Practical Management of Neurogenic Bladder in the Spinal Cord Injured Patients

Spinal Kord Yaralanmalı Hastalarda Nörojenik Mesaneye Pratik Yaklaşım

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Summary

Neurogenic bladder is a highly prevalent dysfunction among the patients with spinal cord lesion. Past experiences have taught us that a strict management is necessary to prevent complications and also to lower the risk of a life-threatening development. Fortunately, during the recent decades it has become evident that risks can be controlled. This gained control stems from the increasing knowledge of neurophysiology and physiopathology, and also from the improvements that have been made in the utilization of certain diagnostic techniques and the usage of more efficient treatment modalities.
The way patients are handled during the first weeks following the occurrence of the primary lesion often determines the life-long outcome; meaning that basically overdistention of the bladder and infection have to be avoided with a correct bladder drainage approach. Furthermore, urodynamic tests are needed, during this period, to determine the activity and coordination of different parts of lower urinary tract (LUT). Intermittent catheterization/self catheterization is the method of choice in the instances where a low pressure reservoir is practically obtainable. However, suprapubic tapping to elicit a reflex bladder contraction, and Valsalva/Crédé manoeuvres to hasten the bladder emptying, should only be used in selected patients. Additional pharmacologic management consists mostly of bladder relaxant drugs. Electrical devices have specific but rare indications. Surgical interventions on the LUT are second level treatments that can only be indicated in certain patients. Indwelling catheters should always be avoided; nevertheless could be the only solution in certain patients. Moreover, external appliances can limit the negative effects of incontinence. *Turk J Phys Med Rehab 2005;51(Suppl B):B1-B7*
Key Words: Neurogenic bladder, spinal cord injury

Özet

Nörojenik mesane spinal kord yaralanmalı hastalarda oldukça sık görülen bir fonksiyon bozukluğudur. Geçmişteki deneyimler bize, komplikasyonların engellenmesi ve hayati tehlike oluşturacak risklerin azaltılmasında, sıkı bir yaklaşımın gerekli olduğunu göstermiştir. Son dekatlarda bu risklerin kontrol altına alınabildiğini görmek mutluluk verici olmuştur. Bu kazanılmış kontrol, artan nörofizyoloji ve fizyopatoloji bilgisinden, belirli tanısal tekniklerin kullanımındaki gelişmelerden ve daha etkili tedavi modalitelerinin kullanımından kaynaklanmaktadır.
Birincil lezyonun gelişimini izleyen ilk haftalarda hastaların ele alınış biçimi sıklıkla ulaşılacak yaşam boyu sondurumu belirlemektedir. Bunun temel anlamı, doğru bir mesane boşaltımı yaklaşımı ile mesanenin aşırı genişlemesi ve enfeksiyondan kaçınılması gerektiğidir. Ayrıca, bu dönemde alt üriner sistemin (AÜS) değişik bölümlerinin aktivitesini ve koordinasyonunu belirlemek için ürodinamik testler gereklidir. İntermittan kateterizasyon/kendi kendine kateterizasyon, düşük basınçlı bir rezervuar pratik olarak elde edilebiliyorsa seçilecek yöntemdir. Ancak, refleks mesane kontraksiyonu elde etmek için suprapubik vurma ve mesane boşalımını hızlandırmak için Valsalva/Crede manevraları sadece seçilmiş hastalarda uygulanmalıdır. Ek farmakolojik tedavi çoğu zaman, mesaneyi gevşeten ilaçlardan oluşmaktadır. Elektriksel cihazların ise, özgül ancak nadir endikasyonları vardır. AÜS üzerindeki cerrahi girişimler ikinci aşama tedavileridir ve ancak belirli hastalarda endike olabilirler. Kalıcı kateterlerden her zaman kaçınılmalıdır; yine de, bazı hastalarda tek çözüm olabilirler. Bunlara ek olarak, eksternal uygulamalar inkontinansın olumsuz etkilerini sınırlayabilmektedir. *Türk Fiz Tıp Rehab Derg 2005;51(Özel Ek B):B1-B7*
Anahtar Kelimeler: Nörojenik mesane, spinal kord yaralanması

Introduction

The innervation patterns of the lower urinary tract (LUT) are both interesting and difficult parts of the present knowledge of pathophysiology regarding patients with spinal cord lesion (SCL). The fact that it depends upon combined activities of autonomic and somatic nerves is both important and elaborate. Being under central control makes "voluntary" working of a mostly "autonomic" system possible in normal conditions, and yields adaptability to daily living. This functi-

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on is, however, greatly distorted after SCL. The increasing knowledge of neurotransmitters, of the afferent system, and of neuroplasticity improves our understanding of the grey zones. The advances in diagnostics and in treatment modalities are creating a much more favourable medium for the patient and her/his treating physician. All these advances and all the energy derived from them have dramatically improved the life expectancy of patients with the LUT problems of neorological origin. But, there is still a lot of work to be done.

Overview of Actual Knowledge of the Neurophysiology of the LUT

The innervation pattern of the lower urinary tract is manifold. Sympathetic, parasympathetic, and somatic nerves are involved. Neuropharmacological studies and studies on receptors and transmitters have presented an incomplete but easy to use scheme for daily practice.

The innervation of the LUT relies on both sensory and motor nerves. The sensory system is comprised mainly of free nerve endings in the bladder wall and also of receptors which are linked to at least two types of nerve fibres: A-delta and several types of C fibres, some of which become active only when there is neuropathy.

Three peripheral nerves are involved in the innervation of the LUT:

- The hypogastric nerve with its medullar location at T12-L1 level is involved in the first sensation of filling and the orthosympathetic innervation;
- The pelvic nerve, originating at medullar S2-S4 levels, which is involved in the first desire to void and the parasympathetic innervation;
- The pudendal nerve, originating from S3-S5 levels, is involved in the sensation of bladder fullness "strong desire to void", the voluntary activity of the pelvic floor muscles, and the external striated sphincter as part of it.

A special distribution of neuroreceptors in the LUT has been described (1) (Table 1).

This has yielded in the acceptance of the autonomic nervous system as the main system involved in bladder filling and the parasympathetic nervous system as the main system involved in micturition. Apart from the cholinergic and adrenergic systems, the nonadrenergic and noncholinergic systems have also been shown to play a predominant role.

The higher neurological system related to the LUT function has several pathways in the spinal cord, the brainstem, and the brain. This schematic overview is far from complete, concerning the actual knowledge, yet it is not intended to be so. It aims to give data that permits an easy understanding and applicability of the knowledge to daily practice. It becomes clear that a neurological lesion can cause great disturbance in the LUT functions.

Overview of Neuropathy of the LUT

If the innervation of the LUT is disrupted the detrusor, the urethra, and the sphincter are affected. More often than not, the lesion is combined.

The goals of neuro-urological approach after spinal cord lesion are twofold: firstly, to prevent deterioration of the kidneys which in the end permits the patient to survive and secondly, to permit a good bladder management to limit urologic symptoms and complications which is equal to a good quality of life.

For centuries, renal failure from upper tract obstruction and/or uro-sepsis has been the primary causes of mortality among the spinal cord injured. During the last 5 decades a gradual improvement has been made and this process is still going on (2,3). The percentage of uro-renal mortality has decreased since 1961 from 50% to 15% in 1983 (4). The increased risk of renal failure has further come down in recent years and was described in 1997 as 3.5 times higher in the paraplegic than in the general population (5).

One does not have to speculate on the causes of this favourable evolution. It can be easily attributed to the better knowledge, the better diagnostic means, and the better treatment incorporated more appropriately in the general management of these patients. Overall, this good evolution is the result of hard conscientious work and if such approach were interrupted the involution back to a high uro-renal morbidity would be unavoidable and prompt.

The general principles of the management actually are clear:

- The status of the upper urinary tract depends greatly on the function of the lower urinary tract;
- Pressure in the urinary canals and bladder is of utmost importance during filling as well as during voiding;
- Regular complete emptying is needed for the prevention of infection and to secure continence;
- Treatment needs to be optimally designed from day one;
- If the patient does not have any infection nor any incontinence there is not proof that the urodynamic situation would be safe.

LUT During the Spinal Shock

During the spinal shock period the structures in the LUT are in an areflexic state but the bladder keeps its tone. To avoid overdistention, regular drainage of the bladder is necessary. This have to be done with an indwelling catheter, either transurethral or suprapubic, until the vascular balance has been restored. No clamping is done as diuresis can show large variations. It is best not to leave a catheter in the bladder for a too long time. The shift into intermittent catheterization can be done within weeks. We compared the results in 25 paraplegic patients (23 men and 2 women) started on clean intermittent self catheterization (CISC) at a mean of 35 days (7 to 85+ days) post trauma with those in 48 paraplegic patients

Table 1: Distribution of neuroreceptors in the LUT (1)

Receptor	Location	Neurotransmittor	Function
Alpha	Bladder neck	Noradrenaline	Closing bladder neck
Beta	Bladder wall	Noradrenaline	Relaxing bladder
Muscarinic	Bladder wall	Acetylcholine	Contracting bladder

catheterized by nurses with a non-touch technique and found comparable results in the final outcome of the bladder training, and infection rate (6). Early self catheterization permitted to go home for weekends earlier and was considered positive by the majority of those participating.

Using indwelling catheters makes the prevention of complications possible.

Infection prevention is possible by mental care, use of closed drainage system with no unindicated rinsing, valve against reflux in urinary collecting bag, distal drain opening in bag, and a broad and long connecting tube. For suprapubic catheters a closed drainage system, covered punction area, and no rinse unless indicated are prevention rules.

One must realize that infection prevention can be successful only at times. The infection rate of indwelling catheters is 5% per day. With intermittent catheterization, several weeks' infection free is possible.

Diagnosis of Neurogenic LUT

As always is the case, the patient history is an essential part of the diagnosis. Date and level of lesion and previous medical histories are important data.

The special history includes a complete questioning about the general neurological, the specific somatic and sensory, urinary, anorectic, sexual, gynaecological symptoms and signs.

Sensations normally elicited with bladder filling have to be asked. Autonomic dysreflexia has to be investigated if a spinal lesion above T6 has occurred. The way bladder emptying has been done so far, the eventual presence of incontinence, and any usage of catheter or appliances are important.

Bowel history and sexual history can give important information concerning the neurological status.

A frequency/volume chart gives objective information on the frequency of emptying and the distribution of volumes between daytime and nighttime. It can also register the time urine has been lost and urgency has been felt.

The clinical examination has a general and a specific part. The general examination includes an appreciation of the motor and sensory functions of the body, the limbs, the hand function, and the mental capability. It also includes an examination of the genitals, the prostate, the search for a suprapubic globe, and an appreciation of the skin in the genital and perineal region. The specific clinical neurological examination is mandatory and includes several tests for sacral reflex activity and an evaluation of the sensation in the perineal area. The sensation of touch may be tested in different dermatomes.

The external sphincter tone is usually assessed by the perceived resistance imposed by the muscle upon the entering finger.

Volitional contraction and relaxation of the anal sphincter by digital examination indicates presence of control by suprapubic centres. Volitional contraction and relaxation of the other pelvic floor muscles (urethral sphincter, levator ani) can be helpful to test the function of these structures and the eventual therapeutical possibilities for pelvic floor physiotherapy.

The classical bulbocavernosus reflex test consists of a perineally palpated contraction of the bulbo-and ischiocavernosus muscles in a response to squeezing the glans penis/the clitoris.

The contraction of the external rectal sphincter in response to deep inspiration or to coughing i.e., the cough reflex, is a spinal reflex which depends on the volitional innervation of the abdominal musculature extending from the T6 to L1 levels.

The anal reflex consists of a visible external rectal sphincter response to perineal skin stimulation by pinprick or touch.

These combined basic urological data can give an estimation of completeness of the lesion, and of the detrusor and sphincter functions in up to 80% (7). It has also become clear that this data gives partly unreliable data on the preservation of the sensory function in the LUT (8). In this respect the excellent ASIA scoring system needs adaptation.

Data gathered from clinical observation are also important: incontinence episodes by involuntary voiding, leakage while moving, smelly urine, fever or other signs of infection, swelling in lower abdomen (globe), evaluation of small stone, and other situations need attention.

Urodynamic testing must be mandatory and should be implemented into routine investigations. It will permit a proper diagnosis of functional problems in all parts of the lower urinary tract in the individual patients. It will show the urodynamic situation, if this situation is safe or potentially dangerous, and will indicate optimal ways to treat.

The first test can be done within a couple of weeks after trauma, as it has been shown that most patients will have developed already their final bladder state and sphincter activity by that time.

The evaluation of the upper tract should be part of the management as well. Figure 1 gives the most prevalent types of neurogenic bladder as described by Madersbacher (9).

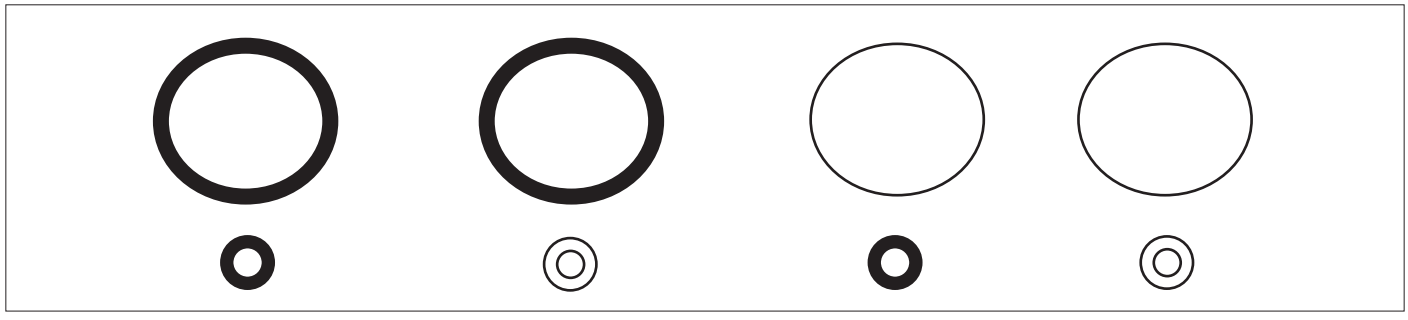

Figure 1: The most prevalent types of neurologic bladder as described by Madersbacher. Heavy lines represent hyperreflexic, thin lines hypo-/areflexic structures. On top the detrusor, on the bottom line the sphincter

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Apart from these types activity of the bladder neck must also be evaluated. Sensation can be either present or absent and should be evaluated specifically (8) as it can be important for the treatment outcome (10).

Another way of describing the neurogenic bladder is by giving a summary of all known urodynamic data, including those from a clinical examination, neurological testing, and radiological investigation.

Such a diagnosis can yield the following:

Detrusor: hyperactive (unstable or hyperreflexic), hypoactive, areflexic, or normal;

Compliance: normal, low, or high;

Bladder neck: normal, open during filling, closed, or even contracting during micturition (dyssynergia);

Striated sphincter: normal, unstable, acontractile, hyporeflexic, or dyssynergic;

Sensation of filling: normal, absent, hyposensitive, or hypersensitive;

Neurological lesion of the spinal cord: complete, or incomplete;

Radiological: vesicoureteral reflux, bladder trabeculation and diverticula, inflow in prostate gland, and more.

Urodynamic tests should be repeated if development in the state of the LUT is sought, or if treatment needs to be re-evaluated (11). It should also be part of the follow up in the long-term management.

Post-shock Treatment

The therapeutic modalities and techniques are well described: Triggered voiding, bladder expression/Valsalva, intermittent catheterization, pharmacological management, electrical stimulation, appliances, and indwelling catheter. All these methods will be discussed separately:

Triggered reflex voiding: The importance of this technique has decreased considerably though it can still be used in selected patients. The technique provokes bladder contraction mostly by suprapubic percussion, though different techniques are common such as squeezing the penis, pulling on the crines pubis, anal/rectal manipulation. A mass reflex will occur if the triggering is successful. To avoid simultaneous sphincter contraction tapping is best to be stopped as soon as micturition starts. Adjunctive measures may be needed to decrease outflow resistance, or to counteract too excessive bladder spasticity. The most appropriate patient for this technique is the one having a synergic sphincter, an easy-triggered bladder contraction, not too high a pressure during contraction, a long enough contraction to permit proper emptying, and no incontinence between voids. However, these criteria are generally difficult to meet by any patient. Most studies have described high rates of complications (12). The technique must be considered as harmful and as indicated only in very selected patients (13).

Bladder expression: This technique comprises various manoeuvres to increase the intravesical pressure in order to empty the bladder as Valsalva and Crédé. It is seldomly indicated. It may be harmful as frequently high pressures are needed because of outflow obstruction through sphincter activity, kinking of the urethra etc. If evacuation is easy, presence of incontinence between voids must usually be accepted. Its value is very limited (14).

Intermittent catheterization (IC) and intermittent self-catheterization (ISC): The main aims of IC and ISC are to empty the bladder and to prevent bladder overdistention in order to avoid complications and to improve urological conditions. Many studies showed good results in achieving continence with less complications leading to a better prognosis and a better quality of life in many patients with neurogenic bladder (15-17).

IC and ISC have recently been considered as the methods of choice for the management of neurogenic bladder dysfunction. The good candidate would have a good capacity bladder (300-500 ml), a low pressure bladder (<40 cm H_2O), and sufficient resistance in the urethra present spontaneously or created by therapeutic interventions. Bad candidates would have a small capacity bladder which needs too frequent catheterization, high pressures in bladder during filling, severe incontinence between catheterizations, urethral obstruction that makes introduction of a catheter difficult, and infravesical infection. Additional prerequisites are an easy to reach meatus, sufficient hand function or availability of a third person, good psychological/mental condition to take own responsibility for the IC, and financial resources.

a) Materials: Many types of catheters can be successfully used. The choice depends on the availability and on the cost. Also the material can be of importance if any allergic reaction exists (latex). Most catheters need a separate lubricant; some are hydrophilic and self lubricated after immersing in water. For those with preserved urethral sensation, a local anaesthetic jelly may be needed. Size 10-14 Fr for males and 14-16 for females are preferable but bigger sizes/lumen might be necessary if urine is very cloudy as it would be after bladder augmentation.

b) Techniques: Several techniques are used: Sterile IC is seldom applied except in the hospital environment. Most preferred methods are clean IC by a third person, intermittent self catheterization (ISC) and clean ISC (CISC).

c) Patient education: If a decision is made to manage with IC or ISC then the patient education would be of utmost importance. She/he should learn the technique properly and should be able to negotiate specific questions or problems encountered to her/his physician or nurse (18). It goes without saying that these care givers must themselves be properly and sufficiently trained.

The principles of good catheterization should be used hence atraumatic and with necessary precautions to prevent infection.

To be atraumatic the catheterization has

1. To be done with a normal size catheter (12 to 16 Fr);
2. With a good quantity and type of lubricant;
3. With a good and gentle handling of the catheter.

To prevent infection

1. Hands should be cleaned;
2. If possible, the meatus should be cleaned;
3. A clean and preferably sterile or re-sterilized catheter should be used;
4. The catheter must be handled in a way to keep it clean;
5. The bladder has to be emptied completely by pulling the catheter out slowly while Valsalva is done. Blocking of the catheter when outflow stops will prevent air inflow or urine backflow;

6. Catheterization as frequent as 4-6 times a day has been proved to be optimal (19).

Each catheterization should follow the same routine: clean hands, prepare the material needed, clean the meatal region, apply lubrication, and insert the catheter without touching directly the part which goes into the body. Most women would need no lubrication of the catheter. Furthermore, ISC can be done in any position.

If resources are limited, catheters can be reused for a long time with cleaning and proper storage techniques between catheterizations.

IC and ISC are very good techniques but complications can occur and should be looked for:

- Urinary tract infection: in patients on chronic ISC a prevalence of 13.6 infections per 1,000 patient-days on ISC has been found (20).

- Genito-urinary complications as urethritis and epididymo-orchitis are rare. Prostatitis is probably underestimated and is thought to have a prevalence around 5% to 18% (21).

- Urethral bleeding is encountered in more than 30%. False passage, meatitis and meatal stenosis are rare complications. Urethral strictures in male patients increase in prevalence with longer follow-up (21). Urethral trauma will occur in 30-40% of the patients in the long run. False passages can be successfully treated with a 6-week period of indwelling catheter (22).

IC and ISC are seldom used solely. Their concurrent use with drugs can help overcome incontinence and recurrent infections.

Pharmacological treatment

Most drugs used are bladder relaxant drugs. Oxybutinin, orally or intravesically, propiverine, trospium, tolterodine, propantheline, solifenacine, oxyphencyclimine, tricyclic antidepressants have all been studied with the aim to gain control over the neurogenic detrusor overactivity. They are similar in terms of their success ratios but can differ in terms of side effects. In patients with a neurological lesion an aggravation of constipation has to been evaluated as well as central nervous system side effects. The drugs with favourable effects would basically be a symptomatic one and should be continued as the treatment of choice. The fact that responsiveness to one drug may seem to have decreased after a certain period of time necessitating a change to another one is not a rare condition. In recent years, the use of botulinum toxin has been documented both for sphincter spasticity and detrusor sphincter dyssynergia as for detrusor over activity (23,24). Its long-term use has to be documented, as the effect on LUT is not permanent. Adverse effects, such as general pareses, have been demonstrated to comprise only a low percentage of those treated (25).

Alpha-blockers have been reported to be useful in neurogenic bladder by decreasing urethral resistance during voiding. However, there is a limited number of studies in patients with spinal cord lesion (26).

Electrical stimulation

Two techniques have stood the test of time: intravesical electrostimulation and sacral anterior root stimulator.

The intravesical electrostimulation (IVES) conceptually has proved to be correct in basic research during the last decade. Results in literature however are controversial. Intravesical electrotherapy is able to alter neurogenic bladder dysfunction by inducing bladder sensation and the urge to void, and consequently increasing the efferent output with improvement of micturition and conscious control. IVES is the only available option to induce/improve bladder sensation and to enhance the micturition reflex in patients with incomplete central or peripheral nerve damage. Correct selection of patients is crucial and IVES should be applied only if afferent fibers between the bladder and the cortex are still intact and also if the detrusor muscle is still able to contract. If these premises are respected, IVES would be effective. The ideal indication would actually be the neurogenic hyposensitive and hypocontractile detrusor (27). This method has widely been used in meningomyelocele patients.

Sacral anterior root stimulation: Sacral anterior root stimulation combined with posterior rhizotomy is a valuable method to restore bladder function in selected spinal cord injury patients suffering from neurogenic detrusor overactivity refractory to medical treatment. A problem is the simultaneous contraction of the external sphincter and several studies are being made to try and overcome this (28,29).

Appliances

Condom catheters still have a role in controlling urinary incontinence of neurological origin in male patients. However, their long-term use may cause bacteriuria, but it does not increase the risk of urinary tract infection when compared to other methods of bladder management. Complications may be less if applied properly with good hygiene care, frequent change of the condom, and maintenance of low bladder pressures (30).

Indwelling catheters (ID)

Transurethral ID is not a safe method for long-term use in patients with neurogenic bladder. However, sometimes it is the only solution as it would be in the patients who are unable to perform self-catheterization, and in those who have uncontrollable incontinence. Female patients with high lesions sometimes may need this type of treatment. In order to control urinary incontinence, ID is effective in the absence of no blockade or urethral/bladder neck erosion.

Catheter size 12-16 F with as large a lumen as possible and smaller (5-10 ml) self-retaining balloons is recommended for adults to minimize the pressure effect on the bladder neck and to maximize time for blockage to occur due to incrustation.

Suprapubic catheters (SC) are not recommended either as a safe method for long-term use in patients with neurogenic problems. Long term complications can be decreased with less irritating catheter materials, improved closed drainage systems, and regular urological check-ups. Nevertheless, SC is still the last resort when other methods fail, are not applicable, or are not accepted by the patient. One should consider patient comfort, convenience, sexuality, and quality of life before prescribing SC as a long-term management for SCL patients (31).

Surgery (31)

Surgery is usually indicated only after all conservative measures have been attempted and have proved to be ineffective.

To lower external sphincter spasticity sphinterotomy can be done transurethrally. Intraurethral stents can be placed but long-term results do seem doubtful so far.

Enterocystoplasty has been proved to be reliable after many years of application to create a low-pressure reservoir. However, complications are not rare, nor are the need for re-intervention. Auto-augmentation has also been used by some with some reported success.

Rhizotomy has been used in many patients when a Brindley implant was done.

Increasing urethral resistance is possible only in patients who have a good bladder capacity and accommodation or pharmacologically controlled hyperreflexia. Otherwise, when planning to increase the urethral resistance in these patients, bladder augmentation procedure should be considered.

The implantation of an artificial urinary sphincter has gained much popularity and has actually passed the test of the time. As an alternative to the artificial sphincter a sling procedure might be used, if the patient can perform intermittent catheterization. Dynamic myoplasty appears promising although a cost-efficiency analysis needs to be done. Intraurethral valves need to be evaluated with longer follow ups before they can be accepted. Bulking substances, on the other hand, may play a limited role in the treatment of neurogenic sphincter deficiency.

Although less frequently used, after failure of more conservative treatment, continent or incontinent urinary diversion is an acceptable treatment option in selected cases.

Complication Management

Urinary infection:

In the early stages of the disease the problem of urinary infection is mainly related to catheterization. However, in the later phases of the process the problems related to the neurological deficit comes on top of the catheter problems.

Most patients that are admitted to the hospital after a spinal cord lesion do not have any infection of the urinary tract. The preventive measures to limit the risk of infection have already been explained above.

During the rehabilitation process the risk of infection will depend on the preventive measures taken to control the pattern of bladder emptying, the presence of it, or usage of any catheter. Also, the natural defence mechanisms against infection will come into play i.e., the GAG layer in the bladder, the diuresis, the frequency of emptying, and the completeness of emptying.

Most physicians would advocate controlling the urine regularly: weekly during the spinal shock, every week or every fortnight during the rehabilitation, 4-6 times a year during the follow up period, and at any time necessary if infection is suspected.

There is little doubt about the diagnosis of infection in most cases: pyuria and bacteriuria will be clearly present. During use of indwelling catheters no treatment is given unless there arises a symptom. In cases displaying symptoms of infection, 5-7 days of antibiotic therapy should be attempted. In periods of intermittent catheterization, if pyuria is present with no bacteriuria and there is no suspicion of a specific infection agent (TBC) no treatment is needed. A state of bacteriuria without pyuria follows the same rule of management. During the chronic stage, when repeated infections occur with symptoms in a patient who performs IC, prevention can be accomplished with low doses of antibacterial drugs for a few weeks. The use of cranberries seems promising but needs more documentation. Acidification of the urine has been used for years, but bears the risk of calciuria. Here again, the individual experience during the management of each patient will guide the therapeutic approach (32).

Vesico-ureteral reflux:

Deficiency of the uretero-vesical valve is in most patients related to LUT pressure, infection and, trabeculation. Prevention is the most important rule. If a reflux does develop then the causative mechanisms should be treated if possible. In rare cases anti-reflux surgery may be indicated (33).

Low compliance bladder:

A disturbed ratio of pressure/volume in the LUT can be caused by many factors such as fibrosis of the wall, chronic indwelling catheter, chronic infection, heavy trabeculation, severe neurogenic over activity, severe chronic incontinence, and several above factors interrelated together.

A disturbed ratio of pressure/volume can occur in spastic and in flaccid neurogenic disturbances. It necessitates the measuring as part of the urodynamic diagnosis and the follow up.

In cases of recent and limited disturbance, infection treatment, bladder relaxing drugs, and treatment of other causative mechanisms should be considered. It would be a wiser approach to do follow-ups urodynamically after a couple of weeks of successful treatment. Surgery is needed if a chronic situation is persistent and proves to be resistant to conservative treatments.

Conclusion

Management of patients with neurogenic bladder after spinal cord injury has gone through a tremendous evolution through better knowledge and better understanding of the situation. Treatment must always be tailored for the individual and should aim a making a patient dry, with complete emptying of a low pressure bladder in a way that would permit to avoid complications and allow a good prognosis.

References

1. Elbadawi A, Schenk EA. A new theory of the innervation of bladder musculature. 2. The innervation apparatus of the ureterovesical junction. J Urol 1971;105(3):368-71.
2. Damanski M, Gibbon N. The upper urinary tracts in the paraplegic: a long-term survey. Br J Urol 1956;28(1):24-36.
3. Tribe CR. Causes of death in the early and late stages of paraplegia. Paraplegia 1963;104:19-47.
4. Selzman AA, Hampel N. Urologic complications of spinal cord injury. Urol Clin North Am 1993;20(3):453-64.
5. Lawrenson R, Wyndaele JJ, Vlachonikolis I, Farmer C, Glickman S. Renal failure in patients with neurogenic lower urinary tract dysfunction. Neuroepidemiology 2001;20(2):138-43.
6. Wyndaele JJ, De Taeye N. Early intermittent self-catheterisation after spinal cord injury. Paraplegia 1990;28(2):76-80.
7. Wyndaele JJ. Correlation between clinical neurological data and urodynamic function in spinal cord injured patients. Spinal Cord 1997;35(4):213-6.
8. Wyndaele JJ. Investigation of the afferent nerves of the lower urinary tract in patients with 'complete' and 'incomplete' spinal cord injury. Paraplegia 1991;29(7):490-4.
9. Madersbacher HG. Neurogenic bladder dysfunction. Curr Opin Urol 1999;9(4):303-7.
10. Ersoz M, Akyuz M. Bladder-filling sensation in patients with spinal cord injury and the potential for sensation-dependent bladder emptying. Spinal Cord 2004;42(2):110-6.

11. Wyndaele JJ. A critical review of urodynamic investigations in spinal cord injury patients. Paraplegia 1984;22(3):138-44.
12. Kuhlemeier KV, Lloyd LK, Stover SL. Long-term followup of renal function after spinal cord injury. J Urol 1985;134(3):510-3.
13. Gerridzen RG, Thijssen AM, Dehoux E. Risk factors for upper tract deterioration in chronic spinal cord injury patients. J Urol 1992;147(2):416-8.
14. Madersbacher H, Wyndaele JJ, Igawa Y, Chartier-Kastler E, Fall M, Kovindha A, et al. Conservative management in the neuropathic patient. In: Abrams P, Khoury S, Wein A, editors. Incontinence. Paris: Health Publications; 1999. p. 775-812.
15. Sutton G, Shah S, Hill V. Clean intermittent self-catheterisation for quadriplegic patients-a five year follow-up. Paraplegia 1991;29(8):542-9.
16. Maynard FM, Diokno AC. Clean intermittent catheterization for spinal cord injury patients. J Urol 1982;128(3):477-80.
17. Diokno AC, Sonda LP, Hollander JB, Lapides J. Fate of patients started on clean intermittent self-catheterization therapy 10 years ago. J Urol 1983;129(6):1120-2.
18. Parmar S, Baltej S, Vaidyanathan S. Teaching the procedure of clean intermittent catheterisation. Paraplegia 1993;31(5):298-302.
19. Anderson RU. Prophylaxis of bacteriuria during intermittent catheterization of the acute neurogenic bladder. J Urol 1980;123(3):364-6.
20. Perkash I, Giroux J. Clean intermittent catheterization in spinal cord injury patients: a followup study. J Urol 1993;149(5):1068-71.
21. Wyndaele JJ, Maes D. Clean intermittent self-catheterization: a 12-year followup. J Urol 1990;143(5):906-8.
22. Michielsen DP, Wyndaele JJ. Management of false passages in patients practising clean intermittent self catheterisation. Spinal Cord 1999;37(3):201-3.
23. Dykstra DD, Sidi AA, Scott AB, Pagel JM, Goldish GD. Effects of botulinum A toxin on detrusor-sphincter dyssynergia in spinal cord injury patients. J Urol 1988;139(5):919-22.
24. 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(3 Pt 1):692-7.
25. Wyndaele JJ, Van Dromme SA. Muscular weakness as side effect of botulinum toxin injection for neurogenic detrusor overactivity. Spinal Cord 2002;40(11):599-600.
26. Abrams P, Amarenco G, Bakke A, Buczynski A, Castro-Diaz D, Harrison S, et al. Tamsulosin: efficacy and safety in patients with neurogenic lower urinary tract dysfunction due to suprasacral spinal cord injury. J Urol 2003;170(4 Pt 1):1242-51.
27. Ebner A, Jiang C, Lindstrom S. Intravesical electrical stimulation-an experimental analysis of the mechanism of action. J Urol 1992;148(3):920-4.
28. Brindley GS. The first 500 sacral anterior root stimulators: implant failures and their repair. Paraplegia 1995;33(1):5-9.
29. Kirkham AP, Knight SL, Craggs MD, Casey AT, Shah PJ. Neuromodulation through sacral nerve roots 2 to 4 with a Finetech-Brindley sacral posterior and anterior root stimulator. Spinal Cord 2002;40(6):272-81.
30. Newman E, Price M. External catheters: hazards and benefits of their use by men with spinal cord lesions. Arch Phys Med Rehabil 1985;66(5):310-3.
31. Wyndaele JJ, Castro D, Madersbacher H, Igawa Y, Kovindha A, Pradzeiszewski P, et al. Neurologic urinary incontinence and faecal incontinence. In: Abrams P, Cardozo L, Khoury S, Wien A, editors. Incontinence. Paris: Health Publications; 2005. p. 1059-162.
32. Biering-Sorensen F. Urinary tract infection in individuals with spinal cord lesion. Curr Opin Urol 2002;12(1):45-9.
33. Lamid S. Long-term follow-up of spinal cord injury patients with vesicoureteral reflux. Paraplegia 1988;26(1):27-34.