

Biofeedback Therapy and Dysfunctional Voiding in Children

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Dysfunctional voiding, a condition in which a neurologically intact child fails to relax the urinary sphincter during micturition, was first described in the 1970s. Clinically, these children have urinary incontinence and recurrent urinary tract infections. Biofeedback, through which the child is taught to relax the pelvic floor during voiding, has become an increasingly popular method of treatment. Many series, most retrospective, have shown biofeedback to be very effective in the treatment of this disorder.

Introduction

Dysfunctional voiding, also known as "non-neurogenic bladder" or "Hinman-Allen Syndrome," was first described by Hinman and Baumann in 1973 [1•]. They reported on a group of children who did not show any evidence of neurologic disease, but exhibited abnormal non-relaxation of the external sphincter during voiding. In some cases, this led to severe irreversible damage to the upper urinary tracts and bladder. This initial description was expanded on by Allen in 1977 [2], who also noted the association with functional bowel disturbances. Subsequently, Allen and Bright [3] and Firlit *et al.* [4] recognized the importance of urodynamic evaluation for these children. Since that time, standard definitions of dysfunctional voiding have been developed by the International Children's Continence Society; much of the important work in this field has been conducted by workers in Europe [5••]. Although different patterns of dysfunctional voiding are recognized, they all share the characteristic of non-relaxation of the sphincter during voiding. Incontinence and recurrent urinary tract infections (UTI) are the most common clinical presentations. Vesicoureteral reflux, nocturnal enuresis, and associated constipation or encopresis also are seen frequently in these children.

Once anatomic urologic or neurologic disease has been ruled out, treatment focuses on retraining the voiding pat-

tern. In recent years, biofeedback therapy, which usually uses electromyogram (EMG) monitoring, has become the method of choice. Although individual techniques vary, all biofeedback programs seek to train the child to relax the external sphincter during voiding, thus normalizing the voiding pattern and reducing residual urine volumes. Although the devices used to perform biofeedback have become more sophisticated throughout the years (video games are even used in some cases) [6•], its use actually was first reported in 1979 [7]. In general, results with biofeedback have been encouraging; there continues to be studies conducted in this field. This article focuses on the new and interesting developments that have occurred during the past year.

Diagnosis of Dysfunctional Voiding

Although there are standardized definitions of what dysfunctional voiding is, pediatric urologists continue to refine the techniques for its diagnosis. Hoebeke *et al.* [8•] reported their findings of 1000 children who underwent urodynamic observation for dysfunctional voiding. Initially, they evaluated 3500 children with incontinence and selected a subgroup for further testing. Criteria included history of UTI, small bladder capacity, abnormal uroflow, abnormal ultrasonographic findings, and resistance to behavioral therapy. Based on the results of the studies, several different subgroups were described. These included urge syndrome (58%), dysfunctional voiding (32%), lazy bladder (4%), and normal bladder-sphincter function (4%). Surprisingly, approximately 50% of their patients with dysfunctional voiding and urge syndrome were boys, which contradicts the results reported in most series in which these problems were much more common in girls. Not surprisingly, they saw a higher incidence of UTI in girls, especially in those diagnosed with "lazy bladder," which is characterized by infrequent voiding and incomplete emptying. This supports the commonly held view that high residual urine is the culprit for recurrent UTI in these children. Another large series of children with voiding dysfunction [9] from Vanderbilt University also advocated the practice of reserving urodynamic studies for a select subset of these children. It is the contention of Parekh *et al.* [9] that urodynamic studies rarely change the course of therapy, which is suggested by a thorough history and physical examination. This also has been the experi-

ence at our institution. For our patients, the children usually are diagnosed with dysfunctional voiding on the basis of their initial office visit. However, as the Vanderbilt group pointed out, voiding cystourethrography continues to play an important role in the evaluation of UTI. In these cases, we prefer to perform videourodynamics because the urodynamic portion of the study does not result in increased discomfort for the child and may add useful diagnostic information. Another recent publication evaluated the use of ultrasonography to measure the urinary flow rate in young boys and infants [10]. At the same time, uroflow was measured by the rotating-disk method. It was found that the ultrasonography probe was especially useful in infants who were not toilet-trained. In the future, such techniques may be used to study lower urinary tract function in very young children and children who void small volumes, which is not possible with conventional urodynamics.

There also has been some interesting work conducted regarding the diagnosis and evaluation of voiding dysfunction. At The Hospital for Sick Children in Toronto, Farhat *et al.* [11•] published their experience with the dysfunctional voiding symptom score (DVSS). This survey, which was developed at their institution, assesses the severity of a series of voiding symptoms in a language that children can understand easily. In this publication, Farhat *et al.* [11•] showed that improvement in symptoms, as measured by the DVSS, correlates with treatment compliance in a group of children with dysfunctional voiders who were enrolled in a behavioral modification program. The author recently used the DVSS to evaluate a group of children with attention deficit/hyperactivity disorder (ADHD) compared with controls, and found it to be extremely useful. Children with ADHD had a significantly higher prevalence of voiding symptoms compared with controls; the DVSS allowed for a direct comparison between the groups. This finding confirms the clinical impression that physicians and parents have had for some time. Further studies are planned that will elucidate the physiologic mechanism for this to allow better-tailored treatment protocols.

Biofeedback

Biofeedback programs (known as “urotherapy” in Europe) rapidly are becoming the treatment of choice for children with voiding dysfunction. Although there is wide variation among the details of the techniques, all of them involve monitoring of the external sphincter. A critical difference is whether a catheter is used to fill the bladder during the sessions, which was reported by Combs *et al.* [12]. In one recent series [13], sphincter activity was monitored during repeated cycles of voiding by natural filling. Postvoid residuals were measured by ultrasonography, thus catheterization was unnecessary. The investigators found at least some improvement in 92% of their patients. Specifically, they saw durable symptom improvement, a decrease in postvoid residual, and normalization of uroflows. Herndon *et al.* [14]

used a similar program and saw subjective and objective improvement after biofeedback treatment. However, their biofeedback protocol was particularly innovative in its use of interactive video games rather than a simple EMG read-out. Presumably, such games may engage a child’s interest and would be expected to have a higher success rate than what may occur with a simple EMG read-out. They found very high (95%) compliance with their program, and saw subjective uroflow improvement in 87% of the patients. Bladder capacity that was less than 60% of what they predicted and patient noncompliance were found to be predictors of failure. In a particularly thought-provoking article, Shulman *et al.* [15] initially used a labor-intensive protocol in which children went through three to four sessions of natural fill-voiding during each session. EMG, residual urine, and uroflow were monitored, and the patients were taught sphincter relaxation techniques. Subsequently, they switched to a series of 60-minute sessions in which the patients voided at the beginning and at the end. Uroflow, residual urine, and EMG were evaluated at the beginning and end of each session. However, patients later were taught to recognize sphincter relaxation using a series of EMG-based exercises; multiple cycles of filling and emptying were not done. Shulman *et al.* [15] found both protocols to be equally effective in reducing incontinence and UTIs. Not surprisingly, they saw a larger improvement in uroflow in their earlier patients, for whom repeated uroflow measurements were the primary method of biofeedback. However, their article serves to highlight the effectiveness of biofeedback, in whatever form. At the Antoci Center for Pediatric Urology and Nephrology in Orange, California, an EMG-based biofeedback program has been chosen in which the children are led through a series of exercises that teach them to relax the sphincter. We initially used a video game system, but found the software to be somewhat cumbersome and unreliable. Uroflow, EMG, and ultrasonography residual volume were monitored at the beginning of each of session. After a mean of 5.1 biofeedback sessions, a 50% decrease in diurnal incontinence and a 60% decrease in UTIs were observed in the patients. This serves to further reinforce the message that various biofeedback protocols can be effective, provided that they are applied consistently as part of an overall program of bowel and bladder management.

Although improvement in incontinence and recurrent UTI are the usual goals of biofeedback programs, it also is becoming clear that vesicoureteral reflux can be impacted by techniques that improve bladder dynamics. Palmer *et al.* [16] observed a series of patients receiving biofeedback therapy, paying specific attention to a subgroup of children with vesicoureteral reflux. They found a 56% rate of resolution during the 1-year period. This is much higher than would have been expected for spontaneous resolution. In other words, it appears that reflux resolves much faster in children with dysfunctional voiding who are treated with biofeedback therapy. In another interesting retrospective study [17], a group of children who failed dextranomer

injection for reflux were found to have a high rate of displacement of the implant (25 of 27 failures). The authors attributed these failures to graft displacement as a result of voiding dysfunction (which actually seems to be defined as detrusor instability in this article). This confirms the importance of evaluation of bladder function in children with vesicoureteral reflux.

Other Treatments for Dysfunctional Voiding

Although biofeedback is emerging as the dominant therapy for children with dysfunctional voiding, other techniques have been used and deserve mention. In the past, many children, especially girls, were thought to have intrinsic urethral obstruction and were treated with urethral dilation. A recent survey of 197 pediatric urologists found that only 2.5% would use urethral dilation as a primary treatment for a girl with dysfunctional voiding; another 10% would use dilation after biofeedback had failed. Overall, 61% of respondents never use urethral dilation; of those who use it, 63% thought it to be effective in less than 50% of the patients [18•]. However, the survey was administered among members of the urology section of the American Academy of Pediatrics; the use of urethral dilation may be higher among urologists who do not confine their practice to pediatrics. In an article that may shed light on why instrumentation may be effective at times, Pohl *et al.* [19] reported retrospectively on the use of clean intermittent catheterization in children with dysfunctional voiding and poor emptying. Although they reported improved continence and positive patient tolerance, none of the patients were administered a biofeedback regimen. With the availability of such programs, it should be rare that a patient requires clean intermittent catheterization.

There also are other approaches to treating dysfunctional voiding, some of which are pharmacologic. Munding *et al.* [20] treated a group of dysfunctional voiders with tolterodine and found that 33% had complete cessation of wetting episodes, 40% improved, and 27% showed no improvement. However, the voiding dysfunction was not defined by urodynamics, postvoid residual, or uroflow, which makes the results somewhat difficult to determine. If tolterodine therapy had been limited to a group of children with proven sphincter overactivity, the results may have been somewhat better. In an earlier article that deserves mention, Austin *et al.* [21] used doxazosin to treat a group of patients with poor bladder emptying. The group was mixed, consisting of patients with neurogenic bladder, posterior urethral valves, bladder instability, dysfunctional voiding, and prune belly syndrome. Although urodynamic data were not presented in all of the cases, some symptomatic improvement was noted in patients with detrusor instability. Less favorable results were seen in patients with true dysfunctional voiding that was secondary to non-neurogenic sphincter dyssynergia.

Conclusions

Dysfunctional voiding is a fairly common disorder that has been recognized increasingly. When discussing this disorder, standardized definitions (*eg*, those proposed by the International Children's Continence Society) should be used to avoid confusion. Biofeedback techniques have been shown to be simple and effective in several series. Other treatments, such as α -agonist medication and simple behavioral modification, also have been shown to be effective in subsets of patients. In the future, prospective randomized studies hopefully will better define the children who would be best treated with biofeedback, and what technique should be used.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:

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