Turk J Phys Med Rehab 2022;68(2):278-285
DOI: 10.5606/tftrd.2022.7719
Available online at www.turkishjournalpmr.com

Original Article

Urinary system complications and long-term treatment compliance in chronic traumatic spinal cord injury patients with neurogenic lower urinary tract dysfunction

Çağlayan Dere[1], Didem Dere[2], Nurdan Paker[2], Derya Buğdaycı Soy[2], Sedef Ersoy[2]

[1]Department of Physical Medicine and Rehabilitation, Kocaeli Darıca Farabi Traning Hospital, Kocaeli, Türkiye
[2]Department of Physical Medicine and Rehabilitation, Istanbul Physical Medicine and Rehabilitation Training and Research Hospital, Istanbul, Türkiye

Received: February 27, 2021 **Accepted:** July 29, 2021 **Published online:** June 01, 2022

ABSTRACT

Objectives: The aim of this study was to evaluate upper and lower urinary tract complications and the compliance of long-term treatment in patients with spinal cord injury (SCI) by urodynamic examination.

Patients and methods: Between January 1997 and May 2007, a total of 89 patients with SCI (79 males, 19 females; mean age: 39.8±12.2 years; range, 19 to 72 years) who were admitted to physical medicine and rehabilitation clinic were retrospectively analyzed. Demographic, neurological, and urodynamic data of the patients with the diagnosis of neurogenic lower urinary tract dysfunction (NLUTD) in their initial urodynamic examination and without regular follow-up were recorded.

Results: The mean time to the first urodynamic examination was 8.6±5.4 months. Sixty-seven patients who had neurogenic detrusor overactivity (NDO) in their first urodynamic tests were recommended anticholinergics. Clean intermittent catheterization (CIC) was recommended after initial urodynamic examination in all patients. Thirty-nine patients of 67 who had NDO were taking medications, while 28 were not. In the patients who continued anticholinergic treatment, bladder capacity was found to statistically significantly increase, compared to the initial measurement values and detrusor pressures significantly decreased ($p<0.001$). The compliance rate with CIC and anticholinergic treatment was 79.8% and 58.2%, respectively. Sixteen of the patients had calculus in the urinary system. Forty-two patients had infections more than once a year and used antibiotics.

Conclusion: Neurogenic bladder should be evaluated at the beginning of SCI and, then, followed on a regular basis. Urodynamic tests should be performed immediately after spinal shock and can be repeated, as indicated.

Keywords: Neurogenic bladder, spinal cord injury, urinary incontinence, urodynamics.

Annual incidence of spinal cord injury (SCI) in Türkiye has been reported to be 12.7 per million population.[1] Neurogenic lower urinary tract dysfunction (NLUTD) is an important problem in people experiencing traumatic SCI (TSCI). Neurogenic lower urinary tract dysfunction can cause vesicourethral reflux (VUR), hydronephrosis and, consequently, chronic kidney failure.[2] Increasing the bladder storage capacity, using appropriate urinary excretion methods, and preventing complications also improve the quality of life of patients with TSCI.[3,4] It is important to identify NLUTD in patients with TSCI. Even if there is a relationship between injury level and NLUTD, different disorders are observed, particularly in cases where supra-sacral and sacral lesions coexist.[5,6] Therefore, video urodynamics

Corresponding author: Didem Dere, MD. Kocaeli Darıca Farabi Hastanesi Fizik Tedavi ve Rehabilitasyon Kliniği, 41700 Darıca, Kocaeli, Türkiye.
e-mail: caglayandr@hotmail.com

Cite this article as:
Dere Ç, Dere D, Paker N, Buğdaycı Soy D, Ersoy S. Urinary system complications and long-term treatment compliance in chronic traumatic spinal cord injury patients with neurogenic lower urinary tract dysfunction. Turk J Phys Med Rehab 2022;68(2):278-285.

(VUD) are used in addition to clinical examination in the evaluation of the urinary system in patients with TSCI.[7] Urodynamic estimations are useful to determine bladder type, evaluate sphincter function, and assess pressure measurements. The VUD findings have a predictive value to detect complications that may develop in the upper urinary system in the early period.[8] Urodynamic examination is recommended at regular intervals to protect the upper urinary system and evaluate continence.[8,9]

Conservative or surgical methods are used in the treatment of NLUTD. Oral anticholinergics are the most commonly used drugs to decrease detrusor pressure and increase bladder capacity. Clean intermittent catheterization (CIC) is recommended, as it has less complications as the excretion method.[10,11] Urinary infection rates of early CIC patients are lower than indwelling catheter (IC) use.[12] During long-term follow-up of patients with CIC, the transition from CIC to IC has been reported.[13]

In the present study, we aimed to evaluate the rates of receiving CIC and medical treatment, to assess urinary tract complications and to highlight the importance of regular follow-up for patients with chronic TSCI who do not attend to regular control visits.

PATIENTS AND METHODS

This single center, retrospective study was conducted at University of Health Sciences Istanbul Physical Medicine and Rehabilitation Training and Research Hospital, Department of Physical Medicine and Rehabilitation outpatient clinic between January 1st, 1997 and May 31st, 2007. A total of 89 patients (79 males, 19 females; mean age: 39.8±12.2 years; range, 19 to 72 years) with TSCI and with NLUTD who did not regularly attend to urological follow-up visits were included. The physical and urodynamic examination results, and laboratory findings were obtained retrospectively from the patient files. Patients aged <18 years, having non-traumatic SCI, having concomitant head trauma, or those who had spinal cord surgery or any other injury after discharge were excluded from the study. The patients who did not attend to the annual control visit were invited for follow-up by phone call.

Demographic and injury-related features, urological features, bladder excretory method, permanent urethral catheter duration, examination findings, urodynamic examination and laboratory values were filled from the patients' records. Information about excretion method change, number of infections and antibiotic use, anticholinergic drug use and urine leakage were noted during the follow-up visit. The American Spinal Cord Injury Association (ASIA) Impairment Scale (AIS) was used for the severity of neurological injury.[14] Urological operations were recorded.

Video urodynamic study was performed in accordance with the International Continence Association (ICS) criteria using the Laborie-Enchore UDS-600 (Laborie Medical Technologies Corp., Portsmouth, NH, USA) and MMS Solar (Solar Blue, Medical Measurement Systems, Dover, NH, USA) urodynamic devices while the patients were in the supine position.

Cystometry was performed using a 7F double-lumen catheter with a bladder filling rate of 20 mL per minute using saline and contrast agent at 37°C in the supine position. A 7F intrarectal catheter was used for abdominal pressure measurement. The bladder was filled and the first urine sensation (mL), non-inhibited detrusor contractions, bladder capacity (mL), compliance (mL/cmH_2O) values were recorded. Detrusor pressure was automatically calculated by computer with the formula Pdet = Pves-Pabd. The pelvic floor electromyography was performed using superficial electrodes. After reaching the maximum cystometric capacity, filling cystometry was terminated.

Detrusor overactivity was defined as an unintentional increase in detrusor pressure associated with sudden urine sensation and urinary incontinence, or an increase in pressure of 15 cmH_2O and above this without urine sensation. Bladder compliance was calculated in accordance with the standards recommended by the ICS. If the calculated value was <10 mL/cmH_2O, a diagnosis of hypocompliant bladder was made.[15] Acontractile detrusor (AD) was defined as no increase in detrusor pressure during urodynamic studies. The diagnosis of detrusor sphincter dyssynergia (DSD) was made by fluoroscopic view of the external sphincter area during the pressure increase in the detrusor. The VUR was the leakage to the ureter on the right and/or left side during urodynamic studies. Medical treatment compliance was defined as using the anticholinergics regularly. Compliance with CIC was evaluated by asking patients, their regular use at certain intervals without break from injury.

Statistical analysis

The study power analysis was performed using the G*Power version 3.1.9.4 software

(Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The effect size was calculated as 1.44. The study power was calculated as 0.99 for α=0.05.

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max), or number and frequency. In the comparison of quantitative data of urodynamic results between the groups, the independent samples t-test and Mann-Whitney U test were used. In the comparison of the results of the first and second urodynamic test, in-group paired sample t-test and Wilcoxon test were used. The chi-square test and Fisher's exact test were used to identify the significant relationship among categorical variables. The results were evaluated at 95% confidence interval (CI). P values of <0.05 and <0.001 were considered statistically significant.

RESULTS

The primary outcome of this study was the evaluation of the detrusor pressure. The mean decrease in the detrusor pressure was 47.7±42.5 cmH_2O in the patients who were using anticholinergics, whereas the mean change in the detrusor pressure was 5.2±29.9 cmH_2O in the patients who did not use anticholinergics. Demographic and clinical features of the patients are shown in Table 1. The mean time to initial urodynamic tests after injury was 8.6±5.4 months. The mean duration of IC use after injury was 3.9±3.2 months. The mean time to control urodynamic examination was 55.7±22.2 months. The first and second urodynamic findings are summarized in Table 2 and the diagnoses based on the urodynamic test results are summarized in Table 3.

In the first urodynamic examination, detrusor overactivity was detected in 69 (77.5%) patients, and AD in 20 (22.5%) patients. Ten (11.2%) of the patients with detrusor overactivity had DSD and five (5.6%) had VUR. Forty-five (50.6%) patients had hypocompliance and all of these patients had detrusor overactivity. After the first urodynamics, CIC was recommended to all patients. The patients with detrusor overactivity were given anticholinergic treatment. Serum urea

TABLE 1
Demographic and clinical characteristics of patients

Parameters	n	%	Mean±SD	Median	Min-Max
Age (year)			39.8±12.2		
Sex					
Female	19	21.3			
Male	70	78.7			
Disease duration (year)				6	3-29
Marital status					
Married	50	56.2			
Single	39	43.8			
Etiology					
Falls	40	44.9			
Motor vehicle accident	35	39.3			
Gunshot injury	14	15.7			
Neurological level					
Cervical injury	30	33.7			
Thoracic	47	52.8			
Lumbosacral	12	13.5			
Severity of the injury					
Complete (ASIA A)	48	53.9			
Incomplete (ASIA B-C-D)	41	46.1			
Level of lesion					
Tetraplegia	25	28.1			
Paraplegia	64	71.9			
Neurogenic bladder					
Detrusor overactivity	69	77.5			
Acontractile detrusor	20	22.5			

SD: Standard deviation; ASIA: American Spinal Cord Injury Association.

TABLE 2
Baseline and control urodynamic findings

	Baseline (First urodynamics)						Control (Second urodynamics)					
	Detrusor overactivity (n=69)			Acontractile detrusor (n=20)			Detrusor overactivity (n=62)			Acontractile detrusor (n=27)		
	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max
Bladder capacity (mL)	378.3±121	397	101-651	535±57.8	550	375-609	393±118	419	105-605	541±62	514	457-740
Detrusor pressure (cmH_2O)	77±37	73	21-184	12.6±3.9	13	5-22	58.9±24.8	60.5	16-130	10±8	8	3-52
Bladder compliance (mL/cmH_2O)	8.45±8.5	5.43	1-48	72.3±51.4	57.4	19-244	10±10	6.58	1-74	75±41	68.4	8-200

SD: Standard deviation.

TABLE 3
Initial and second urodynamic findings of patients with detrusor overactivity in the initial urodynamic test

	Initial urodynamic findings			Second urodynamic findings								
	Detrusor overactivity (n=67) (all recommended anticholinergi C treatment)			Anticholinergic treatment (n=39)				No Anticholinergic treatment (n=28)				
Urodynamic findings	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*	Mean±SD	Median	Min-Max	*p*	*p*
Bladder capacity (mL)	379±122	400	101-601	457±76.5	485	230-605	<0.001[1]	330±132	308.5	105-645	<0.001[2]	<0.001*
Detrusor pressure (cmH_2O)	76.6±37.7	72	21-184	42.4±19.5	43	7-79	<0.001[2]	73±27	74	6-130	=0.04[2]	<0.001**
Bladder compliance (mL/cmH_2O)	8.5±8.5	5.98	1-48	18.6±26.6	9.3	2.7-153.9	<0.001[1]	11.6±21.8	4.26	1-97	=0.01[1]	0.001*

SD: Standard deviation; [1] Willcoxon test; [2] Paired sample t-test, * Mann-Whitney U test, ** Independent samples t-test.

and creatinine levels of all patients were normal both at baseline and at control visit. Acontractile detrusor was found in seven patients, who had detrusor overactivity at baseline urodynamic tests, in the second urodynamic examination. Two of these patients underwent augmentation operation. Two patients who underwent augmentation operation were excluded from the statistical analysis.

In the second urodynamic tests, 15 (16.9%) patients had DSD and eight (9%) patients had VUR. Vesicourethral reflux was persistent in three of five patients who had VUR in their first urodynamic tests. In contrast, VUR was detected in five patients who did not have VUR previously. Forty-three (48.3%) patients had a hypocompliant bladder in the second urodynamic examination.

Although CIC was recommended to all patients after initial urodynamic evaluation, only 71 (79.8%) of 89 patients who attended to control examination continued to use CIC. Three of 18 patients were not on CIC anymore, instead they were using condom catheters. Four patients were emptying the bladder with an IC and 10 were using reflex voiding. One patient was using diapers. Twenty-three (25.8%) patients with leaks were using an auxiliary form of discharge. The most common additional methods were condom catheters and diapers. During follow-up, 18 (20.2%) patients changed the form of discharge and switched to another method. The bladder emptying methods changed more frequently in women. Moreover, the bladder emptying methods were found to be significantly different in the patients with lumbar lesions over time ($p<0.05$).

Thirty-nine of 67 patients who were diagnosed with detrusor overactivity in their first VUD and prescribed anticholinergic drug therapy were using the anticholinergic treatment. Twenty-eight patients did not use any medication. The patient compliance to medical treatment was 58.2%. Control urodynamic studies revealed that bladder capacities of the patients receiving anticholinergic drugs significantly increased ($p<0.001$) and bladder capacities significantly decreased in patients who did not use anticholinergic treatment, compared to baseline ($p<0.001$). Detrusor pressures decreased in both groups; however, it was more significant in patients receiving anticholinergic drugs ($p=0.001$ and $p=0.04$, respectively). A significantly decreased detrusor pressure, increased bladder capacity, and bladder compliance were observed in the patients receiving anticholinergic drugs, compared to those who did not ($p<0.001$, $p<0.001$, and $p=0.001$, respectively).

Urinary system ultrasonography performed in the control examination revealed urinary calculus in the urinary system in 16 (18%) patients. Five of them were at kidneys and 11 of them were in bladder. Thirty-one (34.8%) patients were found to have urinary tract infections once a year and 42 (47.2%) patients more than once a year and used antibiotic therapy. The infection frequency in the patients with stones in the urinary system was significantly high, compared to the patients without any stone ($p<0.05$). There was no significant difference in the frequency of urinary tract infections, stones, and VUR between the patients who were receiving or not receiving anticholinergic drug therapy ($p>0.05$).

There was no significant relationship between the presence of stone, infection, VUR and age, sex, lesion complexity, lesion level, bladder type and urodynamic findings in the urinary system during follow-up ($p>0.05$).

DISCUSSION

In the present study, compliance with CIC was 79.8% in the evaluation of the patients for an average duration of 55 months after the disease, who were not under regular urological follow-up, and who had NLUTD due to chronic TSCI. After discharge from the hospital, the urinary excretion pattern changed in 20% of the patients. In our standard neurogenic bladder protocol, patients are instructed and applied CIC during hospitalization. If there is no contraindication to anticholinergic treatment in patients with detrusor overactivity, medical treatment is initiated. Although CIC was recommended to all patients after injury, only 71 patients continued to empty their bladder with CIC in the second evaluation. Four patients underwent IC. Three patients were emptying their bladder with a condom catheter, 10 patients were emptying their bladder with suprapubic tapping or Credé maneuver. One patient was using diapers.

In a study with SCI patients conducted by Yıldız et al.,[16] CIC compliance was 73% during an average follow-up period of 18 months. The most common and safest urinary excretion method in patients with long-term SCI is CIC.[17,18] Changing the bladder emptying method is common in patients with SCI.[13,19-21] In a study conducted in Türkiye, the most common bladder management method at discharge from inpatient rehabilitation center was CIC (63.4%). During follow-up, 42% of the patients who used CIC changed their bladder emptying method. The

rate of conversion to IC was 21.4%.[21] Currently, the use of suprapubic tapping and Credé maneuver has decreased gradually in patients with SCI.[19] Schöps et al.[22] reported that more than half of patients with SCI used CIC in the long-term follow-up. In two studies conducted in our country, CIC compliance was 98% found by Akkoç et al.[23] and 52% by Yavuzer et al.[20] The CIC compliance rate in the patients without regular urological control examination in our study is consistent with previous studies.

Although, we did not investigate the reasons for quitting CIC, we found that women with TSCI and patients with a lesion of lumbar level made more change in the urinary excretion method. Yavuzer et al.,[20] reported that compliance with the CIC program was lower for women, consistent with the results of this study. However, AlSaleh et al.[24] found no significant association between the receiving CIC and sex or level of injury.

In our study, the compliance rate to anticholinergic treatment was 58.2%. In those who continued anticholinergic treatment, bladder capacity increased statistically significantly, compared to baseline. Bladder capacity of the patients receiving anticholinergic treatment increased by 35.2%, compared to baseline. In addition, bladder capacity decreased statistically significantly in patients who did not use anticholinergic treatment compared to baseline. When the second urodynamic results of the patients using and not using anticholinergic were compared, a statistically significant decrease in detrusor pressure and an increase in the bladder capacity and bladder compliance was found in the patients receiving anticholinergic treatment. In a 17-month follow-up study conducted in patients with SCI who was diagnosed with detrusor overactivity by VUD examination, Gündüz et al.[25] reported that bladder capacity significantly increased and urinary leakage decreased, and the pressure decreased during voiding in patients who were using anticholinergic drugs. In the same study, there was no significant change in these parameters in those who did not use anticholinergic therapy. In addition, the treatment compliance was reported to be 71.4%. Anticholinergic drugs seem to be useful in the treatment of detrusor overactivity both in adults and children.[11,26,27] In a study conducted by Schöps et al.[22] in 246 patients with SCI who were followed regularly, there was an increase in the bladder capacity and compliance with a significant decrease in the detrusor pressure.

The VUR rates at baseline and control examination in our study were 5.6% and 9%, respectively. Bladder compliance was lower in all patients with VUR. Vesicourethral reflux is a condition that can cause upper urinary tract disorders in patients with chronic SCI.[28] In a study conducted by Schöps et al.,[22] with an average of 17 years of injury duration and mostly followed-up patients with SCI, VUR was low grade, and its frequency was about 5%. In the treatment of VUR, CIC is primarily recommended in the first step. Anticholinergic and antibiotic therapy may also be added to the treatment.[28] In the light of the literature data, in our patients, anticholinergic therapy and CIC were recommended to the patients with VUR.

In this study, the rate of patients who had urinary tract infection and whose antibiotic treatment was prescribed until the control evaluation after the initial urodynamic tests was 82%. Since the data were retrospectively analyzed, information about the microorganisms and their colony numbers were limited. In a previous study, the clinical urinary tract infection rate was reported to be 20.9% in patients with TSCI for two years.[16] In our study, the annual urinary tract infection frequency of the patients was found to be 1.52 on average. Nosseir et al.[7] described having four or more infections a year as a failed treatment in their study. According to these definitions, a low portion of our patient group was included in the treatment group that failed in terms of challenging urinary infection. The reason for this is that the average age of the patients is low, the male ratio is high, and antibiotic resistant bacteria are high despite not being evaluated.

Bladder management is important for patients with SCI. The main goals of bladder management are to prevent incontinence, to store urine with low bladder pressure and to empty it effectively, to prevent injury due to excessive strain, and to avoid possible urinary system complications and urinary infections that may arise from high pressure.[29] It has been suggested that the risk factors for urinary tract infection are invasive procedures without prophylaxis, bladder neck injuries, and chronic catheter use.[30] Afşar et al.[21] reported an annual urinary infection rate of 38.8% in their follow-up study. In this study, no significant correlation was found between urinary infection and the form of excretion. This may be due to the fact that the number of patients using permanent catheters in the control is limited (n=4) with a high CIC compliance rate.

One of the main findings of our study was that bladder or kidney calculus was detected in 18% of the patients who underwent urinary system ultrasonography in the control visit. Those with SCI have an increased risk of renal stones.[31] In a study of chronic SCI patients conducted by Hansen et al.,[32] the median duration of injury was 24.1 (range, 10 to 45) years, and the rates of renal and bladder calculi were 20% and 14%, respectively. In patients with SCI, the catheter use method, time after injury, and infections are important in stone formation. In another study with an 18-year follow-up, the stone rate was reported to be 35.1%.[2] In our study, two patients with detrusor overactivity underwent augmentation cystoplasty and their neurogenic bladder type was converted to AD bladder type. In a previous study, the bladder capacity increased and the quality of life improved after ileocystoplasty, although the rate of urinary infection increased.[33] Augmentation cystoplasty is considered the last choice in patients with failed conservative treatment methods.

The rapid and silent development of changes leading to failure in the upper urinary system is a very important problem in the rehabilitation and follow-up of these patients. In our study, serum urea and creatinine levels at the first examination and at the end of follow-up were within normal limits.

This study has its strengths and some limitations. It t is important to take into consideration NLUTD in this group for patients with TSCI who did not attend to the hospital for examination for a long period of time. However, its retrospective design and failure to establish a cause-effect relationship are the main limitations.

In conclusion, neurogenic bladder should be evaluated at the beginning of TSCI and, then, followed on a regular basis. Urodynamic tests should be performed immediately after spinal shock and can be repeated, as indicated. Compliance to medical treatment is associated with a higher bladder capacity and a lower pressure. Nevertheless, further large-scale, randomized-controlled studies are needed to draw firm conclusions on this subject.

Ethics Committee Approval: The study protocol was approved by the University of Health Sciences Bakırköy Sadi Konuk Training and Research Hospital Ethics Committee (2019/422). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Concept: N.P.; Design: N.P., Ç.D.; Supervision: N.P., D.B.S.; Resources, materials: Ç.D., N.P., D.D.; Data collection and/or processing: Ç.D., D.D., S.E.; Analysis and/or interpretation: N.P., Ç.D., D.D., D.B.S.; Literature search: N.P., D.D., Ç.D., S.E.; Writing manuscript: N.P., S.E., Ç.D.; Critical review: D.B.S., N.P.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Karacan I, Koyuncu H, Pekel O, Sümbüloglu G, Kirnap M, Dursun H, et al. Traumatic spinal cord injuries in Turkey: A nation-wide epidemiological study. Spinal Cord 2000;38:697-701.
2. Weld KJ, Dmochowski RR. Effect of bladder management on urological complications in spinal cord injured patients. J Urol 2000;163:768-72.
3. Pannek J, Kullik B. Does optimizing bladder management equal optimizing quality of life? Correlation between health-related quality of life and urodynamic parameters in patients with spinal cord lesions. Urology 2009;74:263-6.
4. Ku JH. The management of neurogenic bladder and quality of life in spinal cord injury. BJU Int 2006;98:739-45.
5. Çağlar N, Yılmaz E, Çetinkaya B, Gültekin Ö, Öneş K, Çelik B, et al. The Correlation of urodynamic findings with injury levels in patients with spinal cord ınjury. Turk J Phys Med Rehab 2007;53:50-3.
6. 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.
7. Nosseir M, Hinkel A, Pannek J. Clinical usefulness of urodynamic assessment for maintenance of bladder function in patients with spinal cord injury. Neurourol Urodyn 2007;26:228-33.
8. Musco S, Padilla-Fernández B, Del Popolo G, Bonifazi M, Blok BFM, Groen J, et al. Value of urodynamic findings in predicting upper urinary tract damage in neuro-urological patients: A systematic review. Neurourol Urodyn 2018;37:1522-40.
9. Stöhrer M, Blok B, Castro-Diaz D, Chartier-Kastler E, Del Popolo G, Kramer G, et al. EAU guidelines on neurogenic lower urinary tract dysfunction. Eur Urol 2009;56:81-8.
10. Groen J, Pannek J, Castro Diaz D, Del Popolo G, Gross T, Hamid R, et al. Summary of European Association of Urology (EAU) guidelines on neuro-urology. Eur Urol 2016;69:324-33.
11. Romo PGB, Smith CP, Cox A, Averbeck MA, Dowling C, Beckford C, et al. Non-surgical urologic management of neurogenic bladder after spinal cord injury. World J Urol 2018;36:1555-68.

12. Hennessey DB, Kinnear N, MacLellan L, Byrne CE, Gani J, Nunn AK. The effect of appropriate bladder management on urinary tract infection rate in patients with a new spinal cord injury: A prospective observational study. World J Urol 2019;37:2183-8.
13. Cameron AP, Wallner LP, Tate DG, Sarma AV, Rodriguez GM, Clemens JQ. Bladder management after spinal cord injury in the United States 1972 to 2005. J Urol 2010;184:213-7.
14. Roberts TT, Leonard GR, Cepela DJ. Classifications in brief: American Spinal Injury Association (ASIA) impairment scale. Clin Orthop Relat Res 2017;475:1499-504.
15. Biering-Sørensen F, Craggs M, Kennelly M, Schick E, Wyndaele JJ. International urinary tract imaging basic spinal cord injury data set. Spinal Cord 2009;47:379-83.
16. Neurogenic Bladder Turkish Research Group, Yıldız N, Akkoç Y, Erhan B, Gündüz B, Yılmaz B, Alaca R, et al. Neurogenic bladder in patients with traumatic spinal cord injury: Treatment and follow-up. Spinal Cord 2014;52:462-7.
17. Jaggi A, Drake M, Siddiqui E, Fatoye F. A comparison of the treatment recommendations for neurogenic lower urinary tract dysfunction in the national institute for health and care excellence, European Association of Urology and international consultations on incontinence guidelines. Neurourol Urodyn 2018;37:2273-80.
18. Adriaansen JJ, van Asbeck FW, Tepper M, Faber WX, Visser-Meily JM, de Kort LM, et al. Bladder-emptying methods, neurogenic lower urinary tract dysfunction and impact on quality of life in people with long-term spinal cord injury. J Spinal Cord Med 2017;40:43-53.
19. Hansen RB, Biering-Sørensen F, Kristensen JK. Bladder emptying over a period of 10-45 years after a traumatic spinal cord injury. Spinal Cord 2004;42:631-7.
20. Yavuzer G, Gök H, Tuncer S, Soygür T, Arikan N, Arasil T. Compliance with bladder management in spinal cord injury patients. Spinal Cord 2000;38:762-5.
21. Afsar SI, Yemisci OU, Cosar SN, Cetin N. Compliance with clean intermittent catheterization in spinal cord injury patients: A long-term follow-up study. Spinal Cord 2013;51:645-9.
22. Schöps TF, Schneider MP, Steffen F, Ineichen BV, Mehnert U, Kessler TM. Neurogenic lower urinary tract dysfunction (NLUTD) in patients with spinal cord injury: Long-term urodynamic findings. BJU Int 2015;115 Suppl 6:33-8.
23. Akkoç Y, Atamaz F, Özdedeli S, Kirazlı Y, Hepgüler S, Durmaz B. Omurilik yaralanmalı hastaların temiz aralıklı kateterizasyona uzun dönemde gösterdikleri uyum. Turk J Phys Med Rehab 2004;50:13-6.
24. AlSaleh AJ, Qureshi AZ, Abdin ZS, AlHabter AM. Long-term compliance with bladder management in patients with spinal cord injury: A Saudi-Arabian perspective. J Spinal Cord Med 2020;43:374-9.
25. Gündüz B, Erhan B, Lakşe E, Akyürek B, Elbaşı N. The effect of anticholinergic treatment on neurogenic bladder dysfunction in spinal cord ınjured patients. Turk J Phys Med Rehab 2006;52:48-50.
26. Chapple CR, Khullar V, Gabriel Z, Muston D, Bitoun CE, Weinstein D. The effects of antimuscarinic treatments in overactive bladder: An update of a systematic review and meta-analysis. Eur Urol 2008;54:543-62.
27. Buser N, Ivic S, Kessler TM, Kessels AG, Bachmann LM. Efficacy and adverse events of antimuscarinics for treating overactive bladder: Network meta-analyses. Eur Urol 2012;62:1040-60.
28. Wu CQ, Franco I. Management of vesicoureteral reflux in neurogenic bladder. Investig Clin Urol 2017;58(Suppl 1):S54-S58.
29. Samson G, Cardenas DD. Neurogenic bladder in spinal cord injury. Phys Med Rehabil Clin N Am 2007;18:255-74.
30. Esclarín De Ruz A, García Leoni E, Herruzo Cabrera R. Epidemiology and risk factors for urinary tract infection in patients with spinal cord injury. J Urol 2000;164:1285-9.
31. Chen YY, Roseman JM, Devivo MJ, Huang CT. Geographic variation and environmental risk factors for the incidence of initial kidney stones in patients with spinal cord injury. J Urol 2000;164:21-6.
32. Hansen RB, Biering-Sørensen F, Kristensen JK. Urinary calculi following traumatic spinal cord injury. Scand J Urol Nephrol 2007;41:115-9.
33. Cheng PJ, Myers JB. Augmentation cystoplasty in the patient with neurogenic bladder. World J Urol 2020;38:3035-46.