ORIGINAL ARTICLE

STUDY OF LOCOMOTOR DISABILITY DUE TO VARIOUS TYPES OF TRAUMA

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ABSTRACT

Background: Many people in the world live with different disabilities. Among various types of disability locomotor disability is one of the major types. Trauma is important cause of locomotor disability and in India it is second most common cause of locomotor disability. There is insufficient data available in India to determine contribution of trauma to loco motor disability. This study is required for the same so as to know the extent of problem of disability in Indian society.

Materials and Methods: All the patients attending the out-patient department of institute were examined after taking verbal consent.Patients having locomotor disability were included in this study.

Results: In our study persons having traumatic permanent locomotor disability were found to be 524 among total 3500 locomotor disabled persons attending our institute. Total numbers of new patients attending our institute were 11990 during study period. The prevalence of locomotor disability was 29.19% (3500) out of total 11990 patients attended this institute. The prevalence of traumatic permanent locomotor disability was 14.97% (524), among all (3500) locomotor disabled patients.The cause of disability in 41.8% was railway accidents, 41.6 % was due to road traffic accidents,12.2% due to machine injuries, 4% due to fall, 0.2% due to bullet injuries, 0.2% due to sports injuries. . It was observed that 85.1% (446) out of 524 are males and 14.9% (78) out of 524 are females having locomotor disability due to trauma.

Conclusion: Trauma contributes not only to significant number of disabilities, but also to severity of disability. Road traffic accidents and railway accidents are major causes of traumatic locomotor disability and young persons are the usual victims of such disasters.

Key words: Locomotor disability, Machine injuries, Rail accidents, Rroad traffic accidents, Trauma.

INTRODUCTION

Around the world more than a billion people live with disabilities and a significant proportion of disabilities are caused by injuries including those which result from traffic crashes, falls, burns, and acts of violence such as child abuse, youth violence, intimate partner violence, and war and conflict.[1]

All disabled people are impaired, and all handicapped people are disabled, but a person can be impaired and not necessarily be disabled, and a person can be disabled without being handicapped.

The analysis of the Global Burden of Disease 2004 data estimates that 15.3% of the world population (some 978 million people of the estimated 6.4 billion in 2004) had "moderate or severe disability", while 2.9% or about 185 million experienced "severe disability". [1] The National Sample Survey Organization (NSSO, 2003) estimated the number of persons with

disabilities in India to be 1.8% (49-90 million) of the Indian population.[2] The census of India (2001) has revealed that over 21 million people in India are suffering from one or other kind of disability. This is equivalent to 2.1 % of the population. Among the total disabled in the country, 12.6 million are males and 9.3 million are females.[3]

Trauma is important cause of locomotor disability and in India it is second most common cause of locomotor disability.[2] The national sample survey (2002) estimated 10.66 million persons are having locomotor disability in the country. It is observed that of all persons having locomotor disability the proportion (per 1000) of them with deformity of limb is the maximum among the different types of locomotor disability. Among the different causes of locomotor disability, polio was found to be the major cause. The next important cause is "injuries other than burns" accounting for 26 to 27%.[2] There are various causes of traumatic locomotor disability such as road traffic accidents, railway accidents, falls, bullet injuries, machine injuries.

Though there are many studies available outside, there have not been many studies in India to determine contribution of trauma to loco motor disability. This study is required for the same so as to know the extent of problem of disability in Indian society.

MATERIALS AND METHODS

This observational study was conducted in a tertiary care physical medicine and rehabilitation center in western India. All the patients attending the outpatient department of institute were examined after taking verbal consent. Patients having locomotor disability were included in this study. This study was conducted from November 2011 to November 2012 on the persons/patient attending the outpatient department.

This study was started after approval of Institutional Ethics Committee. Verbal consent was taken prior to examination of patient.

All the patients attending the institute were first examined in OPD. Patients having locomotor disability due to trauma were considered for the study. This study was conducted to assess the prevalence of permanent locomotor disability due to trauma among the persons with disability attending one of the rehabilitation centre in Mumbai; to find out distribution of traumatic causes of locomotor disability; to study locomotor disability due to trauma according to part of body affected; and to study pattern of traumatic locomotor disability among different age groups and sex.

Inclusion criteria: This study includes cases of all age group and both sex with Loco motor disability due to trauma attending the rehabilitation institude.

Exclusion criteria: Persons with loco motor disability due to cause other than traumatic and disabled patient other than loco motor disability were excluded from the study.

RESULTS

In our study persons having traumatic permanent locomotor disability were found to be 524 among total 3500 locomotor disabled persons attending our institute. And total numbers of new patients attending our institute were 11990 during study period. The prevalence of locomotor disability was 29.19% (3500) out of total 11990 patients attended this institute. The prevalence of traumatic permanent locomotor disability was 14.97% (524) among all (3500) locomotor disabled patients.

In our study we found that the cause of disability in 41.8% was railway accidents, 41.6 % was due to road traffic accidents, 12.2% due to machine injuries, 4% due to fall, 0.2% due to bullet injuries, 0.2% due to sports injuries. It was observed that 85.1% (446) out of 524 are males and 14.9% (78) out of 524 are females having locomotor disability due to trauma. It was observed that 37.8% (198) out of 524 persons are affected in the age group 21 to30 and 34% (178) persons are in the age group of 31 to 40.

Table 1: Causes of traumatic locomotor disability in males and females

Causes of traumatic locomotor disability	Male (n=446)	Female (n=78)
Falls	18	3
Machine injuries	60	4
Railway Accidents	178	41
Road Traffic Accidents	188	30
Bullet Injuries	1	0
Sport Injuries	1	0

Railway accidents and road traffic accidents found to be major causes affecting 178 (42.15%) and 188

(39.91%) out of 446 males respectively. Railway accidents and road traffic accidents found to be major causes affecting 41 and 30 out of 78 females respectively.

Table 2: Cause of Locomotor Disability due to trauma in different age groups

Cause of traumatic	Age group			
Locomotor Disability	0-20	21-40	41-60	61-80
Falls	1	12	5	3
Railway Accidents	9	164	37	9
Road Traffic Accidents	17	150	42	9
Machine injuries	5	50	9	0
Bullet injuries	0	0	1	0
Sport Injuries	1	0	0	0

Table 3: Distribution of Locomotor Disability due to trauma according to Body Parts

Body part affected		Subjects
Upper Limb	Right	105
	Left	64
Lower Limb	Right	225
	Left	168
Trunk		27

Table 4: Distribution of severity of locomotor disability due to trauma (N=524)

Disability Percentage	No. (%)
0-25	45 (8.59)
26-50	58 (11.07)
51-75	205 (39.12)
76-100	216 (41.22)

Table 2 shows distribution of causes of locomotor disability among age group 0-20, 21-40, 41-60 and 61-80 years. Railway accidents and road traffic accidents found to be major causes and 21-40 years age group is the most vulnerable population.

Table 3 shows distribution of locomotor disability according to body parts. **Table 4** shows distribution of traumatic locomotor disability according to disability percentage.

DISCUSSION

This study conducted in a representative sample of Indian population, estimates the distribution of traumatic locomotor disability (TLD) according to cause, age, sex, part of body affected and severity of disability among the patients attending a rehabilitation centre in Mumbai. The current study estimated the prevalence of locomotor disability among all patients (11990) attending a rehabilitation centre in Mumbai to 29.19% (3500). The prevalence of traumatic locomotor disability was 14.97% (524) among all locomotor disabled patients (3500).

According to Census of India 2001, the prevalence of locomotor disability was 28% among all disabled population in India.[3] The current study also estimated the similar prevalence of total disabled population with locomotor disability. National Sample Survey (NSS), 58th round 2002 estimated the prevalence of locomotor disability at 51% out of which 26.7% were traumatic in origin.[2] Current study, however, estimated somewhat different pattern as compared to NSS.

The prevalence of locomotor disability due to trauma in the current study is higher (14.97) as compared to other studies where the prevalence of less than 2% has been reported.[4,5,6] The reason may be that in current study, the prevalence of locomotor disability due to trauma in the rehabilitation institute was calculated, however in other studies prevalence of locomotor in general population was calculated.

A study conducted in the community staying near rural health center in Goa found the prevalence of locomotor disability was 0.92%, and majority were due to fracture of long bones in young population due to road traffic accident and stroke in old age.[7]

Another study conducted in black people of Nyaga estimated the prevalence of locomotor disability and TLD in general population at 1.8% and 31.6% respectively.[5] High prevalence of TLD in above study may be because the study was conducted in general population where as our study was conducted in a rehabilitation centre where majority of disabled patients attending outpatient department included suffering from non-traumatic cause viz. poliomyelitis, cerebral palsy, cerebro-vascular accidents, etc.

In the current study it was found that road traffic accidents (41.6%) and railway accidents (41.8%) were the major causes of TLD in all age groups. Railway is a major transport system in Mumbai where study was conducted. Thus may be reason for railway accident being most common cause of TLD in the city (MUMBAI).

In the current study, 85.1% of males and 14.9% of females were suffering from TLD. Males were suffering five times more than females. A study con-

ducted on the pattern and causes of rural based locomotor disabled found incidence of locomotor disability in males are four times more than in the females, which is similar to current study.[8] However, another study conducted to find factors affecting progress of locomotor disability in a slum in Mumbai found most of individuals with locomotor disability were females. Similar findings have been observed in census 2001, where Tamil Nadu was observed to have a higher number of disabled females than males.

According to current study, railway accidents (164) (31.29%) and RTAs (150) (28.62%) were the leading causes of TLD among age group of 21-40 years. This could be correlated with the fact that this age group is working group and most vulnerable to such mishaps. In the current study percentage of individuals having locomotor disability due to trauma in age group of 20 to 40 is 70%.However rail accidents and road traffic accidents were reported as most common culprits behind traumatic disability in all age group patients.

In a study done on 331 victims of road traffic accident at KMC, Manipal Karnataka in 2001, revealed that the maximum number of victims 23(26%) were in the age group of 21-30 years, followed by 17(20%) in 41-50 years age group. Male to female relation was 7:1 which coincides with findings of current study.[9]

Injuries are a major cause of death and disability among young people. The WHO estimates that some 5.8 million people died of injuries in 1998. This figure is predicted to rise over the next 2 decades to 8.4 million, largely because of predicted rise in men in the 15–29 year age group. Injuries are also an important cause of long-term disability worldwide, with much of the burden once again falling on the young. Despite the higher risk of injury faced by young people, relatively little is known about the long term impact of trauma on this age group.[10]

In 1993, Barker and Power used data from the National Child Developmental Study to ascertain a UK population prevalence of permanent disability following accident in those aged 16–23 years of 28 per 1000. Injury occurring in young adulthood was found to be an important cause of long-term disability as between a third and a half of subjects with onset of disability after the age of 16 had injury as a cause. However, only limited information was collected as to the nature of the disability experienced. In the only other published UK population based study of the long-term outcome of major trauma, Braithwaite reported that 1 in 2 people had moderate, severe or very severe disability. They did not however, describe the degree or nature of the disability experienced by young people within the cohort. Other papers have focused only on specific types of trauma (usually head or brain injury) or on younger age groups.[11]

Kuala Selangor showed that the prevalence increased with age, being as low as 0.6% in the 7-14 year age group and as high as 20.5% in the above 55 year age group. Similarly physical disability among Canadians reporting overall prevalence 5.01 % in the adults with 0.62 % in 15 to 24 years age group and 26.47 % in the age group >85 yrs. Similar results were reported by current as well as many other studies. Injury as a cause of their disability was reported by many affected individuals in the study. Similar results were also observed in other studies, where loco motor disability due to injury was reported as 31.6 % and 41.2 % respectively.[12]

So from above studies it is clear that locomotor disability due to trauma is more prevalent in young population which is similar to current study. Global and regional estimates of the injury-specific causes of disability are lacking. However in the current the prevalence of various causes of traumatic locomotor disability were found according to age and sex.

Most of the cases of TLD were of high grade severity. 39.12% patients were 51-75% disabled and 41.22% patients were 76-100% disabled. This reflects patients with TLD were affected higher severity. In most patients with TLD, lower limbs were affected more commonly than upper limb. This might be because of higher percentage of RTAs and rail accidents as cause of TLD.

This study described causes of TLD with respect age and sex. No other study described these characteristics. As this study included patients only attending to rehabilitation center in Mumbai, the results cannot be extrapolated to general population. Also demographic characters and causes of disability may differ from general population. This limits the large extrapolation of results.

CONCLUSIONS

Among various types of disability locomotor disability is one of the major types. Locomotor disability is

caused by various factors. A billion people worldwide are rendered disabled by injuries resulting from road traffic accidents, crashes, falls, railway accidents, act of violence etc. Global and regional estimates of the injury-specific causes of disability are lacking. However, estimates from some countries suggest that up to one quarter of disabilities may result from injuries and violence.[1] Trauma is important cause of locomotor disability and in India it is second most common cause of locomotor disability. There have not been many studies in India to determine contribution of trauma to loco motor disability.

In the current study we found that road traffic accidents(41.6%) and railway accidents(41.8%) are the major causes of traumatic locomotor disability in rehabilitation center in Mumbai. Railway is major transport system in Mumbai where study was conducted. Thus may be reason for railway accident being most common cause of TLD in the city (Mumbai).

We also found that males are more commonly affected than females. It was seen that most of the persons are young; in the age group of 21 to 40. In males and females most important causes of traumatic locomotor disability are road traffic accidents and railway accidents. Also in the young persons the most important causes are road traffic accidents and railway accidents. Loss of limb (lower > upper) is the most frequent impairment. In our study most of the persons have disability more than 50%.

To conclude trauma contributes not only to significant number of disabilities, but also to severity of disability. Road traffic accidents and railway accidents are major causes of traumatic locomotor disability and young persons are the usual victims of such disasters.

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Original Research Article

Comparison of urodynamic parameters with respect to neurological levels in post-traumatic spinal cord injury patients

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ABSTRACT

Background: Urodynamic evaluation is mandatory in order to correctly assess and classify bladder dysfunction in spinal cord injury (SCI) patients. Study investigated patterns of neurogenic bladder dysfunction in patients with post traumatic spinal cord injury and assessed the relationship of detrusor leak point pressure with compliance, post void residual urine volume and maximum cystometric capacity.
Methods: Eighty six patients with neurogenic bladder secondary to traumatic spinal cord injury (SCI) underwent cystometry with electromyography (EMG). T-test was used to compare detrusor leak point pressure (LPP) between complete and incomplete injury groups. Pearson correlation test was used to seek correlation between detrusor LPP and compliance, post void residual volume (PRV) and maximum cystometric capacity (MCC).
Results: Mean detrusor LPP in suprasacral complete injury group, suprasacral incomplete injury group and sacral complete injury was 52±21 cm of H_2O, 53±18 cm of H_2O and 16±9 cm of H_2O respectively. No significant difference in detrusor LPP was found between suprasacral complete and incomplete group on t-Test (P = 0.571068).Significant difference in detrusor LPP was found between suprasacral and sacral group (P= 5.71891E-12). Mean compliance in sacral injury group was 24±16 and in suprasacral complete injury group was 5±6. Mean compliance in suprasacral incomplete injury group was 4±2. Pearson correlation showed negative correlation(r = -0.6918934) between detrusor leak point pressure and compliance (p = 1.2744E-13). Negative correlation (r = -0.311409922) was observed between detrusor leak point pressure and post leak/ void residual urine volume (p = 0.003335033) and between detrusor LPP and maximum cystometric capacity (r = -0.31354), (p = 0.003115).
Conclusions: Significant difference in urodynamic parameters exists between sacral and suprasacral injury patients. However there is no significant difference in urodynamic parameters between complete and incomplete injury at suprasacral level.

Keywords: Detrusor hyperreflexia, Detrusor sphincter dyssynergia, Urodynamics

INTRODUCTION

Spinal cord injury is a devastating event that leads to loss of mobility and dependence in most activities of daily life. But what brings most discomfort to the patient is the

risk of urinary and/or fecal incontinence.[1] Management of issue related to an incontinent bladder requires proper assessment and treatment according to the type of lower urinary tract dysfunction. The incidence of deaths due to renal failure or urosepsis after SCI has greatly reduced from 75% in 1969 to 2.3% in 1993.[2,3] In spite of this enormous improvement, it should be noted that the standardized mortality ratio due to urinary system diseases is still 22.8 in SCI patients and even more (172.3) due to septicemia, mainly secondary to urinary tract-related infections.[4] Evidence from current literature dictates that good knowledge of lower urinary tract dysfunction (LUTD) in SCI is essential for physicians involved in rehabilitation of post SCI survivors. It should not be forgotten that neurologic bladder control is an important determinant in quality of life after SCI, and that better control of urinary symptoms, mainly incontinence, can improve it significantly.[5]

The range of bladder symptoms caused by neurologic lesions is wide and determined by whether the lesion primarily affects the supraspinal control, the pontine–sacral neural circuit, or the sacral nerves. Clinically it is expected that, lesions above the brain stem will produce neurogenic detrusor activity (NDO) but no detrusor sphincter dyssynergia (DSD). Suprasacral spinal cord lesions are expected to produce NDO with DSD and sacral lesions are expected to show acontractile detrusor with a weak sphincter.[6] However completeness or incompleteness of the lesion and the possible association of multiple level injuries can complicate this picture, so much so that urodynamic evaluation becomes mandatory in order to correctly assess and classify LUTD in SCI patients.[7]

The EAU (European association of urology) guidelines consider video urodynamics (VUDS) as the gold standard for invasive UDS in patients with neurogenic lower urinary tract dysfunction (NLUTD). Urodynamic studies in general assess the function of the bladder and its outlet during the filling/storage and emptying phases of the micturition cycle.[8]

The diagnosis of DSD is made by urodynamic testing, characterized by the presence of elevated electromyographic activity of external urethral sphincter during detrusor contraction.[9,10] Weld and Dmochowski have reported strong correlation between clinical neurologic findings and urodynamic pattern in SCI patients.[11] Patki et al, have reported salient deterioration in bladder dysfunction in 43 patients with incomplete SCI, despite having relatively near total neurological recovery.[12]

In this study patterns of neurogenic bladder dysfunction was investigated in patients with post traumatic spinal cord injury. The relationships between detrusor leak point pressure and compliance, post void residual urine volume and maximum cystometric capacity was also assessed.

METHODS

The study was done to investigate patterns of neurogenic bladder dysfunction in patients with post traumatic spinal cord injury and to assess the relationships between detrusor leak point pressure and compliance, post void residual urine volume and maximum cystometric capacity.

Inclusion criteria

- Diagnosed case of post traumatic spinal cord injury with or without neurological recovery
- Disease duration of > 3 months, or
- Patients recovered from spinal shock phase
- Willing to undergo urodynamic evaluation and pre-urodynamic screening investigations

Exclusion criteria

- Active urinary tract infections
- Bladder calculi
- Bladder cysts or fistula
- Urethral strictures, fistula, false passage

Methodology

A cross sectional observational study was carried out at Department of Physical Medicine and Rehabilitation, All India Institute of Physical Medicine and Rehabilitation, Mumbai over a period of two years from April 2012 to April 2014. Patients suffering from neurogenic bladder secondary to traumatic spinal cord injury, coming to our institute from all over India were included in the study.

Patients who visited the outpatient department or admitted for long term inpatient rehabilitation were counselled and written informed consent was taken prior to urodynamic study, before enrolment in study group. We recorded detailed history of patient's current illness with emphasis on history pertaining to bladder and bowel habits. Thorough neurological examination of each patient was performed and classified according to American Spinal Injury Association (ASIA) impairment scale (© 2020 American Spinal Injury Association).[13] The patients were categorized into neuroanatomical groups according to the neurological level and completeness of injury.

All patients recruited in the study underwent urine routine, microscopy and culture tests. Patients tested positive on culture were treated and taken up for examination only when culture report was negative.

Urodynamic evaluation was performed in all patients using UROCOMP 2000 from Status Medical Equipment, India within 2 year period. The urodynamic evaluation included cystometrogram (filling and voiding cystometry) and surface EMG.

Procedure

After obtaining a written informed consent the patients were explained about the procedure they were about to undergo. Each subject was given proctoclysis enema to ensure that rectum remained empty during study. As an alternative to the triple lumen catheter, 2 infant feeding tubes (size FG 8) were inserted per urethra. One tube was connected to the pressure sensor that measured vesical pressure and the other tube was connected to tubing used to instil normal saline into the bladder.

A rectal balloon was made using a cut off finger from a latex glove tied over the tip of another (size FG8) infant feeding tube. After inserting the rectal balloon into rectum, the tube was connected to the pressure sensor that measured abdominal pressure. The software calculated detrusor pressure by subtracting abdominal pressure from vesical pressure value. A flow rate of 30 ml/min was used with normal saline warmed to patient's body temperature as per international continence society guidelines.[14,15] Through multichannel pressure transduction, intravesical and intra-abdominal pressures were simultaneously recorded and plotted on computer screen along with the sphincter EMG. Sphincter EMG was performed using patch electrodes.

Statistics

Following parameters were taken into consideration

- Detrusor LPP
- Compliance
- PRV
- MCC

T-test was used for comparison of detrusor LPP between complete and incomplete (suprasacral) injury groups. T-test was also used for comparison detrusor LPP between suprasacral and sacral injury groups. Pearson correlation test was used to analyze relationship between detrusor LPP and other parameters (i.e. compliance, PRV and MCC).

RESULTS

A total of 86 patients were evaluated out of which 72 (83.72%) were males and 14 (16.27%) were females. Mean age was 31.86 years. Out of 86 patients 58 (67.44%) had complete injuries and 28 (32.55%) had incomplete injuries as per ASIA criteria.

Thoracic injuries were most common with total 47 (54.65%) patients, followed by 18 (20.93%) lumbar, 12 (13.95%) sacral and 9 (10.46%) cervical level injuries. Level wise distribution of complete and incomplete injuries is given in Table 1. Of the 74 patients with suprasacral lesions, 47 (63.5%) had complete injuries and 27 (36.5%) had incomplete injuries. Detrusor hyperreflexia was observed in 44 (59.5%) individuals with suprasacral complete lesions and 23 (31.1%) suprasacral incomplete lesions.

Table 1: Distribution of complete and incomplete injuries.

Level	Complete	Incomplete
Cervical	5	4
Thoracic	32	15
Lumbar	10	8
Sacral	11	1
Total	**58**	**28**

Areflexic detrusor was observed in 6 (8.1%) suprasacral complete and 1 (1.3%) suprasacral incomplete lesions. Detrusor sphincter dyssynergia was seen in 41 (55.4%) suprasacral complete and 22 (29.72%) suprasacral incomplete lesions. In comparison, all 12 patients with sacral injuries (both complete and incomplete) showed detrusor areflexia and none showed detrusor sphincter dyssynergia (Table 2).

Table 2: Pattern of bladder dysfunction in suprasacral and sacral lesions.

Injury	Detrusor hyperreflexia	Detrusor areflexia	DSD
Suprasacral complete	44	6	41
Sacral complete	0	11	0
Suprasacral incomplete	23	1	22
Sacral incomplete	0	1	0
Total	**67**	**19**	**63**

Among the cervical level injury all 9 patients had overactive detrusor and detrusor sphincter dyssynergia. Forty five (95.7%) individuals with thoracic level injuries had overactive detrusor with 2 (4.3%) exhibiting an underactive detrusor pattern. A total of 42 (89.4%) patients with thoracic level injuries displayed detrusor sphincter dyssynergia. All 12 individuals with sacral injuries showed detrusor areflexia and none exhibited detrusor sphincter dyssynergia. Among the patients with lumbar level injuries 13 (72.2%) had overactive detrusor while 5 (27.8%) exhibited detrusor areflexia and 12 individuals had detrusor sphincter dyssynergia. Figure 1 depicts correlation between neurological levels and pattern of urodynamic findings.

As depicted in Table 3, all cervical level injury patients had low compliance (<20) and 8 (88.9%) out of 9 had high (>40 cm of H_2O) detrusor leak point pressure (det. LPP). While 46 (97.9%) out of 47 thoracic level injury patients had low compliance, only 1 (2.1%) showed high compliance (>20). High detrusor LPP was noted in 36 (76.6%) patients with thoracic injuries.

Among the lumbar level injury patients 17 (94.4%) out of 18 had low compliance, while only 1 (5.6%) showed high compliance. High detrusor leak point pressure was noted in 10 (55.6%) patients with lumbar level injuries. Out of 12 sacral level injury patients 6 (50%) exhibited high compliance, but all had low detrusor LPP. Mean detrusor LPP in Suprasacral complete injury group was 52±21 cm of H2O and in suprasacral incomplete injury group was 53±18 cm of H_2O. Mean detrusor LPP in sacral complete injury group was 16±9 cm of H2O. No significant difference in detrusor LPP was found between suprasacral complete and incomplete group on t-test (p = 0.571068). Significant difference was found in detrusor LPP between suprasacral and sacral group (p = 5.71891E-12). Mean compliance in sacral injury group was 24±16 and in suprasacral complete injury group was 5±6. Mean compliance in suprasacral incomplete injury group was 4±2.

Table 3: Correlation between level of injury, detrusor LPP and compliance.

Level of injury	Detrusor lpp ≥40cm of H_2O	Detrusor lpp <40cm of H_2O	Compliance ≥20	Compliance <20
Cervical	8	1	0	9
Thoracic	36	11	1	46
Lumbar	10	8	1	17
Sacral	0	12	6	6
Total	**54**	**32**	**8**	**78**

Statistical analysis using Pearson correlation showed negative correlation (r = -0.6918934) between detrusor leak point pressure and compliance (P = 1.2744E-13). Negative correlation (r = -0.311409922) was also observed between detrusor leak point pressure and post leak/ void residual urine volume (p = 0.003335033). Similarly negative correlation (r = -0.31354) was observed between detrusor LPP and maximum cystometric capacity (p = 0.003115).

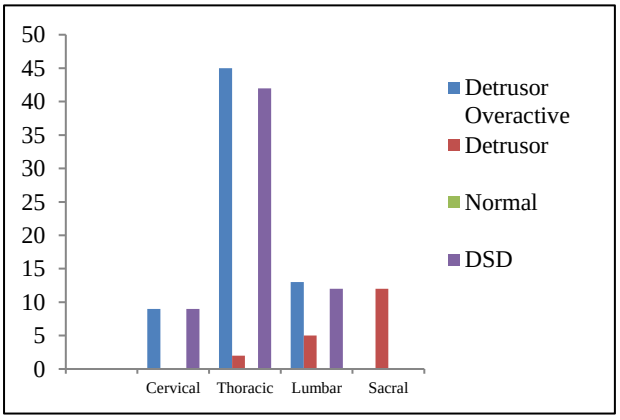

Figure 1: Correlation between neurological levels and urodynamic findings.

DISCUSSION

After the period of spinal shock is over, there is gradual return of reflex bladder function. Conscious sensation of bladder filling may be absent or impaired unless there is neurological recovery. Apart from loss of voluntary inhibition of the micturition reflex, there may be uncontrolled contractions of detrusor muscles (detrusor overactivity) which may or may not be associated with uncoordinated contractions of external sphincter (detrusor sphincter dyssynergia). Typical urodynamic findings in a neurogenic bladder include detrusor overactivity and detrusor striated sphincter dyssynergia (DSD). These uncoordinated contractions result in high voiding pressures, significant residual urine volume, and urinary incontinence which, if not treated, often results in back pressure changes such in upper urinary tract.[1] Though behaviour of detrusor and sphincter is predictable to some extent based on neurological examination, it is not always accurate. In the present study we conducted urodynamic evaluation of 86 post spinal cord injury survivors and classified the findings depending on clinical neurological levels and type of bladder dysfunction.

Numerous studies have attempted to seek correlation between clinical neurologic findings and urodynamic pattern in SCI patients. In our study 90.5% of patients with suprasacral lesions exhibited detrusor hyperreflexia and all patients with sacral lesions displayed areflexia. Similar reports were observed by Weld and Dmochowski, in a population of 243 patients with SCI.[11] Suprasacral lesions were associated with NDO and/or DSD in 94.9%, and sacral lesions with detrusor areflexia in 85.7% of cases. In this study all patients with complete suprasacral injuries had detrusor hyperreflexia and/or detrusor sphincter dyssynergia. Patients with incomplete suprasacral injuries had a slightly lower frequency (93.8%) of hyperreflexia and/or dyssynergia. In our study 85.1% patients with complete suprasacral injury showed detrusor hyperreflexia and 87.2% showed DSD. Among patients with incomplete suprasacral injuries 85.1% had detrusor hyperreflexia and 81.5% had DSD. No significant difference was observed between complete and incomplete suprasacral injury group, which was similar to the study by Weld et al. In a similar study of 489 patients with spinal cord lesions Kaplan et al. found a general correlation between the neurological level of injury and the expected vesicourethral function, but also

noted that it was neither absolute nor specific.[16] They noted that, 84% of the suprasacral cord lesions with detrusor areflexia had positive sacral cord signs while all suprasacral cord lesions with no evidence of sacral cord involvement had either detrusor hyperreflexia or detrusor-external sphincter dyssynergia. Thus implying that clinical assessment for sacral cord signs may help predict bladder behaviour in such cases. They also suggested that the clinical neurological examination alone is not an adequate to predict neurological dysfunction. In another study Bulent et al. reported detrusor hyperreflexia in Twenty-six (72.2%) of 36 patients with suprasacral injuries.[17] Twenty-nine (80.5%) had detrusor sphincter dyssynergia, 9 (25%) had normal compliance and 1 (2.8%) had areflexia. In a recent study by Maryam et al out of 66 patients with suprasacral injuries 27 (40.90%) had detrusor hyperrflexia and 5 (17.9%) out of 19 sacral injuries had detrusor hyperreflexia.[18] These findings differ significantly from observations in the study.

Moslavac et al, in their study of 80 spinal cord injury patients with detrusor hyperreflexia found no difference in cystometric capacity and intravesical leak point pressure between complete and incomplete spinal cord injury patients.[19] Mean CC (cystometric capacity) for ASIA A group was 239±107 ml (range 47 - 526) and mean CC for ASIA B–E group was 227±125 ml (range 42-500). In the study mean MCC (maximum cystometric capacity) for ASIA A group with detrusor hyperreflexia was 190±81 ml and mean MCC for ASIA B-E group with detrusor hyperreflexia was 202±59 ml. Moslavac et al also reported mean Pves leak-point pressure (Pves LPP) at cystometric capacity for ASIA A group as 79±30 cm H2O (range 26-140) and mean Pves LPP for ASIA B-E group as 70±29 cm H_2O (range 25 - 130). In the study, it was found that mean Det. LPP of 57±17 cm of H_2O in ASIA A group (with detrusor hyperreflexia) and 55±18 cm of H_2O in ASIA B-E (with detrusor hyperreflexia).

Weld et al also reported a higher frequency of impaired compliance in sacral injury group (78.6%) compared with the suprasacral injury group (41.8%).[11] They also observed correlation of high detrusor leak point pressures with low bladder compliance. Low compliance was observed in 97.3% of suprasacral injury group and 50% of sacral injury group. However the definition of low compliance in Weld et al was <10, while in present study it is <20; which may explain the observed differences. We found negative correlation of detrusor leak point pressure with compliance, post void residual urine volume and maximum cystometric capacity as has been documented by various studies.

In the study 2 thoracic level and 5 lumbar level lesions with detrusor areflexia was found. Some other authors have also noted occurrence of detrusor areflexia with upper motor neuron lesions, presumably due to a coexistent clinical or subclinical spinal cord lesion. Arnold et al. reported two cases of upper motor neuron lesions with detrusor areflexia.[20] Light et al. also reported 13 patients with suprasacral SCI and detrusor areflexia.[21]

CONCLUSION

Significant difference in urodynamic parameters exists between sacral and suprasacral injury patients. However there is no significant difference in urodynamic parameters between complete and incomplete injury at suprasacral level. Negative correlation exists between detrusor LPP and compliance, PRV and MCC. In most setups without availability of urodynamic study, there is tendency among treating physicians to treat patients based on clinical judgment. As evident from current study, judgments made from the neurologic examination may be incorrect because of the superimposed complexity of multiple injury levels. Urodynamic study in spinal cord injury patients may provide better acumen about bladder pathology which may provide for better bladder management protocol.

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