined as the relationship between the change in bladder volume and change in detrusor pressure. Compliance was calculated by dividing the volume change by the change in detrusor pressure during that change in bladder volume [13]. Low compliance was defined as a compliance value lower than 20 ml/cm H_2O [14].

We measured bladder capacity when the child began to urinate or demonstrated discomfort. In patients in whom bladder sensation was absent, the volume was determined when the intravesical pressure reached 30 cm H_2O. Since bladder capacity changes with age, and in order to account for the different patient ages included in this study, percent bladder capacity was calculated for standardization. Percent bladder capacity was defined as (patient measured bladder capacity divided by the expected bladder capacity for age) $\times$ 100. Expected bladder capacity for age was calculated using the Palmer's age-matched bladder capacity formula for children with spina bifida: expected bladder capacity (ml) $=$ (24.5 $\times$ age) $+$ 62 ml [15].

The urinary incontinence score was recorded on a 0—3 scale as described by Schurch et al. as follows: 0, completely dry; 1, wet once a day; 2, wet for $<$50% of the time between CIC (moderate); and 3, wet for $>$50% of the time between CIC (severe) [16]. A decrement of 1 or more degrees in the daytime incontinence score was considered an "improvement".

For the IVES procedure, a specially designed catheter (cathode) with a monopolar electrode inside the tip was inserted into the bladder, surrounded by a small amount of saline (25—35 ml). The anode comprised 2 coupled diathermy plates (electrosurgical neutral electrode) attached to the abdominal skin above the pubic bone. The total contact area was 250 cm^2. IVES was administered with an MS-310 stimulator (Vitacon, Trondheim, Norway), giving unipolar square waves of 0.2 ms duration, with an intensity of up to 40 mA and frequencies of 22 Hz. Bladder pressure was monitored continuously during the IVES, by connecting the bladder catheter to a pressure transducer. Stimulation intensity was adjusted individually to a level just below that producing an unpleasant sensation. The applied current intensity varied considerably between children (10—40 mA). Care was taken not to induce painful sensations. In the first treatment cycle, 10 sessions of IVES were performed, followed by 5 sessions every 3 months in the subsequent cycles. Each IVES session was of 60 min duration.

For statistical evaluations, the Wilcoxon's signed rank test and Mann—Whitney *U*-test were used.

Results

The 88 patients included 52 boys and 36 girls. Of these, 33 (37.5%) were born with meningomyelocele and 55 (62.5%) with lipomeningomyelocele. Their mean age was 33 months at the start of treatment. The average treatment period for