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Fryderyk Menzel[1], Aleksandra Drabik[2]

Diagnosis and management of neurogenic lower urinary tract dysfunction

Diagnostyka i leczenie neurogennych dysfunkcji dolnych dróg moczowych

[1] Department of Hygiene, Wroclaw Medical University, Wroclaw, Poland
[2] Department and Clinic of Endocrinology, Diabetology and Isotope Therapy, Wroclaw Medical University, Wroclaw, Poland
Correspondence: Fryderyk Menzel, Strońska 41/8, 50-540 Wrocław, Poland, tel.: +48 695 551 937, e-mail: fryderyk.menzel@gmail.com

Abstract

Neurogenic lower urinary tract dysfunctions are a common cause of urination disorders, such as difficulty voiding, incontinence, and overactive bladder. Spinal injury, cerebrovascular accidents, multiple sclerosis, and dementias are the most common causes of neurogenic lower urinary tract dysfunction. The clinical picture may vary significantly in different types of neurogenic lower urinary tract dysfunction. The essence of this disease consists in detrusor and urethral sphincter muscle dysfunction in the form of either overactivity or underactivity. The diagnosis should involve precise neurological assessment, which is often of key importance for determining the aetiology. Urodynamic testing allows for an objective evaluation of lower urinary tract function. It is currently believed that upper and lower urinary tract protection and improving the quality of life of patients should be the primary treatment goals. Conservative treatment is mainly based on antimuscarinics (cholinolytics), which reduce the resting tension and the frequency of uncontrolled muscle contractions, thus limiting bladder overactivity. Minimally-invasive treatment methods for overactive bladder include botulinum toxin injections into the bladder detrusor muscle and intravesical infusion of cholinolytics. Intermittent catheterisation is considered the gold standard of care for voiding dysfunction. Some patients require surgical management – cystoplasty or urinary diversion. Since neurogenic bladder poses diagnostic and therapeutic difficulties, cooperation between general practitioners, urologists, and neurologists is crucial.

Keywords: neurogenic lower urinary tract dysfunctions, neurogenic bladder, urinary incontinence, voiding disorders

Streszczenie

Neurogenne dysfunkcje dolnych dróg moczowych są częstą przyczyną zaburzeń oddawania moczu, takich jak trudności w oddawaniu moczu, nietrzymanie moczu, a także nadreaktywność pęcherza. Do najczęstszych przyczyn neurogennych dysfunkcji dolnych dróg moczowych można zaliczyć urazy rdzenia kręgowego, incydenty naczyniowo-mózgowe, stwardnienie rozsiane, a także choroby otępienne. Obraz kliniczny może się znacząco różnić w poszczególnych typach neurogennych dysfunkcji dolnych dróg moczowych. Istotą tego schorzenia są zaburzenia funkcji mięśnia wypieracza moczu i zwieracza cewki moczowej – ich nadaktywność lub – przeciwnie – osłabienie. W diagnostyce należy zwrócić szczególną uwagę na dokładne badanie neurologiczne, często odgrywające kluczową rolę w określeniu przyczyny schorzenia. Natomiast badanie urodynamiczne pozwala na obiektywną ocenę czynności dolnych dróg moczowych. Obecnie uważa się, że podstawowe cele leczenia powinny obejmować ochronę górnych i dolnych dróg moczowych oraz poprawę jakości życia chorych. W leczeniu zachowawczym zastosowanie znajdują przede wszystkim leki przeciwmuskarynowe (cholinolityki), które zmniejszają napięcie spoczynkowe i częstość niekontrolowanych skurczów, redukując nadreaktywność pęcherza. Wśród małoinwazyjnych metod leczenia nadreaktywności pęcherza warto wymienić podawanie toksyny botulinowej w mięsień wypieracz pęcherza oraz dopęcherzowe wlewki z cholinolityków. Obecnie za złoty standard leczenia zaburzeń opróżniania uważa się cewnikowanie przerywane. Niektórzy pacjenci wymagają leczenia chirurgicznego – cystoplastyki lub wytworzenia odprowadzenia moczu. Pęcherz neurogenny jest schorzeniem trudnym w diagnostyce i leczeniu, dlatego niezwykle istotne znaczenie ma w tym wypadku dobra współpraca lekarzy rodzinnych, urologów i neurologów.

Słowa kluczowe: neurogenne dysfunkcje dolnych dróg moczowych, pęcherz neurogenny, nietrzymanie moczu, zaburzenia mikcji

INTRODUCTION

Neurogenic lower urinary tract dysfunction (NLUTD), which is also referred to as neurogenic bladder, is a lower urinary tract dysfunction associated with neurological disorders, most often caused by spinal cord injuries, stroke, multiple sclerosis or brain tumour. It may also develop in dementia syndromes and Parkinson's disease. Although typical symptoms of NLUTD include urinary incontinence, frequent urination, urgency, loss of bladder sensation or urinary retention, they may vary significantly in different patients. Depending on the site of neural damage and the time elapsed from the injury, areflexia, i.e. absence of bladder systolic function with atony or detrusor overactivity with detrusor sphincter dyssynergia (DSD) may occur. Thorough diagnosis, including detailed medical history, physical examination, diagnostic imaging and urodynamic testing, is needed to implement effective treatment.

URINARY BLADDER PHYSIOLOGY

Urinary bladder is responsible for the accumulation of urine produced by the kidneys and regular, conscious and controlled excretion of urine (micturition). This function is regulated by both the central and the peripheral nervous system. When there is a small amount of urine in the bladder, constant impulses from the sympathetic nervous system induce contraction of the internal and external urethral sphincter as well as detrusor relaxation. Bladder filling causes its walls to stretch. This results in increased stimulation of the receptors sensitive to stretch and centripetal impulses into micturition centres located in the pons and the spinal cord, which are modulated by the cerebral cortex. Cortical areas responsible for controlling micturition are located in the medial part of the frontal lobe and the anterior cingulate gyrus. Urge for micturition is felt when the bladder is filled with 300–400 mL of urine. This is followed by detrusor muscle contraction and urethral sphincter relaxation. This process is controlled by the central nervous system, which allows for its conscious initiation and inhibition. The ability to control voiding is usually acquired at the age of 3 to 5 years.

AETIOLOGY AND EPIDEMIOLOGY

Neurogenic lower urinary tract dysfunctions may be caused by multiple diseases as well as injuries to those parts of the nervous system that are responsible for controlling the lower urinary tract. Although there are currently no detailed data on the incidence of NLUTD in the general population, there are certain conditions that contribute to the development of neurogenic urinary bladder dysfunction. The most common ones include cerebrovascular accidents (stroke). The annual incidence in Europe is about 450 cases per 100,000 inhabitants[1]. Lesions located above the pons may cause the loss of conscious micturition control. Patients may present with overactive bladder, urinary incontinence, and nocturia. Urinary incontinence is observed in 30% up to 80% of patients after stroke, while urodynamic testing confirmed detrusor overactivity in 56% of cases[2]. The presence and persistence of urinary incontinence is associated with worse prognosis in patients after stroke[3]. Furthermore, lower urinary tract dysfunctions are very common (up to 90%) in multiple sclerosis patients[4]. In multiple sclerosis, the lesions are usually located in the sacral micturition centre, which is located in segments S2–S4. Damage to the upper motor neuron causes detrusor overactivity, which primarily manifests as frequent urination, urgency, and urinary incontinence. Dementias are a common cause of neurological lower urinary tract dysfunction. Symptoms typical of dementia were observed in 6.4–12.4% of individuals over 65 years of age[5]. Urinary incontinence is reported in 25% of patients with Alzheimer's disease[6]. Urinary detrusor overactivity is the most commonly observed urodynamic abnormality and affects 56% of patients with dementia[7]. In patients with Parkinson's disease, symptoms occur in 30% of patients at diagnosis and up to 70% 5 years later. Neoplastic diseases, brain tumours and central nervous system neoplasms in particular, may cause urinary bladder dysfunctions. Urinary incontinence usually affects patients with frontal lobe tumours. In the case of spinal cord injury, the level of damage is of key importance. In Europe, the annual incidence of spinal cord injury is 5–58 cases per 1,000,000 inhabitants[8]. Urinary bladder dysfunctions are detected in 90% of these patients. Urodynamic testing confirmed DSD in 80.5–94.9% of these patients, while 41.8–59.4% of patients present with low-compliance bladder[9]. Urinary bladder dysfunctions occur in 90% of patients with spina bifida, a birth defect most commonly located in the lumbar spine[10]. Diabetes mellitus is the most common cause of peripheral neuropathies, with frequent urination, urgency and urinary incontinence observed in these patients. Other causes of neurogenic urinary bladder dysfunctions include cerebral palsy, spinal stenosis, spinal degenerative diseases, discopathies and iatrogenic injuries.

CLASSIFICATION

Several neurogenic bladder classification systems have been proposed so far. Madersbacher proposed a classification system based on detrusor and urethral sphincter tone during filling and voiding phases. Four basic types of classification systems are summarised in Tab. 1. In 2016, Powell proposed the SALE system (stratify by anatomic location and aetiology) based on the anatomical location of neural lesions and their aetiology[11]. He demonstrated in his study that aetiology and anatomical location of lesions, which were not considered in the Madersbacher model, have a significant impact on the prognosis and the choice of appropriate treatment.

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No.	Bladder detrusor function	Urethral sphincter function	Treatment methods
1	Overactivity	Overactivity	Pharmacotherapy Surgery
2	Underactivity	Overactivity	Self-catheterisation
3	Underactivity	Underactivity	Self-catheterisation
4	Overactivity	Underactivity	Surgery

Tab. 1. Classification of neurogenic lower urinary tract dysfunctions according to Madersbacher

DIAGNOSIS

Early diagnosis and rapid treatment implementation are very important for patients with NLUTD. Even in the case of normal neurological reflexes, treatment postponement may result in irreversible changes. Neurogenic bladder may be the only observed symptom of lesions located in the nervous system. Early treatment initiation, e.g. intermittent catheterisation, reduces the risk of complications leading to upper and lower urinary tract damage[12]. Diagnosis should include medical history, with particular attention paid to patient's neurological and urological history, and physical examination, including laboratory and urodynamic tests.

Medical history

Detailed medical history including present and past symptoms is of great diagnostic importance. Symptoms in childhood and adolescence, family history of hereditary conditions, diabetes, neurodegenerative diseases, such as Alzheimer's disease, Parkinson's disease, multiple sclerosis as well as infectious diseases (such as syphilis), injuries and surgeries should be taken into account. Presently used medications, habits and lifestyle are also important. This should be followed by detailed medical history on urological symptoms, including the onset of symptoms, frequent urination, urgency, dysuria, difficulty initiating voiding and voiding, urinary incontinence. Neurological medical history should include congenital and acquired neurological conditions, neurological symptoms, spasticity and autonomic dysreflexia. The patient should be also asked about bowel movement problems and sexual functions.

Physical examination

The neurological examination should be as detailed as possible. Sensation and reflexes in the urogenital areas should be evaluated. When assessing sensation, attention should be paid to dermatomes supplied by roots S2–S5. The investigated reflexes should include bulbocavernosus reflex, anal reflex, patellar reflex, and Babinski sign. Patients after spinal injury may present with autonomic dysreflexia, which manifests in sudden increase in blood pressure and may be life-threatening. Furthermore, anal sphincter and pelvic diaphragm function should be checked.

Urodynamic testing

Urodynamic testing allows for an objective assessment of lower urinary tract function during filling and voiding phases. Bladder diary, which should be kept for at least 3 consecutive days, is a useful and, at the same time, simple tool for assessing symptoms. The diary includes data on the frequency of voiding, voided volumes, nocturia, urgency and urinary incontinence. Urinalysis and urine culture may be performed to exclude infection. It is also worth assessing the post-void residual (PVR) using ultrasound and perform uroflowmetry in patients who urinate independently. Typical symptoms of NLUTD that occur during the filling phase include impaired bladder sensation, vegetative sensations, low compliance and high capacity bladder, detrusor overactivity, and sphincter acontractility. Voiding phase manifestations include detrusor acontractility and DSD, non-relaxing bladder neck, and non-relaxing urethra.

TREATMENT

Protection of the upper and lower urinary tract, improvement of urinary continence and the patient's quality of life, and restoration of normal lower urinary tract function, if possible, are the primary therapeutic goals. Since renal failure significantly increases mortality among patients after spinal cord injury, efforts are made to maintain safe detrusor pressure both during the filling and voiding phase[13]. Prevention of urinary incontinence is another treatment goal.

Conservative treatment

Pharmacotherapy is mainly based on antimuscarinics (cholinolytics). These agents stabilise the detrusor, reduce the resting tension and the frequency of uncontrolled muscle contractions, thus decreasing bladder overactivity. This improves bladder compliance and, at the same time, reduces the risk of renal damage. Drugs from this group include trospium chloride, oxybutynin, fesoterodine, tolterodine, solifenacin, and propiverine. Alpha-blockers are used to decrease outflow resistance, thus reducing PVR[14]. Desmopressin may be used in the case of night incontinence and nocturia[15]. Electrostimulation is used in rehabilitation to restore bladder function.

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Minimally invasive treatment

Intermittent self-catheterisation or third party catheterisation is currently the gold treatment standard for NLUTD. Incomplete voiding significantly increases the risk of urinary tract infections. It was shown that catheterisation should be performed 4–6 times per day to prevent excessive intravesical pressure and reduce the risk of infection[12]. Antimuscarinic therapy is often associated with adverse effects, such as impaired motor coordination, limited peristalsis, dry mouth, impaired cognitive orientation and confusion. The drugs may be infused directly into the bladder to reduce adverse effects. It was demonstrated that intravesical administration of resiniferatoxin (RTX) or capsaicin and its derivatives induces desensitisation of C-fibres and reduces both the tone of detrusor and the frequency of its contractions. Linsenmeyer showed that the use of botulinum toxin reduces intravesical pressure and the number of episodes of urinary incontinence[16]. Botulinum toxin injections in the detrusor are currently considered a safe and, at the same time, one of the most effective methods for the treatment of detrusor overactivity[17]. Published studies reported the use of botulinum toxin type-A (BoNT-A) at a dose of 50–300 U administered in 10–20 injection points in the detrusor except for the trigone area due to the possible risk of secondary vesicoureteral reflux[18]. However, Manecksha et al. and Hui et al. presented findings suggesting that the administration of botulinum toxin type-A including the trigone is more effective and as safe as injection excluding this area[19,20].

Surgical treatment

If conservative and minimally invasive treatment options fail, a decision can be made to implement surgical management. Bladder augmentation (cystoplasty) is a procedure involving increasing the volume of the bladder and reducing the abnormally high intravesical pressure[21,22]. The procedure most often uses a bowel segment (enterocystoplasty); however, auto-augmentation involving resection of the outer layer of detrusor is also possible. Neurogenic bladder is also treated with neuromodulation[23]. Sacral neuromodulation (SNM) is a procedure involving the stimulation of the S3 nerve roots. The method is currently widely accepted in the treatment of idiopathic overactive bladder and urinary incontinence[24]. Many studies have shown promising results and efficacy of this method in the treatment of neurogenic bladder dysfunctions[25]. Engeler et al. demonstrated that neuromodulation used in patients with multiple sclerosis may significantly contribute to reduced PVR and urinary incontinence episodes[26].

In rare cases when the above described methods fail, urinary diversion may be necessary to avoid the risk of permanent renal damage and improve patient's quality of life[27].

COMPLICATIONS

Untreated or ineffectively treated neurogenic bladder dysfunctions may lead to multiple complications. The patients are at an increased risk of urine retention and hydronephrosis, vesicoureteral reflux, renal failure, urinary tract infections, sexual dysfunctions, including infertility as well as bladder and urethral damage. Urinary tract infections are particularly common in this group of patients[28]. The use of intermittent or permanent catheterisation, or suprapubic cystostomy to void the bladder increases the risk of infection[29]. Intermittent catheterisation is considered the gold standard for the management of voiding dysfunction and significantly reduces the risk of infection and formation of struvite and calcium-phosphate stones[30].

CONCLUSIONS

Neurogenic lower urinary tract dysfunctions are an interdisciplinary problem, and their effective treatment requires collaboration of specialists, particularly general practitioners, urologists, neurologists and physiotherapists, who will ensure proper rehabilitation of patients. Treatment implementation should be preceded by thorough diagnosis to determine the cause and the mechanism of lower urinary tract dysfunctions.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organisations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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