Long-term Outcome of Intravesical Oxybutynin in Children With Detrusor-Sphincter Dyssynergia: With Special Reference to Age-Dependent Parameters

Martien Humblet,1 Carla Verpoorten,2 Maria-Helena Christiaens,1 Herbert Hirche,2 Katrien Jansen,1 Gunnar Buyse,1 and Jan D. van Gool2

1Department of Child Neurology, University Hospitals Leuven, Leuven, Belgium
2Institute of Medical Informatics, Biomathematics and Epidemiology, University Hospital Essen, Essen, Germany

Aims: Intravesical instillation of oxybutynin is an accepted and effective treatment in children with neuropathic bladder-sphincter dysfunction, when oral oxybutynin results in inadequate suppression of detrusor overactivity or intolerable side effects. However, as yet no data are available on long-term use and outcome. Methods: A patient cohort with detrusor-sphincter dyssynergia that started oral oxybutynin between 1995 and 1997 was re-evaluated 15 ± 1 years after the switch from oral to intravesical (n = 10), with urodynamic investigations, renal ultrasounds, DMSA-scintigraphy, 51Cr-EDTA-clearance, and validated questionnaires on incontinence and quality of life. Results: At follow-up, cystometric bladder capacity (CBC) had increased to the 25–50% percentiles for age, from the 5% percentile; mean end-filling pressure, 24.5 ± 14.4 cm H2O, had returned to the safe zone; bladder compliance expressed as a fraction of normal compliance for age (Wahl units) showed a statistically significant increase. At follow-up, the prevalence of renal scars was 30% (95% CI: 6–65%). Kidney lengths correlated with scarring at DMSA-scintigraphy, 51Cr-EDTA-clearance did not. In 2 years of oral oxybutynin we documented 10 pyelonephritic episodes, in 15 years of intravesical oxybutynin only three. Urinary continence was reported as satisfying, its impact on quality of life as acceptable. Conclusion: Percentile charts for cystometric bladder capacity and individual kidney lengths, age-dependent parameters, were invaluable in estimating long-term outcome, and the same goes for bladder compliance in Wahl units. We can conclude that intravesical oxybutynin provided more than adequate suppression of detrusor activity, without side effects, over a period of 15 years. Neurourol. Urodynam. © 2014 Wiley Periodicals, Inc.

Key words: bladder compliance; clean intermittent catheterization; cystometric bladder capacity; detrusor-sphincter dyssynergia; end-filling pressure; intravesical oxybutynin; kidney length; kidney scarring; myelomeningocele; neuropathic bladder-sphincter dysfunction; oral oxybutynin; pyelonephritis; urinary incontinence; vesicoureteral reflux

INTRODUCTION

In children, congenital neuropathic bladder-sphincter dysfunction (NBSD) is almost exclusively caused by a congenital myelomeningocele—acquired causes of NBSD, such as tethered cord syndrome, traumatic spinal cord injury, or transverse myelitis is much less frequent. Depending on the extent and level of the neurological lesion, lumbosacral somatic motor neurons and visceromotor neurons, which respectively control striated urethral sphincter and detrusor muscles, may present as hyperreflexive or areflexive, independent of each other. This results in four possible types of NBSD, each with its own clinical impact on urinary continence and the development of an unsafe bladder.1,2

The two types with hyperreflexia of the striated urethral sphincter are characterized by detrusor-sphincter dyssynergia (DSD), resulting in high bladder pressures both during voiding and filling of the bladder, incomplete voiding, recurrent urinary tract infections, and incontinence. When combined with neuropathic detrusor overactivity, DSD will cause detrusor hypertrophy and an increase in collagen relative to smooth muscle in the bladder wall, which will inevitably lead to obstructive uropathy, causing secondary renal damage. The first steps in the management of congenital NBSD are early recognition of DSD and initiation of medical treatment as early in life as possible.1,3

In DSD, clean intermittent (self)catheterization (CIC) will restore complete bladder emptying in bladders with complete areflexia of the detrusor muscle, and with the aid of oxybutynin chloride also in bladders with neuropathic detrusor overactivity.1,2,5 Oxybutynin is a tertiary amine with antimuscarinic, spasmolytic, and local anesthetic properties. Treatment with oral oxybutynin has a high incidence of systemic anticholinergic side effects and adequate suppression of the detrusor can, in some cases, only be reached by increasing the dosage—which will also increase the side effects.2 Intravesical instillation of oxybutynin is an effective alternative,

Abbreviations: NBSD, neuropathic bladder-sphincter dysfunction; DSD, detrusor-sphincter dyssynergia; CIC, clean intermittent catheterization; CBC, cystometric bladder capacity; EFP, end-filling pressure; GFR, glomerular filtration rate; 51Cr-EDTA, 51Cr-ethylene-diame-tetra-acetic acid, DMSA, 99mTc-dimercaptosuccinic acid; UTI, urinary tract infection; VUR, vesicoureteral reflux; 95% CI, 95% confidence interval.

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Conflicts of interest: Nothing to declare.

1Correspondence to: Martien Humblet, Department of Child Neurology, University Hospitals Leuven, Herestraat 49, Leuven B-3000, Belgium.
E-mail: martien.humblet@uzleuven.be
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because it diminishes systemic side effects by reducing the first-pass metabolism in the liver. Compared with oral oxybutynin, intravesical oxybutynin is a more potent and longer-acting suppressor of detrusor reflex activity, with far fewer side effects.

There is growing evidence that with early instituted CIC and oxybutynin, kidney function and bladder capacity can be preserved and social continence achieved. There is consensus that such treatment should be started early in life, to be continued life-long. However, there are as yet no published data on the very long-term use and outcome of intravesical oxybutynin. Therefore, we performed a re-evaluation of a cohort of 13 children with urodynamically diagnosed DDS, who started treatment from oral to intravesical oxybutynin between 1995 and 1997, because of systemic side effects and/or insufficient detrusor suppression with the oral treatment. Following the previously published 2-year treatment data of this cohort by Buyse et al., we now report their very long-term bladder outcome (cystometric bladder capacity (CBC), end-filling pressure, and bladder compliance) and renal outcome (renal length, $^{99}\text{Tm}$-dimercaptosuccinic acid (DMSA) kidney scintigraphy and glomerular filtration rate), after approximately 15 years of treatment with CIC plus intravesical oxybutynin.

**MATERIALS AND METHODS**

Terminology and definitions in this paper comply with the 2006 Standardization Report of the International Children's Continence Society, except for the linear function for expected cystometric bladder capacity versus age.

**Patients**

This study was set up as an extension of a prospective evaluation of a cohort of 13 children with NBSD and urodynamically diagnosed detrusor-sphincter dyssynergia, who started treatment with CIC and oral oxybutynin in their first year of life. The NBSD was due to myelomeningocele ($n = 10$), lipomeningocele ($n = 1$), caudal dysplasia ($n = 1$), or transverse spinal cord injury ($n = 1$). Between 1995 and 1997, after ±2 years of oral treatment, all children switched to intravesical oxybutynin, because of incomplete suppression of detrusor activity and/or intolerable side effects of oral oxybutynin. During the first 2 years of treatment as well as during the long-term follow-up, this cohort has been followed at the Spina Bifida Clinic of the University Hospitals Leuven, Belgium. In all parents and/or children informed consent was obtained.

**Intravesical Oxybutynin**

Oxybutynin for intravesical application was prepared and provided by the hospital pharmacy. Oxybutynin dissolved in 0.9% saline and sterilized (ampoules of 5 mg/5 ml, pH 5.85) was instilled twice daily, through the urethral catheter used for CIC, at a dosage of 0.2 mg/kg body weight per dose.

**Outcome Parameters**

Cystometric bladder capacity, detrusor pressure at the end of the filling phase (EFP) and bladder compliance were measured with standardized five-channel urodynamic investigations, performed by members of the Spina Bifida Team and evaluated by two independent investigators, blinded for patient data.

Cystometric bladder capacity, defined as the maximum bladder volume at which a patient starts voiding or leaking, increases with age. To compensate this increase with age, we compared CBCs obtained at the start of intravesical oxybutynin with those obtained 15 years later by plotting the individual values on a chart with 5%-50%-95% percentiles for cystometric bladder capacity versus age, published by Bael et al. We extrapolated the values above 14 years of age from this publication's original data.

**Detrusor pressure at cystometric bladder capacity or end filling pressure (EFP) above 40 cm H$_2$O is considered a risk for obstructive uropathy and renal parenchymal damage.**

**Bladder compliance**, dependent on intrinsic properties of the bladder wall and reflex activity of the detrusor muscle, is commonly described by expressing $\Delta P$ as a fraction of $\Delta V$; $\Delta P$ can be substituted by CBC, and $\Delta V$ by EFP, provided the urodynamic investigation is started with an empty bladder, with a low filling rate ($\leq 10 \text{ml/ min}$), and a filling fluid with a neutral pH at $37^\circ\text{C}$. As CBC increases with age, while EFP does not, compensation for age-related increase in CBC is also needed when computing compliance. The solution was found in the work of Wahl et al., whose table of average values for CBC and EFP in normal children and adolescents, compiled from publications on urodynamic investigations. For each age, a normal value for compliance, expressed as $C_{\text{INDEX}}$, was calculated. Expressing a given compliance in an individual patient, $C_{\text{NORMAL}}$, as a fraction of the normal compliance according to the patient's age, $C_{\text{INDEX}}$ is taken out of the equation (Table I). In normal individuals, $C_{\text{NORMAL}}$ will be close to 1 Wahl (50% percentile for CBC), varying between 0.6 Wahl (5% percentile for CBC) and 1.7 Wahl (95% percentile for CBC).

**Kidney lengths** Renal parenchymal damage in myelomeningocele is due to obstructive uropathy and reflected in impaired growth of an individual kidney from scarring. For any given age, kidneys in children with myelomeningocele tend to be smaller than in normal children. Hence, in our cohort, the kidney lengths assessed by ultrasound were plotted on a chart with average kidney lengths ±2 SD versus age in children with myelomeningocele, published by Sutherland et al., for ages ranging from 0.25 to 18 years; for ages 19–27 years, average lengths ±2 SD versus age were extrapolated from Sutherland's data. On such a plot, individual kidney lengths correlate well with renal volume, and a difference in length of >10 mm between left and right kidney signifies scarring.

**Glomerular filtration rate (GFR)** was evaluated by using $^{51}$Cr-EDTA ($^{51}$Cr-ethylenediamine-tetra-acetic acid), the declared golden standard for evaluating renal function in children with myelomeningocele.

**Urinary tract infections (UTI) and vesicoureteral reflux (VUR)** compound the risks for deterioration of renal function: urine cultures were performed systematically to detect UTI, and voiding cystourethrogram was used in all patients to investigate the presence of VUR, at the start of the study—whenever VUR and/or pyelonephritis was detected, this was followed by repeat cystourethrography.

**Quality of life and urinary incontinence** was assessed by using a questionnaire based on the Linkert scale and the ICIQ-SF (International Consultation on Incontinence Questionnaire—Short Form). Specifically, tolerability and side effects of CIC and instillation of intravesical oxybutynin were checked.

**Statistical Methods**

Distributions of variables are given as means ± standard deviation (SD) and as box-plots with 25–75% boxes and 5–95% percentiles.
whiskers at 5% and 95%. Ranges of normality were assessed with 95% confidence intervals (CI). The statistical comparison of groups before and during long-term intravesical oxybutynin was done with the paired Wilcoxon rank test. The two-sided level of statistical significance, \( \alpha = 0.05 \), was predefined.

RESULTS

From the initial 13 patients who started intravesical oxybutynin treatment between 1995 and 1997, 7,10 patients could be re-evaluated between January 2008 and January 2010, after a follow-up of 15 \( \pm \) 1 year. Three patients dropped out before re-evaluation: one (myelomeningocele) died in a car accident, one (myelomeningocele) developed urethral stenosis due to repeated urethral trauma with CIC, and a third (spinal cord injury) left the program because of persisting incontinence.

Instillation of oxybutynin twice daily, through the urethral catheter used for CIC, was well tolerated, and no oxybutynin side effects, local or systemic, were reported. None of the urodynamic studies done after 15 years of treatment with intravesical oxybutynin showed signs of detrusor overactivity.

Urodynamic Parameters

Table I shows the individual values for CBC, EFP, and compliance at the start of treatment and after 15 years of intravesical oxybutynin treatment. Prior to the start of intravesical oxybutynin, all children had a CBC around the 5% percentile. At follow-up the CBCs of seven children (nrs 1, 2, and 4–8 in Table I) are around the 50% percentile, while two children (nrs 9–10) show a CBC around the 25% percentile—these two patients started relatively late with intravesical treatment. One child’s CBC stayed on the 5% percentile: this female patient (nr 3 in Table I) still has slight stress incontinence.

### Table I. Listing of Cystometric Bladder Capacity (CBC), End-Filling Pressure (EFP), and Bladder Compliance (C), During Oral Oxybutynin (Start) and After 15 Years of Intravesical Oxybutynin (Follow-Up).

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age at start (years)</th>
<th>CBC at start (ml)</th>
<th>EFP at start (cm H2O)</th>
<th>( C_{\text{INDEX}} ) (ml/cm H2O)</th>
<th>( C_{\text{NORMAL}} ) (ml/cm H2O)</th>
<th>( C_{\text{INDEX}} / C_{\text{NORMAL}} ) (Wahl)</th>
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<td>0.33</td>
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<td>33</td>
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<td>10</td>
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<td>26.50</td>
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<td>75</td>
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<td>34.83</td>
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<td>64</td>
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<th>Age at follow-up (years)</th>
<th>CBC at follow-up (ml)</th>
<th>EFP at follow-up (cm H2O)</th>
<th>( C_{\text{INDEX}} ) (ml/cm H2O)</th>
<th>( C_{\text{NORMAL}} ) (ml/cm H2O)</th>
<th>( C_{\text{INDEX}} / C_{\text{NORMAL}} ) (Wahl)</th>
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<td>500</td>
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<td>84.33</td>
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<td>19</td>
<td>20.89</td>
<td>86.50</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Calculated compliances of our patients \( C_{\text{INDEX}} \) are listed alongside the reference values versus age in Wahl’s 16 normal population \( C_{\text{NORMAL}} \). When \( C_{\text{INDEX}} \) is expressed as a fraction of \( C_{\text{NORMAL}} \), the resulting compliance in Wahl units \( C_{\text{INDEX}} / C_{\text{NORMAL}} \) no longer contains the age-dependent CBC variable.
incontinence, and she has to perform CIC every 3 hr to achieve social continence.

The individual values for EFP in Table I average out at $24.5$ cm H$_2$O after 15 years of intravesical treatment. Prior to the start of such treatment the average EFP was $52.5$ cm H$_2$O. All patients, except one female patient with low treatment compliance (nr 9 in Table I), are in the safe range for EFP: $<40$ cm H$_2$O. Bladder compliance is also listed in Table I, after 15 years of intravesical treatment (follow-up) and after 2 years of oral treatment (start). The values for compliance are given in milliliter per cm H$_2$O ($C_{INDEX}$/$D_P$) and also in Wahl units ($C_{INDEX}/C_{NORMAL}$), factoring out the age-related CBC-variable. The distribution of individual values in Wahl, at start of treatment and at follow-up, is shown in Figure 2 with 25–75% box plots. The prevalence of children with a normal compliance at follow-up, between 0.6 and 1.7 Wahl, is 20% (95% CI: 3–56%). Although this prevalence is low, the increase in compliance obtained with 15 years intravesical oxybutynin is highly significant.

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**Kidney Lengths**

Two patients had a congenital renal anomaly: nr 6 in Table II had a solitary kidney on the left side, and nr 7 had a unilateral rudimentary upper pole and underwent a right-sided heminephrectomy at 3 months of age. In Figure 3, individual renal lengths are plotted on a chart with the average renal length ±2 SD for myelomeningocele children. Nine out of 10 patients have renal lengths between +2 and −2 SD. One patient, nr 2 in Table II, has renal lengths at or just below −2 SD. In patient 8 (Table II), the difference in length between left and right kidney is substantial, caused by pyelonephritic scarring of the left kidney, secondary to pyelonephritic episodes in the first year of life, when still on oral oxybutynin. In patient 1, the difference in length between left and right kidney is due to a focal scar in the right kidney, compounded by treatment for urolithiasis in the right pyelocalyceal complex.

**Renal Scintigraphy With DMSA**

DMSA-scintigraphy was done in all children (Table II): nr 1 had extensive scarring of the right kidney due to urolithiasis, nr 8 had extensive scarring of the left kidney and one focal scar in the right upper pole. In this cohort, the prevalence of scars at follow-up was 30% (95% CI: 6–65%). Only one of the three patients with unilateral reduced uptake of DMSA, nr 8, had a GFR below the normal range. The lower uptake of the right kidney in patient nr 7 is due to the resection of the right upper pole, not to scarring.

**Glomerular Filtration Rate**

$^{51}C$r-EDTA clearance was done in all children (Table II): nr 1 had extensive scarring of the right kidney due to urolithiasis, nr 8 had extensive scarring of the left kidney and one focal scar in the right upper pole. Boxes denote the 25–75% distribution, whiskers are drawn at 5 and 95%. Two out of 10 patients (20%, 95% CI: 2.5–55.6%) reached a normal compliance at follow-up (between 0.6 and 1.7 Wahl units). The increase in compliance after 15 years of intravesical oxybutynin is highly significant.

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age (years)</th>
<th>EFP (cm H$_2$O)</th>
<th>L kidney (mm)</th>
<th>R kidney (mm)</th>
<th>Pyelonephritis (BF)</th>
<th>Pyelonephritis (FU)</th>
<th>VUR (FU)</th>
<th>VUR (FU)</th>
<th>DMSA scintigraphy FU (% function)</th>
<th>Cr-EDTA at FU (ml/1.73 m$^3$/min)</th>
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<td>2006 R</td>
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<td>L 0, R 0</td>
<td>L 79%, R 21%, R scars</td>
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<tr>
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<td>74</td>
<td>80</td>
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<td>95</td>
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<td>90</td>
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<td>88</td>
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<td>2007 L</td>
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<tr>
<td>10</td>
<td>F</td>
<td>27.9</td>
<td>19</td>
<td>92</td>
<td>94</td>
<td>None</td>
<td>None</td>
<td>L 1, R 2</td>
<td>L 0, R 0</td>
<td>L 45%, R 55%, no scars</td>
<td>76</td>
</tr>
</tbody>
</table>

*1 congenital solitary kidney (R agenesis).

bR upper pole resection at age 3 months (duplex kidney R).

**Fig. 2.** Box plot representation of bladder compliance expressed in Wahl units ($C_{INDEX}/C_{NORMAL}$) during oral oxybutynin (Start) and after 15 years of treatment with intravesical oxybutynin (Follow-up). Boxes denote the 25–75% distribution, whiskers are drawn at 5 and 95%. Two out of 10 patients (20%, 95% CI: 2.5–55.6%) reached a normal compliance at follow-up (between 0.6 and 1.7 Wahl units). The increase in compliance after 15 years of intravesical oxybutynin is highly significant.

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age of our cohort at follow-up, 19.2 ± 4 years, the normal range of GFR is 80–120 ml/1.73 m²/min.18,19 Two patients had a clearance of 70 ml/1.73 m²/min: nr 8, with global scarring of the left kidney and a focal scar on the right upper pole, and nr 9, with a high EFP, 47 cm H₂O, because of poor compliance with CIC and medication.

Urinary Tract Infections, Vesicoureteral Reflux

Before the start of intravesical oxybutynin, five patients had VUR (Table II): nrs 3 and 9 with grade 2 reflux bilateral, nr 10 grade 2 right, nrs 5 and 8 with grade 4–5 bilateral. Now, 15 years later, only nrs 3, 5, and 9 have VUR, unilateral and grade 1, without clinical consequences. Asymptomatic lower UTI were common, but these infections all resolved by optimizing catheterization, without antibiotic therapy. Pyelonephritic episodes occurred mostly before the switch from oral to intravesical oxybutynin: 10 episodes before the switch versus 3 episodes after (Table II).

Quality of Life and Urinary Incontinence

Based on the Likert scale and on the ICIQ-SF (International Consultation on Incontinence Questionnaire—Short Form)19–21 incontinence and quality of life was evaluated. A score of 0% (0/21) means no urine loss and quality of life is unaffected by incontinence, a score of 100% (21/21) is a sign of severe incontinence with a big impact on quality of life. In our cohort, the mean score was 23% ± 15 SD; three patients reported an optimal score of 0. We can state that the general continence status was reported as satisfying, with an acceptable impact on the quality of life. Safety and tolerability of intravesical instillation of oxybutynin twice daily, through the urethral catheter used for CIC, was well tolerated, and no oxybutynin side effects were reported.

DISCUSSION

The management of NBSD in children with myelomeningocele is a life-long balancing act between avoiding high end-filling pressures at small-for-age bladder capacity values by suppression of detrusor activity, and using whatever striated sphincter reflex activity is still present to gain urinary continence with CIC.

Cystometric bladder capacity is an important parameter in this balancing act, but when starting treatment as early in life as possible,3 the normal increase with age of CBC precludes the use of linear functions9 as yardsticks for bladder capacity: linear functions progressively underestimate normal capacity at ages below 12, and overestimate progressively above that age.13,14 Instead, one should use percentile charts for CBC versus age (Fig. 1), similar to the use of percentile charts for body length versus age. The gain in individual capacity by suppression of detrusor activity has to be as large as possible for any given age, in order to reach an optimal schedule for CIC and limit the periods where end-filling pressures are reached.

A second important parameter is end-filling pressure (EFP), which needs to be below the 40 cm H₂O margin to avoid obstructive uropathy. In this cohort the EFPs at follow-up are lower than the average values reported in a recent meta-analysis of intravesical oxybutynin in children with poorly compliant neuropathic bladder.23 We took the 40 cm H₂O margin, because we consequently measured EFP at 100% of cystometric bladder capacity versus age (Fig. 1), before and after follow-up. At follow-up (Table II), patient nr 9 had an EFP of 47 cm H₂O, due to a low compliance with the prescribed treatment; the values for EFP in patients 1 and 2 are marginally
unsafe because, in all probability, their periods with inadequate oral treatment resulted in irreversible structural changes of the bladder wall.

Bladder compliance, an important parameter in judging structural changes in the stiffness of the bladder wall, is commonly calculated by expressing CBC as a fraction of EFP (ΔP/Vp). To compensate for an automatic increase of compliance with age in measuring the effects of treatment with oxybutynin, CBC has to be taken out of this equation. We opted for Wahl’s method, by expressing the compliance of our patients as a fraction of normal compliance for age.15,16: a significant increase in compliance at follow-up was found, as a lasting effect of intravesical oxybutynin, although only two patients reached normal values for compliance (Fig. 2). This is a strong argument to start intravesical oxybutynin as early as possible.

Ultrasound of kidneys and bladder offers easy and repeatable measurement of kidney lengths. Kidney length is age dependent in growing individuals and here too percentile charts should be used to plot changes in length versus age (Fig. 3). In myelomeningocele children, kidneys tend to be smaller than in normal children, which is why we used Sutherland’s chart for average kidney length versus age.17 Although individual kidney lengths can be used to monitor the development of parenchymal scars (difference in length between left and right kidney of >10 mm), a DMSA scan is to be preferred because of its higher sensitivity. Both renal ultrasound and DMSA are much more sensitive for picking up incipient renal parenchymal damage than GFR. The prevalence of kidney scars in our cohort was 30% (95% CI: 6–65%), similar to the average prevalence of 45% ± 15% SD found in a recent review.24

Pyelonephritic episodes occurred mostly before the switch from oral to intravesical oxybutynin: 10 episodes before the switch versus 3 episodes after. This is a strong argument to start oxybutynin treatment in all cases with the intravesical route.

In infants and children, intravesical oxybutynin is superior to the oral route, in terms of speed and duration of action, efficacy, ease of administration as part of the CIC routine, and incidence of systemic side effects.8–14 The superior efficacy of the intravesical route is difficult to explain by muscarinic receptor blockade alone—it resembles the speed and power of afferent blockade, a well-known avenue in the management of NBSD,25–27 and this resemblance might fit in with action on both efferent and afferent nerves.

Although pharmacokinetics, efficacy, and safety of the intravesical route have been reported,28 it is still very difficult to obtain sterile solutions of oxybutynin in 0.9% saline outside hospital pharmacies. Only recently, a German company started phase I–II studies with pre-filled syringes equipped with both LuerLock™ and catheter adapters, containing 10 ml of sterile 1 mg/ml oxybutynin chloride solution (www.grachtenhaus.de). Effective percutaneous of the detrusor muscle can be obtained with Botulinum-A toxin (BTX-A), which blocks the presynaptic release of acetylcholine-A at the nerve endings of the parasympathetic neurons that innervate the detrusor muscle. BTX-A also has effects on the afferent pathways from the bladder to the spinal cord. The toxin has to be injected directly in the detrusor muscle, at about 30 different places, during a cystoscopy. In infants and children this procedure has to be done under anesthesia, and it is to be repeated every 3–8 months.29 The high price of BTX-A and the invasive procedure make intravesical oxybutynin the obvious choice between these two off-label drugs; that both have to be started at a very early age.1,3,14 However, we do lack a randomized controlled trial of oral versus intravesical oxybutynin: the official recommen-

dation from the International Children’s Continence Society still is to use the intravesical preparation only in children where the oral route proved unsatisfactory.29

CONCLUSION

This cohort study and its long-term outcome show that the use of intravesical instillation of oxybutynin and CIC in patients with NBSD is a very effective treatment. Detrusor activity was adequately suppressed, and end-filling pressures were within safe ranges. Consequently renal and infectious complications were prevented. Bladder growth was maintained and CBC versus age increased substantially. The continence status and its impact on quality of life were described as acceptable and no difficulties or side effects were reported about the instillation of oxybutynin into the bladder.

Age-related reference values for CBC in children are indispensable in the evaluation of pediatric bladder function: 5–50% and 50–95% percentiles of normal CBC versus age should be used to assess treatment outcome on CBC. To assess treatment outcome on bladder compliance in children, Wahl’s dimensionless unit of measurement is to be preferred.

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REFERENCES


