

Role of Invasive Urodynamic Studies in Establishing Cauda Equina Syndrome and Postoperative Recovery

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Abstract

Study design: Retrospective with prospective follow-up.

Objective: Confirming the diagnosis of CES based purely on symptoms and signs is unreliable and usually associated with high false positive rate. A missed diagnosis can permanently disable the patient. Present study aims to determine the relationship between clinical symptoms/ signs (bladder dysfunction) with UDS, subsequently aid in surgical decision making and assessing postoperative recovery.

Methods: A prospective follow-up of patients with disc herniation and bladder symptoms from January 2018 to July 2020 was done. All patients underwent UDS and grouped into acontractile, hypocontractile and normal bladder. Data regarding PAS, VAC, GTP, timing to surgery and onset of radiculopathy and recovery with correlation to UDS was done preoperatively and postoperatively.

Results: 107 patients were studied (M-63/F-44). Patients with PAS present still had acontractile (61%) or hypocontractile (39%) detrusor and with VAC present, 57% had acontractile and 43% hypocontractile detrusors. 10 patients with both PAS and VAC present had acontractile detrusor. 82% patients with acute radiculopathy (<2 days) improved when operated <24 hrs while only 47% showed improvement with chronic radiculopathy. The detrusor function recovered in 66.1% when operated < 12 hours, 40% in <12-24 hours of presentation.

Conclusion: Adjuvant information from UDS in combination with clinicoradiological findings help in accurate diagnosis even in patients with no objective motor and sensory deficits. Quantitative findings on UDS are consistent with postoperative recovery of patient's urination power, representing improvement and can be used as a prognostic factor.

Keywords

cauda equina syndrome, urodynamic studies, detrusor function

Introduction

Cauda equine syndrome (CES) is a “possible” clinical diagnosis characterized by bladder and/or bowel dysfunction, sensory deficits in the saddle area, or sexual dysfunction.¹ Bladder dysfunction in patients with CES is usually areflexic/ acontractile detrusor, resulting in urinary retention or overflow incontinence. It also impacts on the anal muscles and causes faecal incontinence.^{1,2} CES represents a unique surgical emergency in spine which if not diagnosed and treated timely can lead to irreversible deficits. Usually it is associated with/without low back ache, radicular symptoms, with/ without sensory and/or motor deficits in the lower limbs. It constitutes 0.07%–2% of Lumbar disc prolapse (LDP).^{3,4}

Confirming the diagnosis of CES based purely on symptoms and signs is unreliable and usually associated with high false positive rate. A missed diagnosis can permanently disable the patient whereas a misdiagnosed patient may have to undergo a surgery which does not address the cause of his

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bladder symptoms, there by adding to the morbidity of the procedure.

Definitive global consensus on the definition of CES still doesn't exist. CES is usually classified as complete (true retention) or incomplete. Incomplete CES is characterized by, motor/ sensory symptoms involving saddle area with incomplete urinary symptoms. However, patients with complete CES present with asymptomatic and painless complete urinary retention, without visceral signals and is usually suffered by overflow incontinence.⁵

Role of Invasive Urodynamic studies (UDS) as an investigation to prognosticate the bladder function in cauda equine syndrome and its role in diagnosis of CES is not fully established till date in patients with LDP with urinary symptoms and is controversial. Present study was done in a tertiary care spine center in patients with suspected diagnosis of CES. It aims to determine the relationship between clinical symptoms/ signs (bladder dysfunction) with UDS and subsequently aid in surgical decision making. Also to establish the role of UDS as an adjunct to clinical findings in the objective diagnosis of CES and post-operative recovery.

Materials and Methods

A prospective study of patients who presented with ambiguous findings of LDP and bladder symptoms from January 2018 to July 2020. Patients with clinical findings of CES (bilateral/unilateral sciatica, severe LBP, saddle and/or genital sensory disturbance), 18-60 years of age, and MRI evidence of compression of cauda equine due to lumbar disc herniation were included. Approval from the institutional review board was taken prior to commencement. (ISIC/ RP/ 2018/ 02). Written informed consents were obtained from all the patients. All patients were advised an Uroflowmetry with pre and post void residual volume assessment by ultrasonography at presentation. The patients with normal flow pattern on Uroflowmetry and no post void residue were excluded. Of note, we excluded patients with other known genitourinary pathology like stricture urethra, benign prostatic hyperplasia, or other diseases of the genitourinary tract, neurological diseases that can confound findings on urodynamic evaluation or altered sensorium patients, and previous history of any surgical intervention in the lower urinary tract. Also patients with Cauda equina syndrome symptoms due to spinal ailments other than lumbar disc herniation were excluded.

Each patient was asked for symptoms associated with the lower urinary tract. The clinical assessment of perianal sensation (PAS) was recorded normal/ weak/ absent). Likewise voluntary anal contraction (VAC) was recorded as normal/ weak/ absent tone. Onset of CES was marked as the time since when the patient first experienced urinary disturbances. All patients complained of lower back pain radiating along the unilateral or bilateral lower lumbar and/or sacral roots. Data regarding great toe perception (GTP), preoperative and postoperative motor power of lower limbs, postoperative timing to surgery and

onset of radiculopathy and back pain and recovery in terms of UDS was collected and divided into acontractile, hypocontractile and normal bladder. The duration of lower limb radiculopathy was categorized into "less than 2 days," "3 to 30 days," "31 to 90 days" and "more than 90 days" for convenience to differentiate acute and chronic conditions. The duration of bowel-bladder symptoms were classified into "less than 2 days," "3 to 30 days" and "more than 30 days." The duration of timing of surgery were classified into ≤ 12 hours, 13 to 24 hours, 25 to 48 hours and > 48 hours after onset of symptoms. The neurology status was categorized as 5/5 or less than that. The surgery was categorized as TLIF or decompression. The GTP sensation was identified as present/absent.

Urodynamic examination consisted of the simultaneous measurement of intravesical pressure, abdominal pressure throughout bladder filling and voiding. Urodynamic catheter was introduced into the bladder at the start of the procedure. Medium water fill cystometry (100 ml/min) was performed. The abdominal pressure was measured by the use of a rectal balloon catheter. Detrusor pressure was obtained by subtracting abdominal pressure from total vesical pressure. Bladder filling was discontinued when bladder capacity reached its maximum. The patient was then instructed to void with the urodynamic catheter in situ. In such a way, both intravesical and abdominal pressure were obtained concurrently with flowmetry.

The term detrusor areflexia means that there is lack of detrusor contractility during voiding phase. As detrusor contraction is absent, the patients void by raising intra-abdominal pressure. Thus leading to raise in intravesical pressures. Normal bladder sensation is defined as sensory input of bladder filling at volume < 300 ml. Decreased bladder sensation is defined as initial sensation of filling at volumes of ≥ 300 ml. Based on these findings, subjects were categorized into 3 groups.

1. Contractile bladder: (Figure 1)
 - a. Demonstrated detrusor over activity /overactive bladder/urge incontinence in the filling/voiding phase
 - b. Established stress incontinence
 - c. High pressure/low flow pattern (labeled under the group "bladder outlet obstruction" if the history is also collaborative)
2. Hypocontractile bladder: (large capacity bladder, weak detrusor contractions (pDET < 40 mm H₂O in males, < 20 mm H₂O in females)/prolonged voiding/incomplete voiding) (Figure 2) (pDET: detrusor pressure)

The patient is reassessed to see if he/she has severe pain, taken high doses of neurotropic medications which may contribute to the picture on UDS. If there are contributing factors, an association with abnormal PAS/VAC/BCR (Bulbocavernosus reflex) finding is diagnosed as CES and underwent an emergency decompression. If there are no contributory factors, the association with Post Void Residual volume (PVR) is

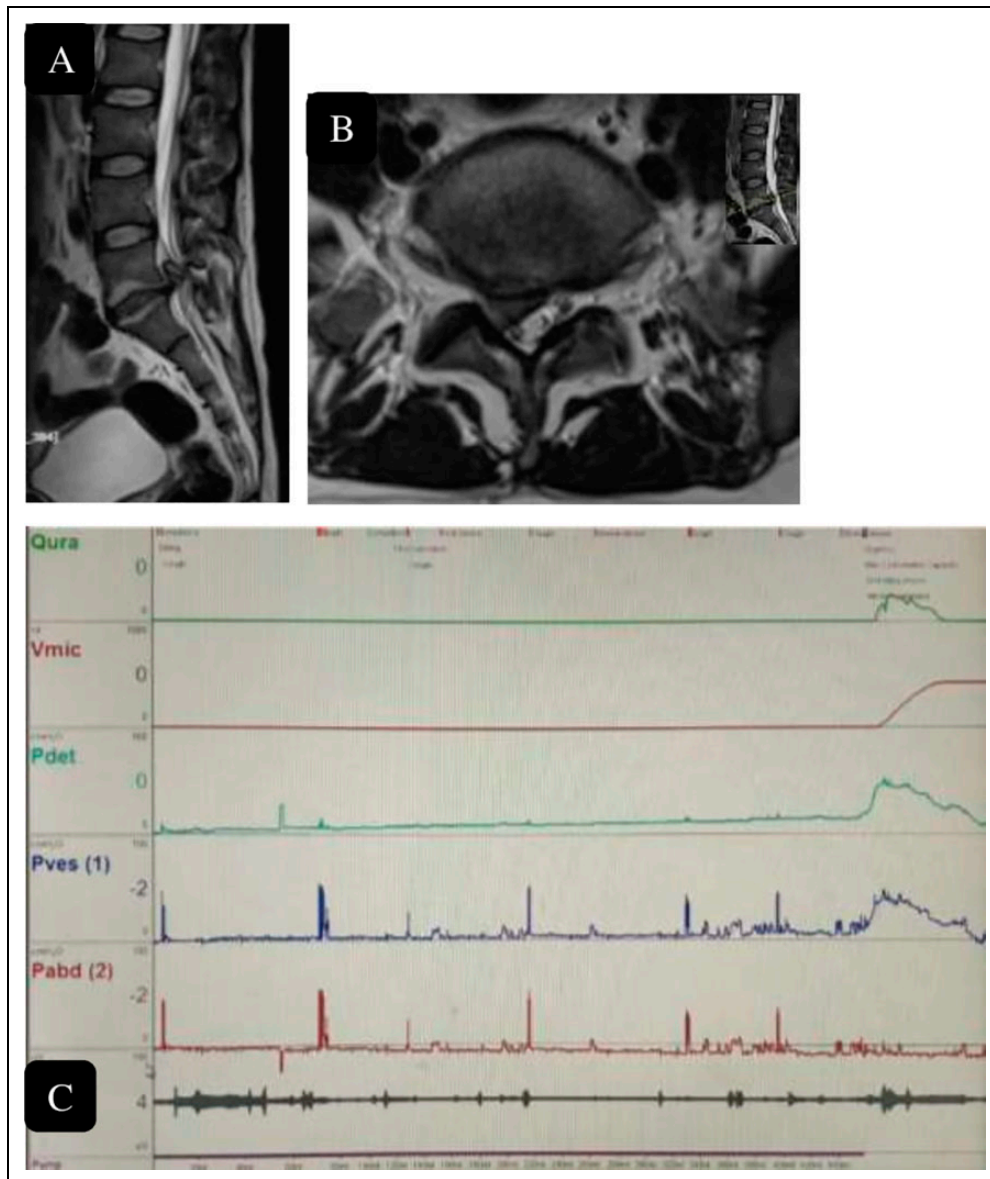


Figure 1. 34 year old male presented with L5-S1 right sided Lumbar disc herniation (A, B) with acute onset radiculopathy associated with difficulty in micturition with intact perianal sensation and voluntary anal contraction. Urodynamic studies revealed normal flow pattern with good detrusor function and normal flow. Qura: Urine flow rate, Vmic: Volume of micturition, Pdet: detrusor pressure, Pves: vesicle pressure, Pabd: intra-abdominal pressure.

checked. If the bladder is hypocontractile but associated with no/less PVR, a serial examination is performed. However, when associated with high PVR, an emergency decompression was suggested.

3. Acontractile bladder: (large capacity bladder, failure to initiate detrusor contractions) (Figure 3).

The patient is similar as in a hypo-contractile bladder if there are contributory factors. If there are no contributory factors, a neurovesical dysfunction due to cauda equine compression is assumed and emergency decompression was suggested.

Preoperative variables like PAS, VAC and GTP, duration of radiculopathy and back pain, timing of surgery, onset of symptoms were correlated individually to postoperative findings and also were also compared to UDS findings to find the prognostic factors.

Statistical Analysis

Data was entered in a Microsoft Excel sheet (Microsoft Corp., Redmond, WA, USA), and statistical analyses were performed using IBM SPSS software ver. 20.0 (IBM Corp., Armonk, NY, USA). The univariate analysis of UDS improvement with these factors was done using chi squares test/Fisher's exact test.

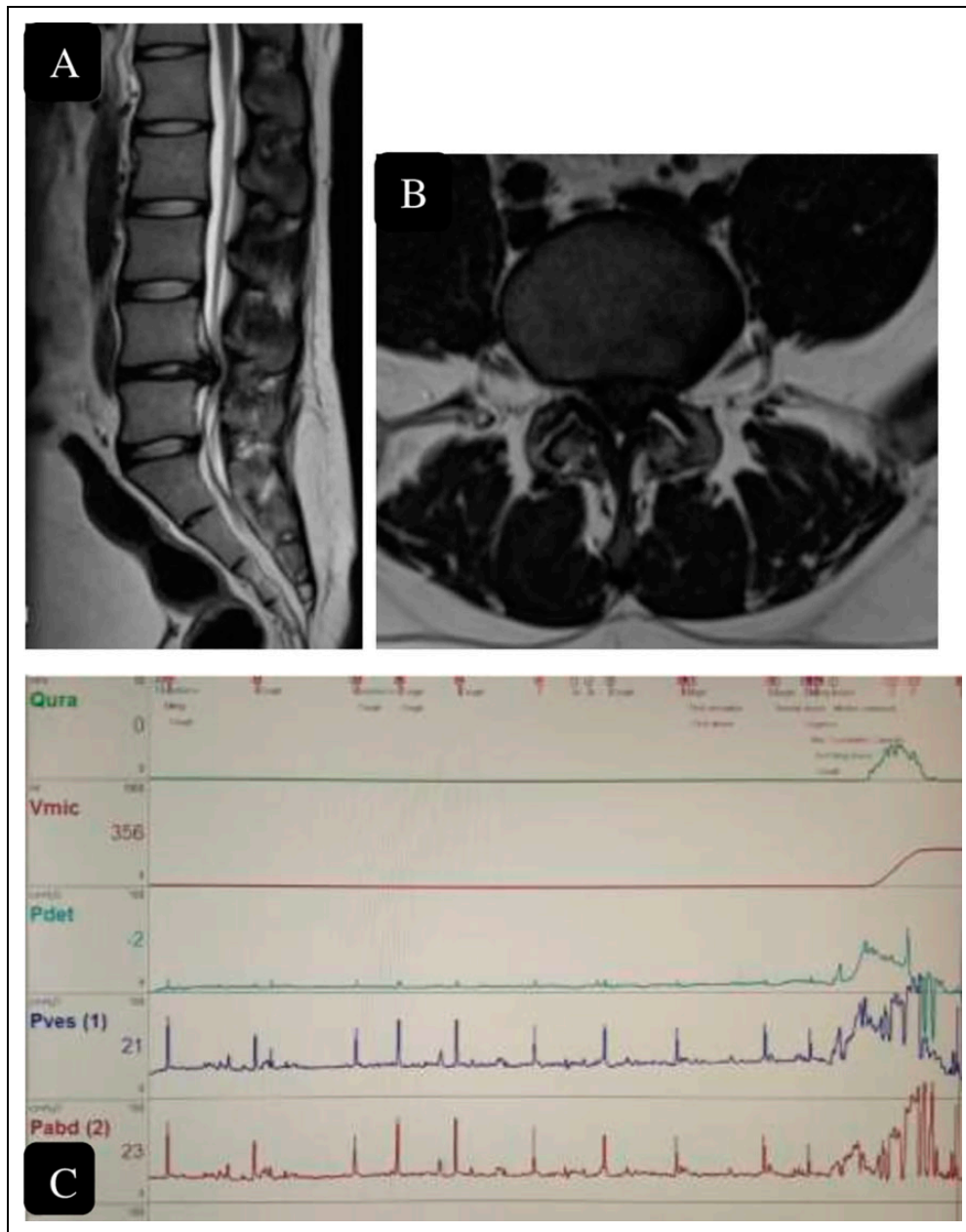


Figure 2. 31 year old female presented with sudden onset bilateral radiculopathy and perianal numbness and difficulty in voiding micturition. Magnetic resonance imaging revealed L4-5 lumbar disc herniation (A, B). UDS revealed a hypocontractile bladder (C) there is raise in intravesical pressure reflecting raise in intra-abdominal pressure resulting in strained voiding.

Multivariate analysis for improvement was done using logistic regression. A p value less than 0.05 was considered as significant for all tests.

Results

A total of 107 patients were studied in the present study. There were 63 males and 44 females. Average age of the study population was 47.16 ± 15.3 years. All the 107 patients had voiding disturbances. Acontractile detrusor was found in 76 patients and 31 patients had hypocontractile bladder. Various parameters

along with PAS and VAC were studied in relationship with the UDS finding among all the patients (Figures 4 and 5).

Among patients with equivocal presence of both PAS and VAC, where in there were no motor or sensory deficits but still patient complained of urinary voiding dysfunction, with MRI showing a lumbar disc herniation, UDS provided insights by quantifying the detrusor activity. There were 10 such patients, of them 7 subjects showed acontractile detrusor activity and 3 were hypocontractile. These patients were advised immediate decompression in view of severe bladder dysfunction.

There was improvement of nearly 47.66% patients who underwent timely decompression who had acontractile or

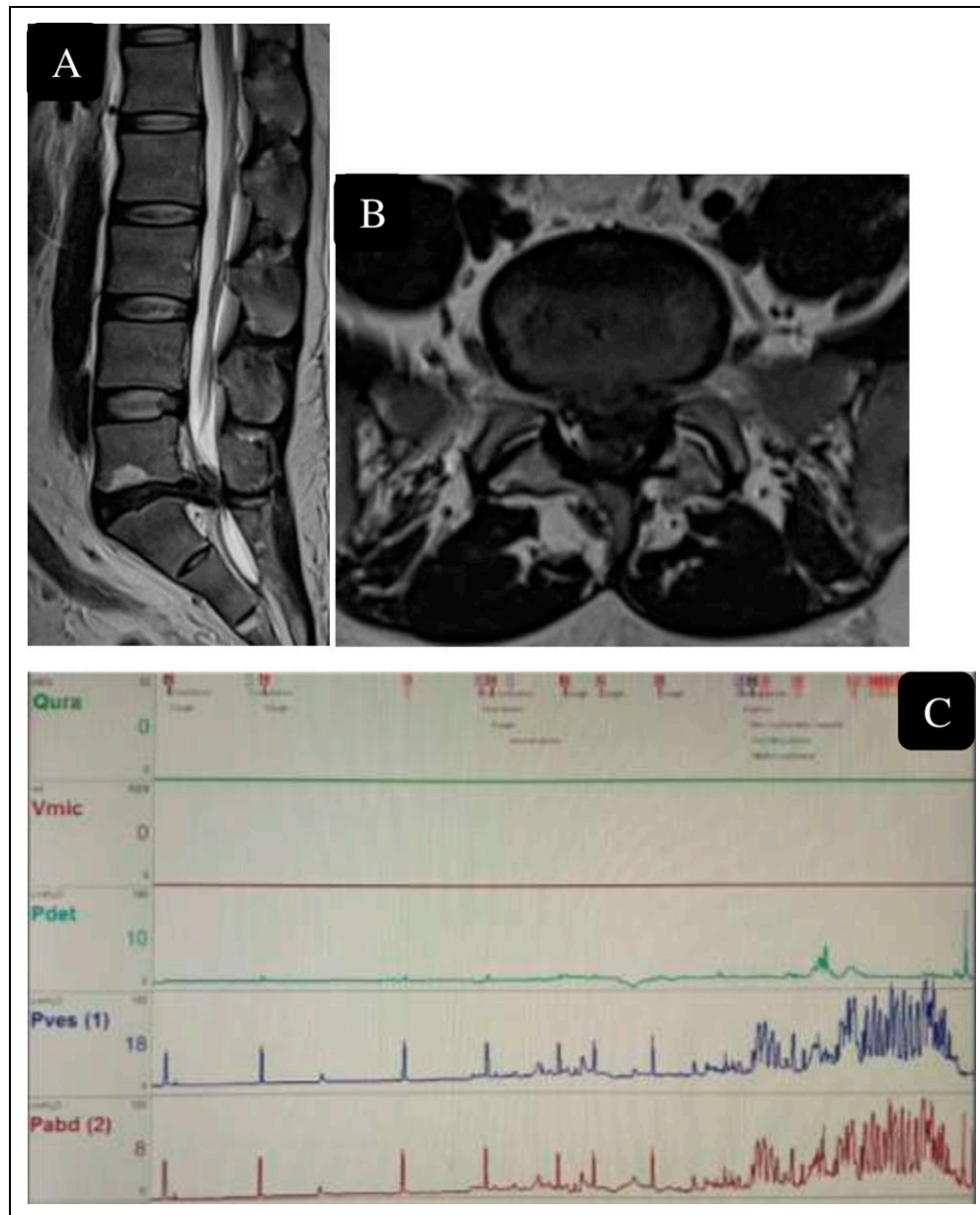


Figure 3. 39 year old female with left radiculopathy and urinary retention since 4 days, MRI (A, B) revealed L⁵-S¹ lumbar disc herniation. UDS revealed acontractile bladder with complete loss of detrusor contractions and raised intravesical pressure reflecting the raised intra-abdominal pressure with no flow.

hypocontractile bladder as shown in Table 1. Though PAS and VAC were both present in 7 patients postoperatively 4 patients continued to have acontractile bladder and 3 patients had hypocontractile bladder.

Great toe perception was also recorded in all the patients and was correlated with urodynamic findings. And changes in PAS or VAC was assessed postoperatively (Tables 2 and 3). If GTP was absent, 78% did not show changes in PAS and VAC, if GTP was present—8 (11%) improved.

For the study purpose patients presenting with CES and leg pain unilateral or bilateral were categorized according duration of leg pain into <2 days, 3-30 days, 31-90 days and >90 days.

Among 22 patients with <2 days duration of acute onset leg pain and CES, 18 patients (81.8%) showed improvement on UDS, 4 patients didn't show any improvement. Among 49 patients with leg pain duration of 3-30 days 35 patients (71.4%) showed improvement in UDS. With increasing duration of leg pain the proportion of improved decreased ($p = 0.071$).

To study the role of timing of surgery and improvement in bladder function we classified patients into 4 groups (<12 hours, 12-24 hours, 24-48 hours and >48 hours) depending on duration of onset of bladder symptoms to surgical decompression. There was a significant trend ($p = 0.056$) toward

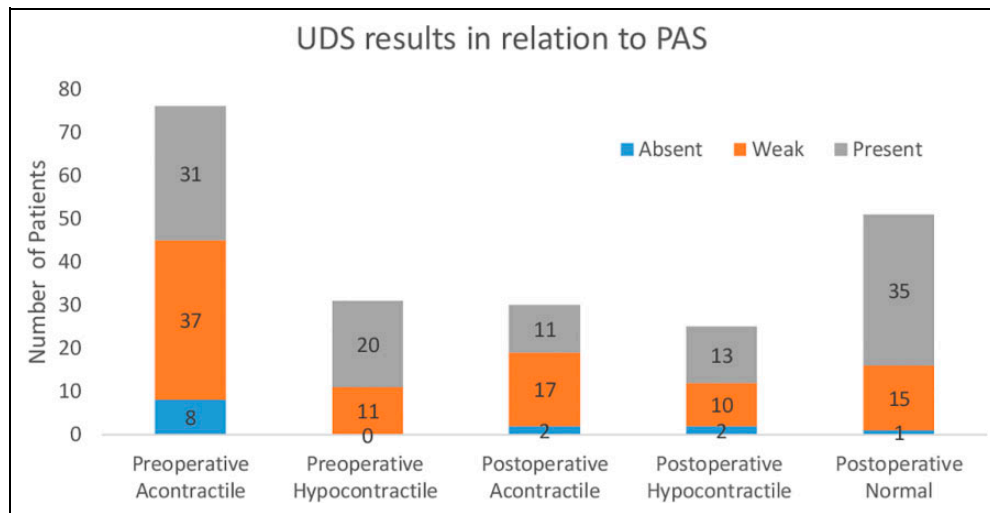


Figure 4. Perianal sensation among patients with urodynamically proven bladder dysfunction preoperatively and post operatively.

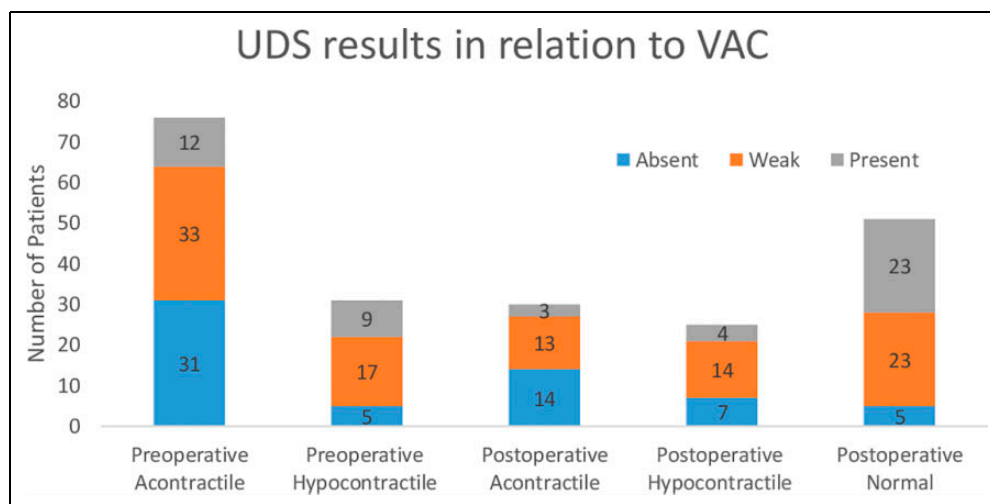


Figure 5. Voluntary anal contraction among patients with urodynamically proven bladder dysfunction preoperatively and postoperatively.

Table 1. UDS Results in Preoperative and Postoperative Period.

		Postoperative diagnosis			Total
		Acontractile	Hypocontractile	Contractile/ Normal	
Preoperative diagnosis	Acontractile	30	21	25	76
	Hypocontractile	0	5	25	30
	Contractile/normal	0	0	1	1
Total		30	26	51	107

higher percentage of improvement in subjects who got operated before 24 hours (Table 4). Improvement in bladder function as a result of decompression (discectomy vs Transforaminal lumbar interbody fusion) procedure is shown in Table 5. The improvement was not statistically significant among both the procedures ($p = 0.348$).

Univariate Analysis

There was no association for improvement with GTP sensation ($\text{chi-square} = 1.193$, $\text{df} = 1$, $p = 0.275$), pre-op neurological status ($\text{chi-square} = 1.292$, $\text{df} = 1$, $p = 0.256$), presence of complete motor deficit i.e. motor power (0/5) ($\text{chi-square} = 3.097$, $\text{df} = 2$, $p = 0.213$), surgery ($\text{chi-square} = 0.542$, $\text{df} = 1$,

$p = 0.462$). There was significant difference across the categories for duration of pain and bowel and bladder symptoms. A significantly higher percentage of subjects improved when they were operated earlier as compared to later (chi-square = 7.831, $df = 3$, $p = 0.05$) when analyzed for leg pain. Similarly, a significantly higher percentage of subjects improved when they were operated earlier as compared to later when analyzed for bowel and bladder symptoms (chi-square = 6.345, $df = 2$, $p = 0.042$). The percentage improvement in UDS was not different across the pre-operative PAS categories of weak, absent or present (chi square = 1.69, $df = 2$, $p = 0.430$). The percentage improvement in UDS was not different across the pre-operative VAC categories of weak, absent or present (chi square = 3.05, $df = 2$, $p = 0.218$).

From the Regression for Significant Predictors of Improvement

A logistic bivariate regression was run with improvement in UDS symptoms as dependent variables. The predictors that

Table 2. Table Showing Changes in Perianal Sensation Postoperatively When Compared to Preoperative Status.

		Postoperative perianal sensation			Total
		Absent	Present	Weak	
Preoperative perianal sensation	Absent	5	2	1	8
	Present	0	50	1	30
	Weak	0	8	40	1
Total		5	60	42	107

Table 3. Table Showing Changes in Voluntary Anal Contraction Postoperatively When Compared to Preoperative Status.

		Postoperative voluntary anal contraction			Total
		Absent	Present	Weak	
Preoperative Voluntary Anal Contraction	Absent	26	3	7	36
	Present	0	20	1	21
	Weak	0	8	42	50
Total		26	31	50	107

Table 4. Improvement in Bladder Function (Urodynamic Findings) in Relation to Timing of Surgery.

		Time interval category				Total
		Less than 12 hours	13-24 hours	25-48 hours	More than 48 hours	
Not improved	No. of patients	20	10	6	0	36
	percentage	33.3%	26.3%	75%	0%	33.6%
Improved	No. of patients	40	28	2	1	71
	percentage	66.7%	73.7%	25%	100%	66.4%
Total		60	38	8	1	107

were included in the model were age, duration of leg pain, bowel bladder symptoms and time of surgery, GTP sensation, neurological status, presence of complete motor deficit i.e. motor power (0/5), type of surgery, and interaction between GTP and presence of complete motor deficit, interaction between Bowel and Bladder (BB) symptoms and leg symptoms, neurological status and presence of complete motor deficit i. e, motor power (0/5). All the predictors were entered in the model using backward regression with 0.10 as the cutoff for removal of predictor and maximum 20 iterations.

The following were found to be significant predictors: Age ($p = 0.004$), duration of leg pain ($p = 0.026$) and time for surgery (0.005). As compared to surgery done after 90 days, the odds of improvement are 25 times higher if done within 2 days. As compared to duration of symptoms of more than 25 hours, the odds of improvement are 55 times higher if time intervals are less than 12; and 87 times higher if between 12 and 24 hours.

The odds of improvement were 1.05 higher with every unit increase in age. Those who improved were significantly younger at mean age of 44.32 ± 14.4 years as compared to those who remain unchanged (age- 52.75 ± 15.8) years ($p = 0.007$).

Discussion

Lumbar disc prolapse is the commonest causal factor of CES, accounting upto 43% cases.⁶ Discussing bowel and bladder deficits and recovery in CES with patients is of prime importance.^{7,8} Also there is dearth of data available regarding identification of the clinical factors prognosticating recovery in CES. There are 2 features that make cauda equina sensitive to compression and tension forces. Firstly, they are devoid of Schwann cell protection and secondly, they lack a regionalized segmental blood supply. This renders the central segments of nerve roots relatively hypovascular, making it susceptible to ischemic injury.⁹

Bladder function in patients treated for CES was, until now, mainly studied clinically and by cystometry. This article concerns the urodynamic results of a prospective study regarding the type and reversibility of detrusor damage in patients operated upon for acute CES. The role of UDS in the neurogenic bladder is well established. To date, some studies have described the role of UDS in the management of neurogenic bladder following nontraumatic myelopathies but work on CES

Table 5. Postoperative Recovery Among Patients With Discectomy and TLIF (Transforaminal Lumbar Interbody Fusion) for Lumbar Disc Herniation With Cauda Equina Syndrome.

		Surgical procedure		Total
		Discectomy	TLIF	
Postoperative bladder status	Acontractile	13	17	30
	Hypocontractile	12	14	26
	Contractile/Normal	25	26	51
Total		50	57	107

limited. This study intended to assess patients with CES presenting with bladder and bowel symptoms using clinical and urodynamic parameters. Also, present study evaluated the same parameters before and after spinal surgery. To the best of our knowledge, present study is first of its kind that compares the clinical and urodynamic parameters before and after surgical treatment for CES. This study reveals that patients with CES presenting with Lower urinary tract symptoms (LUTS) could have a varied detrusor function. According to the recommendations of the International Continence Society, neurogenic bladder dysfunction can be diagnosed if there is a correlation between the urodynamic diagnosis and the patient's symptoms and signs,¹⁰ and in the presence of neurological pathology only.¹¹

PAS being reported "normal" in 47.66% (51/107) cases of CES preoperatively where in saddle anesthesia is a hallmark could be a matter of debate. However, it is beyond the scope of this study to explain these findings. PAS is a patient reported, subjective feeling, hence a potential for bias cannot be ruled out. We believe that though patients reported normal PAS, had decreased sensations in perianal region and were unable to categorically report.

VAC is affected in CES and is decreased or absent in patients with CES. Literature reports, range of 7.6%–52% for the association of VAC with CES.^{12,13} We found that VAC was either absent (n = 36) or weak (n = 50) but present in 21 patients. This was an objective finding; therefore, unlikely to be false positive.

In this study, though there were considerable number of patients with intact PAS (n = 31/107), UDS showed to effectively quantify them as acontractile bladder and were advised urgent surgical decompression. Similarly 37/107 patients who had weak PAS on clinical examination showed to be acontractile on UDS findings. The percentage improvement in UDS was not different across the pre-operative PAS categories of weak, absent or present (p = 0.430). UDS also helped to quantify the amount of detrusor function in patients complaining with voiding disturbances but with intact VAC (S2-4), acontractile bladder was seen in 12 such patients and hypocontractile in 9 patients similarly 33 patients revealed to be acontractile and 17 patients were hypocontractile in spite of having weak VAC. The percentage improvement in UDS was not different across the pre-operative VAC categories of weak,

absent or present (p = 0.218). Surprisingly, there were 10 patients who had intact motor and sensory neurology with sphincter disturbance with MRI showing Herniated lumbar disc causing severe thecal sac compression. Urodynamic studies was able to quantify the bladder dysfunction in these cases with diagnostic dilemma, 7 of them had acontractile and 3 had hypocontractile bladder who recovered completely after urgent decompression.

Postoperatively Urodynamic studies were helpful to differentiate whether there was recovery in detrusor function in patients who reported normalcy of voiding. Present study had 15 patients with weak PAS and 1 patient with absent PAS, whose detrusor function was normal. Similarly there was normal detrusor function in 23 patients with weak VAC and 5 patients with absent VAC. The reason for this differential return of bladder function with incomplete recovery of PAS and VAC is yet to be understood completely. Differential ischemia of the supplying nerve roots may be a possible explanation for this differential recovery pattern which requires further understanding.

It is controversial to choose the best time to do the surgery with some authors supporting early intervention^{7,14-21} and others finding no correlation between timing and outcomes.^{13,22-25} It is also controversial on whether the timing of surgical decompression is effective on motor function, sensory and improvement in urinary disorder created. However, exact information about the role and effectiveness of clinical information in follow-up period is not available.^{1,20,26} Due to high morbidity associated with CES and insufficient knowledge regarding the symptoms and urodynamic findings, the need for this comprehensive study was felt. So the study was conducted in order to probe extensively and study the predictive effect of urodynamic studies in patients with this syndrome.

A meta-analysis by Ahn et al.⁷ provided a recommendation for treatment within 48 hours. The authors concluded that treatment within 48 hours but not 24 hours was advantageous. However, the statistical methods followed were not approved.¹⁶ DeLong et al.¹⁹ did a comprehensive meta-analysis with stringent inclusion criteria than Ahn et al., and concluded that earlier intervention at 36 hours was beneficial.¹⁹ However, prospective use of validated questionnaires by McCarthy et al.²⁷ and Qureshi and Sell²⁸ did not support a relationship between timing and patient-reported quality of life. All these prior studies analyzed time (Onset of symptoms to surgery) as a discrete variable, though convenient does not represent the pathophysiology of the lesion.

Relationship of duration of compression in continuum with cauda equina injury has been less investigated. Though duration of symptoms affects outcome in CES, it is plausible to speculate that it drives a constant decay in outcomes. Using distinct thresholds, such as 24 or 48 hours, though practical, do not likely mirror the biochemical and cellular aspects neuronal damage.^{17,18} Present study is unique as it treats time as a continuous variable determining the time of onset of symptoms to surgery required detailed reporting in the medical record. All the data was collected from medical records of patients. As

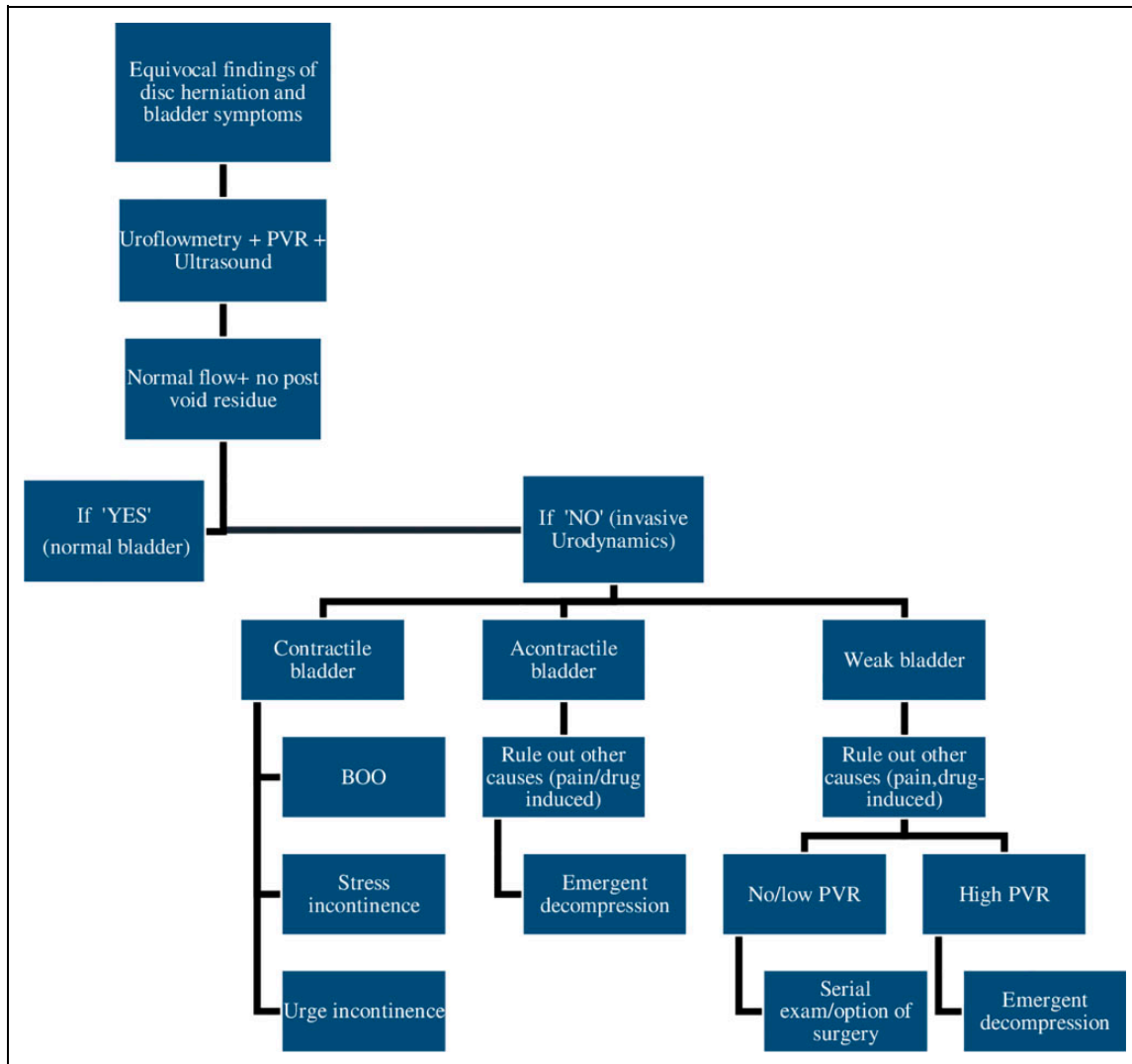


Figure 6. Flowchart for clinical and urodynamic assessment of a patient presenting symptoms of voiding dysfunction with lumbar disc herniation.

patients self-reported the onset of voiding disturbances, may not be entirely reliable. Recorded times of symptom onset and surgical decompression were deemed reliable. Single-centre nature of the study is both a shortcoming and strength. In this study, though patients were not largely similar sufficient data was collected to quantify time to surgical procedure in hours. In spite of these limitations, present study is among the largest CES cohorts reported in literature in this regard. In the present study we quantified time to surgery from the symptom onset into 4 groups (<12 hours, 12-24 hours, 24-48 hours and >48 hours). The present study shows similar results (Table 5) as shown by Ahn et al.⁷ in their meta-analysis recommending early decompressive surgery within 48 hours of symptom onset.

Also in this study we recorded timing of leg pain duration to bladder symptom onset and recovery patterns using the urodynamics studies. The results showed that acute onset bladder symptoms with acute leg pain had a favorable recovery patterns

when compared to chronic leg pain with sudden onset bladder symptoms. Predictors of outcomes in CES have proved elusive, akin to surgical management of acute spinal cord injury.^{29,30} Time-dependent cellular and physiologic effects of cauda equina impingement could be irreversible well before patients reach surgery, leaving outcome dependent on other factors, which may explain that chronic compression of nerve roots causing leg pain with acute exacerbation leading to voiding dysfunction and irreversible damage reducing chances of recovery. The presence of saddle anesthesia and absent voluntary anal contraction may be an indicator of the severity of tissue damage, as it was associated with persistent symptoms in this study. Overall, CES outcomes remain difficult to prognosticate.

The lack of prognostic value of presenting variables emphasizes the multifactorial complex etiology of CES. Also it is difficult to determine guidelines for diagnosis, prognosis, and treatment. Hence our institute follows a guided examination

protocol for the patient presenting with bladder symptoms especially with equivocal findings as shown in the Figure 6.

Our study indicates the relationship between early diagnosis and treatment and the extent of detrusor impairment. The improved bladder function in our patients, where preoperative micturition disorders were short-lasting. Our results point out the importance of careful urological evaluation in patients with back ache and sciatica. Furthermore we would like to stress the importance of a close observation of bladder function in the postoperative period in an attempt to prevent detrusor damage due to myogenic decompensation.

Limitations of the Study

Firstly a single centre study and non-randomised study is a major limitation to the present study. Emergent nature of the condition and need for urgent decompression in equivocal cases may be the reason for non-randomization. Secondly PAS is a subjective variable which may be biased observation. Also we had to rely on the patient and medical records for the symptom onset duration for calculating the time duration from onset to surgical decompression.

Conclusion

Urodynamic study is indispensable in classifying, diagnosing, treating and predicting the neurogenic bladder dysfunction in CES. Adjuvant information from urodynamic studies in combination with the examination and imaging help in accurate diagnosis even in in patients with no objective motor and sensory deficits. Early decompressive procedure in equivocal cases proven by urodynamic studies improves bladder outcomes. Quantitative findings on urodynamic study are clearly consistent with the recovery level of patient's ability to void and can be used as a prognostic factor in these patients and represents an improvement.


Declaration of Conflicting Interests

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