Urological Science 25 (2014) 35–41

Contents lists available at ScienceDirect

Urological Science

journal homepage: www.urol-sci.com

Review article

Taiwanese Continence Society clinical guidelines for diagnosis and management of neurogenic lower urinary tract dysfunction☆

CME Credits

Hann-Chorng Kuo [a,*], Sung-Lang Chen [b,c], Chieh-Lung Chou [d], Yao-Chi Chuang [e], Yu-Hui Huang [c,f], Yung-Shun Juan [g,h,i], Wei-Ching Lee [e], Chun-Hou Liao [j], Yao-Chou Tsai [k], Yun-An Tsai [l], Chung-Cheng Wang [m]

[a] Department of Urology, Buddhist Tzu Chi General Hospital and Tzu Chi University, Hualien, Taiwan
[b] Department of Urology, Chung-Shan Medical University Hospital, Taichung, Taiwan
[c] School of Medicine, Chung-Shan Medical University, Taichung, Taiwan
[d] Department of Urology, China Medical University Hospital, Taichung, Taiwan
[e] Department of Urology, Kaohsiung Chang Gung Hospital and College of Medicine, Chang Gung University, Kaohsiung, Taiwan
[f] Department of Physical Medicine and Rehabilitation, Chung-Shan Medical University Hospital, Taichung, Taiwan
[g] Department of Urology, Kaohsiung Municipal Hsiao-Kang Hospital, Kaohsiung, Taiwan
[h] Department of Urology, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan
[i] Department of Urology, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan
[j] Department of Urology, Cardinal Tien Hospital and School of Medicine, Fu Jen Catholic University, New Taipei, Taiwan
[k] Department of Urology, Taipei Tzu Chi Hospital, Buddhist Tzu Chi Medical Foundation, New Taipei, Taiwan
[l] Department of Neurosurgery, Neurological Institute, Taipei Veterans General Hospital and School of Medicine, National Yang-Ming University, Taipei, Taiwan
[m] Department of Urology, En Chu Kong Hospital and College of Medicine, National Taiwan University, Taipei, Taiwan

ARTICLE INFO

Article history:
Received 25 January 2014
Accepted 27 March 2014
Available online 24 May 2014

Keywords:
detrusor overactivity
lower urinary tract dysfunction
neurogenic bladder
urological complication

ABSTRACT

This article reports the current evidence and expert opinions on diagnosis and management of neurogenic lower urinary tract dysfunction (NLUTD) in Taiwan. The main problems of NLUTD are failure to store, failure to empty, and combined failure to store and empty. The priority of management of NLUTD should follow the order of: (1) preservation of renal function; (2) freedom from urinary tract infection (UTI); (3) efficient bladder emptying; and (4) freedom from indwelling catheter, and patients' expectation of management should be respected. Management of the urinary tract in patients with spinal cord injury (SCI) or multiple sclerosis (MS) must be based on urodynamic findings, rather than inferences from the neurologic evaluation. Selecting high risk patients is important to prevent renal function impairment in patients with chronic NLUTD. Patients with NLUTD should be regularly followed up for their lower urinary tract dysfunction by urodynamic study and any urological complication should be adequately treated. Avoiding a chronic indwelling catheter can reduce the incidence of developing a low compliant bladder. Antimuscarinic agents with clean intermittent catheterization (CIC) may reduce urological complications and improve quality of life (QoL) in patients with NLUTD. Intravesical injection of botulinum toxin A provides an alternative treatment for refractory detrusor overactivity (DO) or low compliant bladder and can replace the need for bladder augmentation. When surgical intervention is necessary, we should consider the least invasive type of surgery and reversible procedure first and avoid any unnecessary surgery of the lower urinary tract. Keeping the bladder and urethra in a good condition without interference of the neuromuscular continuity provides patients with NLUTD a chance for future new technologies. It is most important to never give up on improving the QoL in patients with NLUTD.

Terminology

The following abbreviations are used throughout this guideline. The other terminology follows the recommendations of the

* Corresponding author. Department of Urology, Buddhist Tzu Chi General Hospital, 707, Section 3, Chung-Yang Road, Hualien 970, Taiwan.
E-mail address: hck@tzuchi.com.tw (H.-C. Kuo).
☆ There are 3 CME questions based on this article.

http://dx.doi.org/10.1016/j.urols.2014.03.003

International Continence Society (ICS).[1] [LE,1a,A] AD = autonomic dysreflexia; BND = bladder neck dysfunction; BOO = bladder outlet obstruction; CVA = cerebrovascular accidents; CIC = clean intermittent catheterization; DA = detrusor areflexia; DHIC = detrusor hyperreflexia with impaired detrusor contractility; DO = detrusor overactivity; DSD = detrusor sphincter dyssynergia; DU = detrusor underactivity; GFR = glomerular filtration rate; HR-QoL = health-related Quality of Life; LUTS = lower urinary tract symptoms; Qmax = maximum flow rate; MS = multiple sclerosis; NDO = neurogenic detrusor overactivity; NLUTD = neurogenic lower urinary tract dysfunction; NVD = neurogenic voiding dysfunction; PD = Parkinson's disease; PVR = post-void residual; SCI = spinal cord injury; UTI = urinary tract infection; UUI = urgency urinary incontinence; and VUR = vesicoureteral reflux.

1. Introduction

NLUTD includes the dysfunction of urinary bladder and urethra due to central nervous system or peripheral neurogenic lesions. CVA, intracranial lesion, PD, cerebral palsy, MS, transverse myelitis, spinal cord lesions, and diabetic neuropathy, etc., will result in NLUTD.[2] [LE, 2a,B]

NLUTD presents a great disease burden on patients, affecting not only their prognosis, but also QoL, self-esteem, and families' relationship. It is commonly associated with urinary incontinence, voiding difficulty, reduction in bladder compliance, upper urinary tract damage, and UTI.[3] [LE, 2a,B]

The priority of management of NLUTD should include: (1) preservation of renal function; (2) freedom from UTIs; (3) efficient bladder emptying; and (4) freedom from indwelling catheter and patients' expectation should be respected.[4] [LE, 3b,C]

2. Purpose

The purpose of these clinical guidelines is to provide information on the incidence, definitions, diagnosis, therapy, and follow up observation of the condition of NLUTD. Among all types of NLUTD, SCI and MS remain the most difficult disorders to manage. These guidelines may be useful for physicians and patients in the management of NLUTD, especially SCI and MS.

3. Etiology of NLUTD

NLUTD may be caused by various diseases and events affecting the nervous systems controlling the lower urinary tract. NLUTD should be considered in patients with neurological lesions and LUTS, such as acute urinary retention or UUI. The etiology of NLUTD includes peripheral neuropathy, diabetes,[5] [LE, 2a,A] iatrogenic,[6] [LE, 4,C] demyelinization,[7] [LE, 2a,B] dementia,[8] [LE, 2a,B] basal ganglia pathology,[9] [LE, 4,C] cerebrovascular pathology,[10] [LE, 4,C] brain tumors,[11] [LE, 4,C] SCI,[12] [LE, 2a,B], myelomeningocele,[13] [LE, 2a,B] nerve root compression due to disc disease,[14] [LE, 4,C] and regional spinal anesthesia.[15] [LE, 5,D]

4. Clinical symptoms and urodynamic findings in NLUTD patients

4.1. Cerebral vascular diseases

The clinical symptoms of NLUTD depend on the levels of lesions.[16] [LE, 4,C] Because most of the men with CVA are elderly, some other pathophysiology causing male LUTS, such as BOO, might confuse the diagnosis and treatment of voiding dysfunction in patients with CVA.[17] [LE, 2b,B]

Patients with chronic CVA may have DO causing urinary incontinence.[18] [LE, 2b,B] DU and DHIC might be other problematic issues in elderly patients with multiple CVA.[19] [LE, 2b,B]

Urethral sphincter pseudodyssynergia causing incomplete bladder emptying and excessive residual urine may develop in about 10% of patients during the recovery phase (4–10 months post CVA) after stroke.[19] [LE, 2b,B]

4.2. PD

PD is a multisystem disorder involving dopaminergic, noradrenergic, serotoninergic, and cholinergic systems, characterized by motor and non-motor symptoms.[20] [LE, 2a,B]

A previous investigation showed that 40–70% of Parkinsonian patients have some degree of voiding dysfunction, and nearly 70% of them have irritative symptoms. DO was the predominant urodynamic finding.[21] [LE, 4,C]

Patients with PD and a hyperactive urethral sphincter might not be able to adequately relax their urethral sphincter during volitional or reflexic micturition, resulting in inadequate detrusor contractility and increased PVR.[22] [LE, 4,C]

4.3. SCI

The incidence of SCI worldwide reported in the literature ranged from 12.1 per million to 57.8 per million.[23] [LE, 2a,B] The most common etiology of SCI in patients under 60 years old is motor vehicle crush, whereas in those older than 61 years old, it is fall.[24] [LE, 2a,B]

According to the National Health Insurance Research Database analysis in Taiwan, the frequency of NDO in SCI was around 16.9% with transient urinary incontinence and 17.5% with permanent NDO.[25] [LE, 3b,B]

Spinal cord lesions can be traumatic, vascular, medical, or congenital. A high correlation exists between the clinical neurologic findings and the NLUTD in single-level traumatic spinal cord lesions, but not in myelomeningocele and combined traumatic spinal cord lesions.[26] [LE, 2a,B] At SCI lesions above T6, patients may have smooth muscle dyssynergia and AD in addition to DSD.[26] [LE, 2a,B]

SCI patients may have LUTS of urgency and UUI. Some patients with BND and DSD may also experience difficult bladder emptying and urinary retention.[27,28] [LE, 2a,B; LE, 3b,C]

Considering the priority of recovery in SCI patients with paraplegia or tetraplegia, bladder dysfunction, bowel dysfunction, and AD are listed in the first seven highest priorities that patients demanded for recovery.[29] [LE, 2b,B]

The frequency of incontinence is a strong influence on HR-QoL. Patients with CIC by attendant, indwelling transurethral catheterization, and suprapubic catheterization had the worst mental status.[30] [LE, 2c,B] SCI patients have higher degrees of depression than a normal population, which is closely related to female gender and inability to perform self-catheterization.[31] [LE, 2b,B]

Many clinicians ignore that NDO may affect mortality/morbidity. In addition, SCI patients do not know where or how to get medical resources.[32] [LE, 2b,B] There is an urgent need to increase awareness of patients to understand the urological complications of NLUTD, and to educate physicians to understand the treatment strategy of NLUTD.

4.4. MS

MS is a major cause of nontraumatic disability in young adults. The total estimated prevalence is 83/100,000, most commonly seen between ages 35 years and 64 years, with a male to female ratio of

1:2. Urodynamically, DO occurs in about 44–81% of patients with MS, DSD in about 25%, and DU in 19–40% of MS patients. Up to 10% of patients had bladder dysfunction at initial MS diagnosis.[33,34] [LE, 2b,B; LE, 2b,B] In Taiwan, there were 1262 cases of MS during the period of 2000 through to 2005. The male to female ratio was 0.4. The average annual incidence rate was 0.79/100,000.[35] [LE, 2c,B]

The clinical symptoms of MS patients include urgency (32–86%), nocturia (25–82%), and UUI (19–80%). They may also have difficult urination (6–79.5%) and urinary retention (8.3–73.8%), depending on the involvement of the CNS and the chronicity of disease.[36] [LE, 2a,B]

5. Classification of NLUTD

A perfect classification system is not yet available. Most of the currently used classifications of NLUTD are based on the bladder and urethral dysfunctions. Wein[37] and Fall et al[38] classified NLUTD as failure to store and failure to empty based on detrusor and urethral dysfunction. [LE, 2a,B; LE, 2a,B]

The ICS also separates the NLUTD as detrusor and urethral dysfunction in storage and voiding phases. The main problems of NLUTD are: (1) failure to store due to DO or urethral incompetence; (2) failure to empty due to DA, BND, or DSD; and (3) combined failure to store and empty due to DSD or DO and DHIC.[1] [LE, 1a,A]

Early diagnosis and treatment is essential, as irreversible changes may occur. Individual variations exist in the NLUTD caused by a specific neurologic lesion. [LE, 5,D]

DO and DSD commonly occur in patients with suprasacral cord lesions, such as SCI, MS, or transverse myelitis. The presence of DSD is associated with complete injuries, elevated intravesical pressures, and upper urinary tract complications.[26] [LE, 2a,B]

6. Classification of SCI severity

In the American Spinal Injury Association (ASIA) Impairment Scale,[39] [LE, 1b, A] ASIA-A is defined as a person with no motor or sensory function preserved in the sacral segments S4–S5. ASIA-B is essentially identical to Frankel B, but adds the requirement of preserved sacral S4–S5 sensory function. ASIA-C is if more than half of the muscles evaluated had a grade of less than 3/5. If not, the person was assigned to ASIA-D. ASIA-E implies that somebody can have SCI without having any neurological deficits at least detectable on a neurological examination of this type (Table 1).

The ASIA committee also classified incomplete spinal cord injuries into five types. A central cord syndrome is associated with greater loss of upper limb function compared to the lower limbs. The Brown-Sequard syndrome results from a hemisection lesion of the spinal cord. Anterior cord syndrome occurs when the injury affects the anterior spinal tracts, including the corticospinal tract. Conus medullaris and cauda equina syndromes occur with damage to the conus or spinal roots of the cord.

Table 1
The ASIA Impairment Scale.

A = Complete: No motor or sensory function is preserved in the sacral segments S4–S5.
B = Incomplete: Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4–S5.
C = Incomplete: Motor function is preserved below the neurological level, and more than half of the key muscles below the neurological level have a muscle grade <3.
D = Incomplete: Motor function is preserved below the neurological level, and at least half of the key muscles below the neurological level have a muscle grade of ≥3.
E = Normal: Motor and sensory functions are normal.

ASIA = American Spinal Injury Association.

7. Diagnosis of NLUTD

Diagnosis of NLUTD should be based on neurological lesions and somatic and visceral dysfunctions. Medical comorbidity may alter the LUTS.[12] [LE, 2a,B]

8. Urological surveillance

The assessments of patients with NLUTD include: urinalysis, urine culture, renal function test, GFR, intravenous pyelography, renal ultrasound, renal scan, voiding cystourethrography, cystoscopy, and urodynamics at physicians' discretions.

Video urodynamics is the gold standard in patients with NLUTD to detect bladder and urethral dysfunction, as well as morphological pathology in the lower and upper urinary tracts.[40–42] [LE, 2a,B; LE, 2a,B; LE, 2a,B] Should this not be available, then a filling cystometry continuing into a pressure flow study should be performed.

9. Selecting high risk patients

It is important to screen the patients at high risk, including patients with complete neurological lesion, cervical spinal cord paraplegics, a prolonged indwelling catheter, high detrusor leak point pressure (DLPP), presence of DSD and AD, large PVR, presence of VUR, urolithiasis, and recurrent UTI. Detrusor leak point pressure is an important parameter, especially in patients with endangered upper urinary tracts.[43] [LE, 2a,B] When the DLPP is >40 cm H_2O, the upper tract is endangered.[40,43] [LE, 2a,B; LE, 2a,B]

10. Non-surgical treatment of NLUTD

The main goals of treatment of NLUTD are: (1) correction of urinary tract complications including hydronephrosis, VUR, UTI, and contracted bladder; (2) lowering intravesical pressure, controlling or alleviating symptoms (including incontinence and difficult urination)[40,43]; [LE, 2a,B; LE, 2a,B] (3) improving QoL, to treat urinary incontinence and difficult urination, to improve bladder emptying, to avoid indwelling catheter and UTI[44,45]; [LE, 2a,B; LE, 2a,B] and (4) further considering the patient's disability, the cost effectiveness, the technical intricacy, and the possible complications. It is important that individual strategy for each NLUTD patient is mandatory.

10.1. Conservative management of NLUTD

Conservative management is the mainstay of urological treatment for NLUTD if possible. Behavioral modification should be the first management. CIC either by themselves or by a care-giver is recommended in patients who cannot have a balanced bladder (defined as adequate bladder emptying with a low intravesical pressure and low PVR). Patients can be instructed to void by abdominal stimulation (triggered reflex voiding), Crede maneuver, or abdominal straining (Valsalva). Spontaneous voiding with and without triggered voiding and/or bladder expression has proven to be less safe, except in well-defined patients with regular urological follow-up.[46,47] [LE, 2a,B; LE, 2b,B]

In patients with poor hand function and urinary incontinence, an external appliance is feasible to collect urine. Long-term indwelling catheters should be avoided unless for patients with tetraplegia and who are bed-bound, in whom suprapubic cystostomy or an indwelling urethral Foley catheter may be an alternative choice.[48–50] [LE, 2a,B; LE, 3b,C; LE, 2a,B]

10.2. Intermittent catheterization

Intermittent catheterization (IC) is the standard treatment for patients who are unable to empty the bladder.[51,52] [LE, 2b,B; LE, 2a,B] Patients should be well instructed on the technique and risks of IC. Aseptic or CIC is the recommended method.

Indwelling transurethral and suprapubic catheterization should be used only in exceptional circumstances, under close control, and the catheter should be changed frequently. Silicone catheters are preferred and should be changed every 2–4 weeks; (coated) latex catheters need to be changed every 1–2 weeks.[48] [LE, 2b,B]

10.3. Drug treatment of NLUTD

NDO can be treated effectively by anticholinergic substances (such as oxybutynin, tolterodine, trospium, propiverine, solifenacin, etc.).[53–56] [LE, 1b,A; LE, 1b,A; LE, 1b,A; LE, 4,C] Long-term efficacy and safety of antimuscarinic therapy for NDO is well documented. A combination of antimuscarinic agents can be used in patients who were insufficiently treated with a single antimuscarinic agent, and is often considered to maximize outcomes for NDO.[57] [LE, 3b,C] In a highly selected group of patients with NDO and poor bladder compliance, combination medical therapy with two or three drugs improved compliance, decreased bladder pressures at capacity, and improved clinical outcomes.[58] [LE, 4,D]

There is no well-designed study available on drugs for improving detrusor contractility. Using oral bethanechol can increase intravesical tone and facilitate bladder emptying by abdominal straining in patients who responded positively to the electromotive intravesical bethanechol testing.[59] [LE, 4,C] However, some patients may benefit from bethanechol. [LE, 5,D]

Alpha-blockers (such as alfuzosin, terazosin, doxazosin, tamsulosin, or silodosin) and skeletal muscle relaxants (such as baclofen or diazepam) have been used partly successfully in decreasing bladder outlet resistance.[60–62] [LE, 4,C; LE, 2a,B; LE, 3b,B]

Because patients with NLUTD may suffer from both storage and empty LUTS, a combination of medication to improve bladder storage and facilitate bladder emptying can be used.[63] [LE, 2a,B] For most patients, flexible dosing with an anticholinergic agent, with CIC when indicated, has been shown to reduce the risks of urological complications, improve levels of continence, and enhance patient QoL in both children and adults.[64] [LE, 2a,B]

10.4. Botulinum toxin bladder and urethral injections

The treatment strategy for NLUTD should be a less invasive and reversible procedure, such as neurotoxin injection into detrusor or urethral sphincter for bladder control and emptying. Botulinum toxin-A (BoNT-A, Botox) intradetrusor injection has been demonstrated to be effective in the restoration of urinary continence and remains durable from 3 months to 9 months.[65–67] [LE, 3b,B; LE, 1b,A; LE, 3b,B] Detrusor BoNT-A injection increases bladder capacity and decreases intravesical pressure. Doses of 200 U and 300 U Botox produce the same therapeutic effects on NDO, and 200 U is approved by the Food and Drug Administration.[68] [LE, 1b,A] Repeat BoNT-A detrusor injections seem to be as effective as the first injection.[69] [LE, 3b,B]

Detrusor BoNT-A injection is also effective in treating children with myelomeningocele with DO and incontinence.[70,71] [LE, 3b,B; LE, 3b,B] BoNT-A significantly reduced the maximum pressure of uninhibited detrusor contractions more than resiniferatoxin at all follow-up time points.[72] [LE, 2b,B]

Clinically, detrusor BoNT-A injection usually induces impaired detrusor contractility, large PVR or urinary retention in NDO, about 70% of patients require periodic CIC, and subsequent UTI could become a *de novo* problem.[73] [LE, 2b,B]

In patients with PD and refractory DO, intradetrusor injection of 100 U BoNT-A also induced clinical and urodynamic improvement in overactive bladders that lasts for 6 months.[74] [LE, 4,C]

Detrusor 200 U BoNT-A injection is the recommended dose for patients with NDO to decrease intravesical pressure and achieve continence. Under some conditions, a starting dose of 100 U detrusor injection might be feasible in case that the patient wants to preserve spontaneous voiding function or CIC/CISC is not acceptable. However, if the patient is not satisfied with the therapeutic effect of 100 U, 200 U detrusor BoNT-A should be used in the following treatment.

Urethral BoNT-A injection can reduce urethral resistance in patients with DSD or DA.[75,76] [LE, 3b, B; LE, 3b,B;] Early return of detrusor contractility seems possible in patients with DU and urethral sphincter pseudodyssynergia due to CVA or PD.[77] [LE, 3b,C]

10.5. Urethral or detrusor BoNT-A injections for DSD?

Patients with DSD usually have both storage and empty symptoms. Patients with DSD may prefer to be dry and perform CIC by themselves, or prefer spontaneous voiding without instituting CIC.[78] [LE, 3b,C] Therefore, management of voiding dysfunction and incontinence in patients with SCI and DSD is a challenge to physicians and should be considered an art-of-the-medicine.

About 95% of patients with suprasacral lesions demonstrated DO with or without DSD.[79] [LE, 2a,B] The hand dexterity, abdominal muscle power, bladder sensation, and the degree of urethral sphincter dyssynergia might affect the voiding efficiency and LUTD. Urethral BoNT-A injection can reduce urethral resistance.[65,75] [LE, 3b,B; LE, 3b,B] Combined detrusor and urethral sphincter BoNT-A injections may achieve continence control and volitional voiding.[80] [LE, 3b,B]

Treatment of NDO and DSD might be different between genders. Physicians should consider the patient's expectation and ability of bladder management when planning BoNT-A injection into detrusor or urethral sphincter in treatment of NLUTD.[81] [LE, 3b,B]

There are several important issues that physicians should know prior to when they perform BoNT-A injection to patients with NLUTD: (1) behavioral modification should be the first management; (2) BoNT-A injection should be given to patients in whom antimuscarinics failed or produced intolerable adverse events; (3) CIC is necessary for most patients to respond to BoNTA; (4) monitoring PVR and subsequent UTI is necessary; (5) monitoring upper urinary tracts is important; (6) repeated BoNT-A injections are necessary to maintain the desired therapeutic effect; and (7) patients with urethral stricture, unwillingness to perform CIC, and in whom BoNT-A is contraindicated should not be tried. [LE, 5,D]

10.6. Renal function preservation

The renal function is also an important issue in management of NLUTD, especially in chronic SCI patients. Patients with DSD, low compliant bladder, and high intravesical pressure at end-bladder filling may be at high risk of renal failure. The incidence of chronic renal disease in paraplegia and neural tube defects is higher than in a normal population.[82] [LE, 2a,B]

Low bladder compliance was statistically associated with VUR, radiographic upper urinary tract abnormality, pyelonephritis, and upper urinary tract stones. CIC is the superior method for preserving bladder compliance and preventing the upper urinary tract complications associated with low compliance.[83] [LE, 4,C]

Patients with DSD who currently have an indwelling catheter, who are performing CIC or who have spontaneous voiding should

be monitored annually to prevent the occurrence of renal insufficiency. Oral antimuscarinic agents or intravesical BoNT-A injections might provide a low-pressure bladder and preserve renal function in long-term management of NLUTD. [LE, 5,D]

10.7. AD dysreflexia and UTI in SCI

AD is a potentially life-threatening condition. AD occurs most often in individuals with SCI above the T6 level.[84] [LE, 4,C] Patients with chronic SCI may develop AD during bladder overdistension, stool impaction, or UTI.[85] [LE, 2a,B] The incidence of AD in patients with SCI above T6 ranged from 19% to 70%. Patients with DSD had a higher incidence of AD.

Alpha-blockers or detrusor BoNT-A injections have been proven to be able to alleviate the occurrence of AD. However, some SCI patients may develop exacerbated AD after BoNT-A injection.[77] [LE, 3b,B]

11. Surgical management of NVD

For patients without therapeutic responses to medical treatment or intravesical BoNT-A injection, surgical intervention is mandatory to treat urological complications and preserve renal function.

Transurethral external sphincterotomy provides a significant reduction of voiding pressure and AD in male SCI patients.[86] [LE, 3b,B]

Transurethral incision of BN (TUI-BN) can also reduce AD and facilitate spontaneous voiding in incomplete cervical SCI patients.[87] [LE, 3b,B] TUI-BN is effective in restoring spontaneous voiding, increasing Qmax, and decreasing PVR in high-level SCI patients. TUI-BN also leads to an improvement in reducing bladder outlet resistance, a reduction in occurrence of AD episodes, and an improvement in HR-QoL.[88] [LE, 3b,B]

Bladder augmentation, either by a segment of intestine, or auto-augmentation using myomectomy, can reach a large capacity, low intravesical pressure, and non-reflux condition.[89,90] [LE, 2a,B; LE, 3b,C] However, long-term complications such as stone formation, loose stool, metabolic acidosis, and chronic UTI remain problems to be solved.[91] [LE, 3b,B]

Other surgical treatments for NLUTD to increase bladder capacity and improve storage function include: urethral and bladder neck procedures, urethral sling, artificial urinary sphincter,[92] [LE, 2a,B] functional sphincter augmentation, bladder neck and urethra reconstruction (Young-Dees-Leadbetter procedure),[93] [LE, 3b,B] detrusor myectomy (auto-augmentation), denervation, deafferentiation, neurostimulation, neuromodulation, sacral rhizotomy and sacral anterior root stimulation , bladder covering by striated muscle, or urinary diversion.[89] [LE, 2a,B]

11.1. Treatment of VUR

Ureteral reimplantation has an immediate and long-lasting result in over 90% of patients.[94,95] [LE, 3b,B; LE, 3b,B] Subtrigonal injections of bulking agents may be tried first in selected patients with NLUTD and VUR.[96] [LE, 3b,B]

Ureteral reimplantation alone or combined ureteral reimplantation with bladder augmentation in patients with contracted bladder are effective procedures in patients who fail the initial injection procedure.[97] [LE, 3b,B] In the treatment of VUR, physicians should consider lowering intravesical pressure at the same time.[98] [LE, 3b,C]

12. QoL issues

The QoL issue is also important in the treatment strategy for NLUTD. Patients' will of management modality, their hand function and capability of self-care, social economic support, and family support for patients with NLUTD should be taken into consideration in the management of NLUTD.

When performing BoNT-A injections for patients with DSD, injecting into the detrusor or urethra should be carefully evaluated prior to treatment. Patients with DSD and treated with detrusor BoNT-A had a greater HR-QoL improvement than those treated with urethral injection.[99] [LE, 2b,B]

13. Rational treatment strategy for NLUTD

Bladder and urethral dysfunction changes with time in patients with NLUTD. In treating patients with NLUTD, patients should be regularly followed up for their lower urinary tract dysfunction and any urological complication should be adequately treated.

Avoiding a chronic indwelling catheter can reduce the incidence of developing a low compliant bladder.

Long-term antimuscarinic therapy can decrease urinary incontinence and lower intravesical pressure.

Intravesical injection of BoNT-A provides an alternative treatment for refractory DO or low compliant bladder and can replace the need for bladder augmentation.

When surgical intervention is necessary, we should consider the least invasive type of surgery and reversible procedure first and avoid any unnecessary surgery of the lower urinary tract.

14. Future new technologies

Many novel therapeutic trials have emerged in recent decades to treat SCI and NLUTD. Keeping the bladder and urethra in a good condition without interference of the neuromuscular continuity provides patients with NLUTD a chance for future new technologies. The most important thing is to never give up on improving the QoL in patients with NLUTD.

15. Guidelines for follow-up

All patients should receive life-long annual surveillance to prevent development of urological complications and undesired LUTS.[100] [LE, 2a,B]

The long-term follow-up procedures include: physical examination, blood chemistry, urinalysis, renal ultrasound, bladder ultrasound, PVR measurement, cystoscopy, renal scan, and urodynamic study. [see Assessment]

More frequent examinations are needed in patients with a high risk or if the neurological pathology or the NLUTD status demand this.

Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

Source of Funding

None.

References

1. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. *Neurourol Urodyn* 2002;**21**:167–78.
2. Abrams P, Andersson KE, Birder L, Brubaker L, Cardozo L, Chapple C, et al. Fourth International Consultation on Incontinence Recommendations of the International Scientific Committee: evaluation and treatment of urinary incontinence, pelvic organ prolapse, and fecal incontinence. *Neurourol Urodyn* 2010;**29**:213–40.
3. Ku JH. The management of neurogenic bladder and quality of life in spinal cord injury. *BJU Int* 2006;**98**:739–45.
4. Kuo HC. Quality of life after active urological management of chronic spinal cord injury in eastern Taiwan. *Eur Urol* 1998;**34**:37–46.
5. Bradley WE. Diagnosis of urinary bladder dysfunction in diabetes mellitus. *Ann Intern Med* 1980;**92**:323–6.
6. Seski JC, Diokno AC. Bladder dysfunction after radical abdominal hysterectomy. *Am J Obstet Gynecol* 1977;**128**:643–51.
7. Fowler CJ, van Kerrebroeck PE, Nordenbo A, Van Poppel H. Treatment of lower urinary tract dysfunction in patients with multiple sclerosis. Committee of the European Study Group of SUDIMS (Sexual and Urological Disorders in Multiple Sclerosis). *J Neurol Neurosurg Psychiatry* 1992;**55**:986–9.
8. Olsen CG, Clasen ME. Senile dementia of the Binswanger's type. *Am Fam Physician* 1998;**58**:2068–74.
9. Salinas JM, Berger Y, De La Rocha RE, Blaivas JG. Urological evaluation in the Shy Drager syndrome. *J Urol* 1986;**135**:741–3.
10. Barer DH. Continence after stroke, useful predictor of goal of therapy? *Age Aging* 1989;**18**:183–91.
11. Andrew J, Nathan PW. Lesions of the anterior frontal lobes and disturbances of micturition and defecation. *Brain* 1964;**87**:233–62.
12. Burns AS, Rivas DA, Ditunno JF. The management of neurogenic bladder and sexual dysfunction after spinal cord injury. *Spine (Phila Pa 1976)* 2001;**26**(24 Suppl.):S129–36.
13. van Gool JD, Dik P, de Jong TP. Bladder-sphincter dysfunction in myelomeningocele. *Eur J Pediatr* 2001;**160**:414–20.
14. Rosomoff HL, Johnston JD, Gallo AE, Ludmer M, Givens FT, Carney FT, et al. Cystometry in the evaluation of nerve root compression in the lumbar spine. *Surg Gynecol Obstet* 1963;**117**:263–70.
15. Mardirosoff C, Dumont L. Bowel and bladder dysfunction after spinal bupivacaine. *Anesthesiology* 2001;**95**:1306.
16. Kaplan SA, Chancellor MB, Blaivas JG. Bladder and sphincter behavior in patients with spinal cord lesions. *J Urol* 1991;**146**:113–7.
17. Borrie MJ, Campbell AJ, Caradoc-Davies TH, Spears GF. Urinary incontinence after stroke: a prospective study. *Age Ageing* 1986;**15**:177–81.
18. Taub NA, Wolfe CD, Richardson E, Burney PG. Predicting the disability of first-time stroke sufferers at 1 year. 12-Month follow-up of a population-based cohort in southeast England. *Stroke* 1994;**25**:352–7.
19. Blaivas JG. The neurophysiology of micturition: a clinical study of 550 patients. *J Urol* 1982;**127**:958–63.
20. Awad RA. Neurogenic bowel dysfunction in patients with spinal cord injury, myelomeningocele, multiple sclerosis and Parkinson'zs disease. *World J Gastroenterol* 2011;**17**:5035–48.
21. Pavlakis AJ, Siroky MB, Goldstein I, Krane RJ. Neurourologic findings in Parkinson's disease. *J Urol* 1983;**129**:80–3.
22. Wang SN, Kuo HC. Videourodynamic findings in Parkinson's disease. *JTUA* 2007;**18**:23–6.
23. van den Berg ME, Castellote JM, Mahillo-Fernandez I, de Pedro-Cuesta J. Incidence of spinal cord injury worldwide: a systematic review. *Neuroepidemiology* 2010;**34**:184–92.
24. Jackson AB, Dijkers M, Devivo MJ, Poczatek RB. A demographic profile of new traumatic spinal cord injuries: change and stability over 30 years. *Arch Phys Med Rehabil* 2004;**85**:1740–8.
25. Lai EC, Kao Yang YH, Kuo HC. Complication rate of neurogenic lower urinary tract dysfunction after spinal cord injury in Taiwan. *Int Urol Nephrol* 2013 Dec 18 [Epub ahead of print]. http://dx.doi.org/10.1007/s11255-013-0625-6.
26. Weld KJ, Dmochowski RR. Association of level of injury and bladder behavior in patients with post-traumatic spinal cord injury. *Urology* 2000;**55**:490–4.
27. Weld KJ, Graney MJ, Dmochowski RR. Difference in bladder compliance with time and associations of bladder management with compliance in spinal cord injured patients. *J Urol* 2000;**163**:1228–33.
28. Al-Ali M, Haddad L. A 10 year review of the endoscopic treatment of 125 spinal cord injured patients with vesical outlet obstruction: does bladder neck dyssynergia exist? *Paraplegia* 1996;**34**:34–8.
29. Anderson KD. Targeting recovery: priorities of the spinal cord-injured population. *J Neurotrauma* 2004;**21**:1371–83.
30. Liu CW, Attar KH, Gall A, Shah J, Craggs M. The relationship between bladder management and health-related quality of life in patients with spinal cord injury in the UK. *Spinal Cord* 2010;**48**:319–24.
31. Oh SJ, Shin HI, Paik NJ, Yoo T, Ku JH. Depressive symptoms of patients using clean intermittent catheterization for neurogenic bladder secondary to spinal cord injury. *Spinal Cord* 2006;**44**:757–62.
32. Thietje R, Giese R, Pouw M, Kaphengst C, Hosman A, Kienast B, et al. How does knowledge about spinal cord injury-related complications develop in subjects with spinal cord injury? A descriptive analysis in 214 patients. *Spinal Cord* 2011;**49**:43–8.
33. Giannantoni A, Scivoletto G, Di Stasi SM, Grasso MG, Vespasiani G, Castellano V. Urological dysfunctions and upper urinary tract involvement in multiple sclerosis patients. *Neurourol Urodyn* 1998;**17**:89–98.
34. Koldewijn EL, Hommes OR, Lemmens WA, Debruyne FM, van Kerrebroeck PE. Relationship between lower urinary tract abnormalities and disease-related parameters in multiple sclerosis. *J Urol* 1995;**154**:169–73.
35. Lai CH, Tseng HF. Population-based epidemiological study of neurological diseases in Taiwan: I. Creutzfeldt-Jakob disease and multiple sclerosis. *Neuroepidemiology* 2009;**33**:247–53.
36. de Sèze M, Ruffion A, Denys P, Joseph PA, Perrouin-Verbe B, GENULF. The neurogenic bladder in multiple sclerosis: review of the literature and proposal of management guidelines. *Mult Scler* 2007;**13**:915–28.
37. Wein AJ. Pathophysiology and categorization of voiding dysfunction. In: Walsh PC, Retik AB, Vaughan Jr ED, editors. *Campbell's Urology*. 4th ed. Philadelphia: WB Saunders; 1998. pp. 917–26.
38. Fall M, Ohlsson BL, Carlsson CA. The neurogenic overactive bladder. Classification based on urodynamics. *Br J Urol* 1989;**64**:368–73.
39. Marino RJ, Barros T, Biering-Sorensen F, Burns SP, Donovan WH, Graves DE, et al. International standards for neurological classification of spinal cord injury. *J Spinal Cord Med* 2003;**26**(Suppl. 1):S50–6.
40. Stöhrer M, Goepel M, Kondo A, Kramer G, Madersbacher H, Millard R, et al. The standardization of terminology in neurogenic lower urinary tract dysfunction with suggestions for diagnostic procedures. *Neurourol Urodyn* 1999;**18**:139–58.
41. Rivas DA, Chancellor MB. Neurogenic vesical dysfunction. *Urol Clin North Am* 1995;**22**:579–91.
42. Madersbacher HG. Neurogenic bladder dysfunction. *Curr Opin Urol* 1999;**9**:303–7.
43. McGuire EJ, Cespedes RD, O'Connell HE. Leak-point pressures. *Urol Clin North Am* 1996;**23**:253–62.
44. Hackler RH. A 25-year prospective mortality study in the spinal cord injured patient: comparison with the long-term living paraplegic. *J Urol* 1977;**117**:486–8.
45. Perkash I, Giroux J. Prevention, treatment, and management of urinary tract infections in neuropathic bladders. *J Am Paraplegia Soc* 1985;**8**:15–7.
46. Wyndaele JJ, Madersbacher H, Kovindha A. Conservative treatment of the neuropathic bladder in spinal cord injured patients. *Spinal Cord* 2001;**39**:294–300.
47. Barbalias GA, Klauber GT, Blaivas JG. Critical evaluation of the Crede maneuver: a urodynamic study of 207 patients. *J Urol* 1983;**130**:720–3.
48. Weld KJ, Dmochowski RR. Effect of bladder management on urological complications in spinal cord injured patients. *J Urol* 2000;**163**:768–72.
49. Larsen LD, Chamberlin DA, Khonsari F, Ahlering TE. Retrospective analysis of urologic complications in male patients with spinal cord injury managed with and without indwelling urinary catheters. *Urology* 1997;**50**:418–22.
50. Weld KJ, Wall BM, Mangold TA, Steere EL, Dmochowski RR. Influences on renal function in chronic spinal cord injured patients. *J Urol* 2000;**164**:1490–3.
51. Guttmann L, Frankel H. The value of intermittent catheterisation in the early management of traumatic paraplegia and tetraplegia. *Paraplegia* 1966;**4**:63–84.
52. Lapides J, Diokno AC, Silber SJ, Lowe BS. Clean, intermittent self-catheterization in the treatment of urinary tract disease. *J Urol* 1972;**107**:458–61.
53. Madersbacher H, Stöhrer M, Richter R, Burgdörfer H, Hachen HJ, Mürtz G. Trospium chloride versus oxybutynin: a randomized, double-blind, multicentre trial in the treatment of detrusor hyperreflexia. *Br J Urol* 1995;**75**:452–6.
54. Goessl C, Sauter T, Michael T, Berge B, Staehler M, Miller K. Efficacy and tolerability of tolterodine in children with detrusor hyperreflexia. *Urology* 2000;**55**:414–8.
55. Thuroff JW, Bunke B, Ebner A, Faber P, de Geeter P, Hannappel J, et al. Randomized, double-blind, multicenter trial on treatment of frequency, urgency and incontinence related to detrusor hyperactivity: oxybutynin versus propantheline versus placebo. *J Urol* 1991;**145**:813–6.
56. Krebs J, Pannek J. Effects of solifenacin in patients with neurogenic detrusor overactivity as a result of spinal cord lesion. *Spinal Cord* 2013;**51**:306–9.
57. Amend B, Hennenlotter J, Schäfer T, Horstmann M, Stenzl A, Sievert KD. Effective treatment of neurogenic detrusor dysfunction by combined high-dosed antimuscarinics without increased side-effects. *Eur Urol* 2008;**53**:1021–8.
58. Cameron AP, Clemens JQ, Latini JM, McGuire EJ. Combination drug therapy improves compliance of the neurogenic bladder. *J Urol* 2009;**182**:1062–7.
59. Riedl CR, Stephen RL, Daha LK, Knoll M, Plas E, Pfluger H. Electromotive administration of intravesical bethanechol and the clinical impact on a contractile detrusor management: introduction of a new test. *J Urol* 2000;**164**:2108–11.
60. Perkash I. Efficacy and safety of terazosin to improve voiding in spinal cord injury patients. *J Spinal Cord Med* 1995;**18**:236–9.
61. Sullivan J, Abrams P. Alpha-adrenoceptor antagonists in neurogenic lower urinary tract dysfunction. *Urology* 1999;**53**(3 Suppl. 3a):21–7.

62. Schulte-Baukloh H, Michael T, Miller K, Knispel HH. Alfuzosin in the treatment of high leak-point pressure in children with neurogenic bladder. *BJU Int* 2002;**90**:716–20.
63. Ruggieri MR, Braverman AS, Pontari MA. Combined use of alpha-adrenergic and mascarinic antagonists for the treatment of voiding dysfunction. *J Urol* 2005;**174**:1743–8.
64. Chancellor MB, Anderson RU, Boone TB. Pharmacotherapy for neurogenic detrusor overactivity. *Am J Phys Med Rehabil* 2006;**85**:536–45.
65. Schurch B, Stohrer M, Kramer G, Schmid DM, Gaul G, Hauri D. Botulinum-A toxin for treating detrusor hyperreflexia in spinal cord injured patients: a new alternative to anticholinergic drugs? Preliminary results. *J Urol* 2000;**164**: 692–7.
66. Ehren I, Volz D, Farrelly E, Berglund L, Brundin L, Hultling C, et al. Efficacy and impact of botulinum toxin A on quality of life in patients with neurogenic detrusor overactivity: a randomized, placebo-controlled, double-blind study. *Scand J Urol Nephrol* 2007;**41**:335–40.
67. Patki PS, Hamid R, Arumugam K, Shah PJ, Craggs M. Botulinum toxin-type A in the treatment of drug-resistant neurogenic detrusor overactivity secondary to traumatic spinal cord injury. *BJU Int* 2006;**98**:77–82.
68. Cruz F, Herschorn S, Aliotta P, Brin M, Thompson C, Lam W, et al. Efficacy and safety of onabotulinumtoxinA in patients with urinary incontinence due to neurogenic detrusor overactivity: a randomized, double-blind, placebo-controlled trial. *Eur Urol* 2011;**60**:742–50.
69. Akbar M, Abel R, Seyler TM, Gerner HJ, Mohring K. Repeated botulinum-A toxin injections in the treatment of myelodysplastic children and patients with spinal cord injuries with neurogenic bladder dysfunction. *BJU Int* 2007;**100**:639–45.
70. Riccabona M, Koen M, Schindler M, Goedele B, Pycha A, Lusuardi L, et al. Botulinum-A toxin injection into the detrusor: a safe alternative in the treatment of children with myelomeningocele with detrusor hyperreflexia. *J Urol* 2004;**171**:845–8.
71. Kajbafzadeh AM, Moosavi S, Tajik P, Arshadi H, Payabvash S, Salmasi AH, et al. Intravesical injection of botulinum toxin type A: management of neuropathic bladder and bowel dysfunction in children with myelomeningocele. *Urology* 2006;**68**:1091–7.
72. Gianantoni A, Mearini E, Di Stasi SM, Costantini E, Zucchi A, Mearini L, et al. New therapeutic options for refractory neurogenic detrusor overactivity. *Minerva Urol Nefrol* 2004;**56**:79–87.
73. Reitz A, Stohrer M, Kramer G, Del Popolo G, Chartier-Kastler E, Pannek J, et al. European experience of 200 cases treated with botulinum-A toxin injections into the detrusor muscle for urinary incontinence due to neurogenic detrusor overactivity. *Eur Urol* 2004;**45**:510–5.
74. Giannantoni A, Conte A, Proietti S, Giovannozzi S, Rossi A, Fabbrini G, et al. Botulinum toxin type A in patients with Parkinson's disease and refractory overactive bladder. *J Urol* 2011;**186**:960–4.
75. Kuo HC. Botulinum A toxin urethral injection for the treatment of lower urinary tract dysfunction. *J Urol* 2003;**170**:1908–12.
76. Schurch B. Neurogenic voiding disorders. Current status of diagnosis and therapy. *Schweiz Med Wochenschr* 2000;**130**:1618–26.
77. Chen SF, Kuo HC. Improvement in autonomic dysreflexia after detrusor onabotulinumtoxinA injections in patients with chronic spinal cord injuries. *Tzu Chi Med J* 2012;**24**:201–4.
78. Kuo HC. Therapeutic effects of suburothelial injection of botulinum a toxin for neurogenic detrusor overactivity due to chronic cerebrovascular accident and spinal cord lesions. *Urology* 2006;**67**:232–6.
79. Weld KJ, Graney MJ, Dmochowski RR. Clinical significance of detrusor sphincter dyssynergia type in patients with post-traumatic spinal cord injury. *Urology* 2000;**56**:565–8.
80. Schulte-Baukloh H, Weiss C, Stolze T, Herholz J, Stürzebecher B, Miller K, et al. Botulinum-A toxin detrusor and sphincter injection in treatment of overactive bladder syndrome: objective outcome and patient satisfaction. *Eur Urol* 2005;**48**:984–90.
81. Kuo HC. Therapeutic satisfaction and dissatisfaction in patients with spinal cord lesion and detrusor sphincter dyssynergia who received detrusor botulinum toxin A injection. *Urology* 2008;**72**:1056–60.
82. Lawrenson R, Wyndaele JJ, Vlachonikolis I, Farmer C, Glickman S. Renal failure in patients with neurogenic lower urinary tract dysfunction. *Neuroepidemiology* 2001;**20**:138–43.
83. Yiangou Y, Facer P, Ford A, Brady C, Wiseman O, Fowler CJ, et al. Capsaicin receptor VR1 and ATP-gated ion channel P2X3 in human urinary bladder. *BJU Int* 2001;**87**:774–9.
84. Valles M, Benito J, Portell E, Vidal J. Cerebral hemorrhage due to autonomic dysreflexia in a spinal cord injury patient. *Spinal Cord* 2005;**43**:738–40.
85. Karlsson AK. Autonomic dysreflexia. *Spinal Cord* 1999;**37**:383–91.
86. Perkash I. Transurethral sphincterotomy provides significant relief in autonomic dysreflexia in spinal cord injured male patients: long-term followup results. *J Urol* 2007;**177**:1026–9.
87. Perkash I. Contact laser sphincterotomy: further experience and longer follow-up. *Spinal Cord* 1996;**34**:227–33.
88. Ke QS, Kuo HC. Transurethral incision of the bladder neck to treat bladder neck dysfunction and voiding dysfunction in patients with high-level spinal cord injuries. *Neurourol Urodyn* 2010;**29**:748–52.
89. Castro-Diaz D, Barrett D, Grise P, Perkash I, Stöhrer M, Stone A, et al. Surgery for the neuropathic patient. In: Abrams P, Khoury S, Wein A, editors. *Incontinence*. 2nd ed. Plymouth: Health Publication Ltd; 2002. pp. 865–91.
90. Stöhrer M, Kramer A, Goepel M, Lochner-Ernst D, Kruse D, Rübben H. Bladder auto-augmentation—an alternative for enterocystoplasty: preliminary results. *Neurourol Urodyn* 1995;**14**:11–23.
91. Blaivas JG, Weiss JD, Desai P, Flisser AJ, Stember DS, Stahl PJ. Long-term followup of augmentation enterocystoplasty and continent diversion in patients with benign disease. *J Urol* 2005;**173**:1631–4.
92. Light JK, Scott FB. Use of the artificial urinary sphincter in spinal cord injury patients. *J Urol* 1983;**130**:1127–9.
93. Donnahoo KK, Rink RC, Cain MP, Casale AJ. The Young-Dees-Leadbetter bladder neck repair for neurogenic incontinence. *J Urol* 1999;**161**:1946–9.
94. Engel JD, Palmer LS, Cheng EY, Kaplan WE. Surgical versus endoscopic correction of vesicoureteral reflux in children with neurogenic bladder dysfunction. *J Urol* 1997;**157**:2291–4.
95. Granata C, Buffa P, Di Rovasenda E, Mattioli G, Scarsi PL, Podesta E, et al. Treatment of vesico-ureteric reflux in children with neuropathic bladder: a comparison of surgical and endoscopic correction. *J Pediatr Surg* 1999;**34**: 1836–8.
96. Haferkamp A, Mohring K, Staehler G, Gerner HJ, Dorsam J. Long-term efficacy of subureteral collagen injection for endoscopic treatment of vesicoureteral reflux in neurogenic bladder cases. *J Urol* 2000;**163**:274–7.
97. Simforoosh N, Tabibi A, Basiri A, Noorbala MH, Danesh AD, Ijadi A. Is ureteral reimplantation necessary during augmentation cystoplasty in patients with neurogenic bladder and vesicoureteral reflux? *J Urol* 2002;**168**:1439–41.
98. Lopez Pereira P, Martinez Urrutia MJ, Lobato Romera R, Jaureguizar E. Should we treat vesicoureteral reflux in patients who simultaneously undergo bladder augmentation for neuropathic bladder? *J Urol* 2001;**165**:2259–61.
99. Kuo HC. Therapeutic outcome and quality of life between urethral and detrusor botulinum toxin treatment for patients with spinal cord lesions and detrusor sphincter dyssynergia. *Int J Clin Pract* 2013;**67**:1044–9.
100. Nijman RJ. Neurogenic and non-neurogenic bladder dysfunction. *Curr Opin Urol* 2001;**11**:577–83.