Original Article

Urodynamic Study of Bladder Function in Patients with Lumbar Compression Disorders and the Effect of Decompressive Surgery

Alaa A. Farag (MD), Osama Abdel Wahab (MD)
Neurosurgery and Urology Departments, Banha University

ABSTRACT

Background: Patients with lumbar spinal canal compression not only experienced leg neuropathy but also lower urinary tract symptoms. There are few reports concerning the prevalence of bladder symptoms and the effect of decompression on urodynamic findings. Objectives: The goal of the present study is to determine the incidence of bladder symptoms and urodynamic findings in lumbar spinal compressive disorders and report on outcomes in patients who have undergone decompressive surgery. Patients and Methods: This prospective study included 35 consecutive patients with lumbar spinal compressive disorders and report on outcomes in patients who have undergone decompressive surgery. Results: There was significant difference between the two studied groups regarding the occurrence of urological symptoms. In the present study, among those 18 patients in group II, areflexic bladder was the most frequent urodynamic diagnosis encountered in 12 (66.6%) patients and 6 (33.4%) of patients were with detrusor overactivity. 6 patients with areflexic bladder showed improvement post operatively. Patients with preoperative neuropathic detrusor overactivity became normal postoperatively. Conclusion: Decompression surgery had a beneficial effect not only on urological symptoms but also on urodynamic study of bladder function.

INTRODUCTION

Lumbar disc disease (LDD) and lumbar spinal stenosis (LSS), causing sciatic pain, can be complicated with urinary voiding dysfunction owing to the common location of somatic nerves and the parasympathetic nerves to the bladder in the cauda-equina (15). The somatic nerves to the bladder, originating from the III and IV sacral segments, reach the external sphincter and other pelvic floor musculature. The parasympathetic pelvic nerves originate from the second to the fourth sacral segments of the spinal cord. They conduct the main excitatory input to the bladder. The sympathetic pathways are provided by the hypogastric nerves arising from I, II and III lumbar segments (2,12,25).

Lower urinary tract symptoms result from compression of the parasympathetic fibers of $S_2-S_4$ nerve roots innervating the bladder. However, the prevalence of lower urinary tract symptoms in patients with LSS or LDD varies, according to the literature, because of differences in subjective symptoms and urodynamic abnormalities (8,13,28). Previous reports have shown lower urinary tract symptoms with disc herniation in up to 50% of patients with matching urodynamic findings (19). According to the literature, the prevalence of lower urinary tract symptoms associated with LSS ranges from 50% to 80% (14).

The primary aims for treatment of neurogenic bladder are: Preservation of the upper tract function; ensuring that detrusor pressure remains within safe limits during both the filling phase and the voiding phase. Improvement of urinary continence to prevent urinary tract infection and Restoration of the lower urinary tract functions in patients with detrusor overactivity or detrusor sphincter dyssynergia (6,7,11,22).

The goal of the present study is to determine the incidence of bladder symptoms and urodynamic findings in lumbar spinal compressive disorders and report on outcomes in patients who have undergone decompressive surgery.

PATIENTS & METHODS

This prospective study included thirty five (35) consecutive patients with lumbosacral root syndrome due to lumbar disc prolapse and/or lumbar canal stenosis with or without overt bladder dysfunction, scheduled for surgery in the department of Neurosurgery at Banha University Hospital during the period from 2009 to 2012.

Inclusion Criteria:

- All patients (males and females) scheduled for surgery for lumbar intervertebral disc prolapse and/or lumbar canal stenosis.

Exclusion criteria:

- Active urinary tract infection.
- Patients with infravesical obstruction.
- Diabetic patients.
- Patients with vesicoureteral reflux.
- Patients with senile prostatic hyperplasia.
Patients grouping:

Patients were classified according to the preoperative urodynamic results into:  **Group I**: patients with pre-operative normal bladder function.  **Group II**: patients with pre-operative bladder dysfunction.

Patients were subjected to the following workup:
- **Thorough history taking.**
- **Full clinical examination including:**
  - a) General examination
  - b) Clinical neurological examination
  - c) Urological examination

**Laboratory Investigations:**

- **Radiological Investigation**

**Urodynamic evaluation**

Urodynamic study was conducted pre-operatively and 3 months after lumbar decompression by one urologist who was unaware of the final diagnosis and just conducted the study procedures objectively. At the beginning of the urodynamic study, an 8- F double lumen catheter was introduced into the bladder. After urination, the residual bladder volume was measured by aspirating residual urine through a catheter and measuring the volume using a syringe.

All urodynamic tests were done under the same circumstances, using the ANDROMEDA medizinische system. The tests were done under complete aseptic technique to all patients preoperatively and at least three months postoperatively.

- **i) Uroflow:** Flow rates were recorded as patients voided privately in the sitting (women) or standing (men) position. Every patient was instructed to be relaxed, not to strain during micturition.

- **ii) Cystometry:** With the patient supine a double lumen 8 Fr. urodynamic catheter (Forges - France) was introduced into the bladder transurethrally. One lumen was used for bladder filling with saline at room temperature at rate of 50 ml per minute. The other lumen was connected to an external pressure transducer for measuring the intravesical pressure. The catheter was taped with adhesive plaster to the medial side of the patient's thigh.

- **iii) Pressure-flow studies of micturition:** When the patients have to urinate, bladder filling was stopped. The measuring system seated to voiding phase. Readjustment of the height of pressure transducer was carried out. The patient was asked to cough to check pressure response. Then the patient was allowed to void.

In our study the diagnosis of detrusor areflexia was made according to the recommendation of the International Continence Society Committee on Standardisation of Terminology. Detrusor areflexia was diagnosed if the absence of detrusor contraction was indicated by simultaneous measurement of intravesical and abdominal pressure during the voiding phase. Due to the absence of detrusor contraction the patient voids by abdominal straining. In the presence of detrusor areflexia intravesical pressure increases through increased abdominal pressure. The diagnosis of "Detrusor Hypereflexia" was made if the presence of detrusor repeated contraction with muscle irritability and minor evoked ms potentials.

All patients were operated upon for decompressive lumbar surgery at the appropriate level by the surgical team in the neurosurgery department, Banha university hospital.

All patients were conducted for follow up scheme same as preoperative work up at least 3 months postoperatively.

**RESULTS**

The present study included thirty five patients with lumbosacral root syndrome due to lumbar disc prolapse and/lumbar canal stenosis with or without overt bladder dysfunction, scheduled for surgery in the department of Neurosurgery at Banha University Hospital. Patients’ age ranged from 36 to 67 years (mean 48 years); 19 patients were male.

A diagnosis of LDD or LSS was confirmed in all patients, using radiological evidence. 15 cases (42.8%) had one-segment involvement, 11 cases (31.5%) had two-segment involvement, 6 cases (17.2%) had three-segment involvement and 3 cases had four segment involvements (8.5%). The Patients were classified pre-operatively into two groups according to preoperative urodynamic function of the bladder:

- **Group I:** patients with pre-operative normal bladder function (17 patients).
- **Group II:** patients with pre-operative bladder dysfunction (18 patients).

There was significant difference between the two studied groups regarding the occurrence of urological symptoms. Fifteen of the patients (88.2%) from group I had no urological complaint and only two were symptomatic. On the other hand Urological symptoms were present in seventeen patients from group II (94.4%) in the form of stress incontinence, frequency, urgency, overflow dribbling, straining with incomplete evacuation and repeated urinary tract infection, while only one patient was urologically free.

**Post voiding residual urine (PVR) assessment:**

In group I, the residual of urine was below 45 ml., while in group II, residual urine volume ranged from 60-180.

Post operative (PVR) change was no significant in group I. Post operative (PVR) change was a significant parameter in the improvement of patients in group II (table 1).
**Table (1): Pre and Post Operative PVR Volume In The Two Studied Groups**

<table>
<thead>
<tr>
<th>Post Voiding Residual PVR (ml)</th>
<th>GROUP I NO=17</th>
<th></th>
<th>GROUP II NO=18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre op</td>
<td>Post op</td>
<td>Pre op</td>
</tr>
<tr>
<td>NO</td>
<td>%</td>
<td>NO</td>
<td>%</td>
</tr>
<tr>
<td>0------30</td>
<td>13</td>
<td>76.4</td>
<td>0</td>
</tr>
<tr>
<td>31------60</td>
<td>4</td>
<td>23.6</td>
<td>4</td>
</tr>
<tr>
<td>61------90</td>
<td>0</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>91------120</td>
<td>0</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>121------180</td>
<td>O</td>
<td>OO</td>
<td>0</td>
</tr>
</tbody>
</table>

**Preoperative and postoperative urodynamic studies:**

**Maximum urinary flow rate (Q.max.):**

The maximum flow rate was measured for all patients (35 patients). The 17 patients of group I (48.5%) of patients had Q max >11mL/sec, two patients were with equivocal range and the others were normal rate. Post operative (Q.max.) change was insignificant parameter in the improvement of patients in group I.

The Q.max among 18 patients of group II ranged from 3 to 14 ml/sec with two patient only in the equivocal range while other sixteen were below accepted rate. Post operative (Q.max.) change among 18 patients of group II was significant parameter in the improvement of patients in group II as a post operative range was 6-20 ml/sec, with marked improvement of the pre op. values (table 2).

**Table (2): Pre and Post Operative Q.Max in the Two Studied Groups**

<table>
<thead>
<tr>
<th>Q.MAX (ml/SEC)</th>
<th>GROUP I NO=17</th>
<th></th>
<th>GROUP II NO=18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre op</td>
<td>Post op</td>
<td>Pre op</td>
</tr>
<tr>
<td>NO</td>
<td>%</td>
<td>NO</td>
<td>%</td>
</tr>
<tr>
<td>0 - ------&lt;10</td>
<td>0</td>
<td>00</td>
<td>0</td>
</tr>
<tr>
<td>11- ------&lt;15</td>
<td>2</td>
<td>11.8</td>
<td>1</td>
</tr>
<tr>
<td>16- ------&lt;20</td>
<td>15</td>
<td>88.2</td>
<td>14</td>
</tr>
<tr>
<td>21- ------&lt;25</td>
<td>0</td>
<td>00</td>
<td>2</td>
</tr>
</tbody>
</table>

**Cystometry and pressure flow study:**

In the present study, the first sensation to void preoperatively in group I patients ranged from (180 to 250) ml saline, postoperatively the first sensation ranged from (195 to 230) ml saline. It was insignificant improvement in bladder sensation. On the other hand in group II patients, the first sensation preoperatively ranged from (80 to 900) ml saline, postoperatively the first sensation was ranging from (150 to 700) ml saline. It was significantly improved in the first sensation.

In the present study, the cystometric capacity in group I patients preoperatively was ranged from 350 to 560ml saline and postoperatively it was ranged from 400 to 620 ml saline. It was insignificant as the cystometric capacity was within the normal limits preand postoperatively. The cystometric capacity in group II the range was 250 to 1600 ml saline preoperatively and ranged from 480 to 1150ml saline postoperatively, but here the difference was significant.

In the present study, among those 18 patients in group II areflexic bladder was the most frequent urodynamic diagnosis encountered in 12 (66.6%) patients and 6 (33.4%) of patients were with detrusor overactivity. The maximum detrusor pressure in 12 patients with areflexic bladder was ranged from 4 to 20 cm H2O while it ranged from 15 to 63 cm H2O in those 6 patients with neuropathic detrusor overactivity. The maximum detrusor pressure in the 17 patients in group I was ranged from 16 to 35 cm H2O.

In the present study, follow up of the 18 patients who had preoperative abnormal pressure-flow parameters (group II) for at least three months after surgical interference. We found that areflexic bladder was encountered in twelve patients preoperatively, six patients showed improvement post operatively Fig. (2). Patients with preoperative neuropathic detrusor overactivity became normal postoperatively Fig. (1).
Fig. (1): (a) Urodynamic study revealed decrease bladder capacity, with early detrusor overactivity and increase filling pressure. (Detrusor overactivity.) (b) Post-op urodynamic study revealed: normal urodynamic study.

Fig. (2): (a) Urodynamic study revealed: low pressure, low flow, interrupted straining pressure with breathing and marked increase of bladder capacity (detrusor areflexia). (b) Post-op urodynamic study revealed: normal urodynamic study.
DISCUSSION

Bladder filling and emptying involve the peripheral sympathetic, parasympathetic and somatic innervations of the lower urinary tract (27). The sacral reflex centre (S₂ – S₄) participates in modulating bladder contraction and fullness. The conus medullaris in adults is usually located at the level of the first vertebral body (28). Thus, lumbar spinal stenosis usually causes lower rather than upper motor neuron lesions. Nerve compression may lead to structural neuronal damage, neuronal ischaemia or oedema, and axonal transport inhibition (17,24).

Previous reports have shown lower urinary tract symptoms with disc herniation in up to 50% of patients with matching urodynamic findings (9). According to the literature, the prevalence of lower urinary tract symptoms associated with LSS ranges from 50% to 80% (10). In this study, 54% of patients complained of urological symptoms.

Residual urine is defined as the volume of fluid remaining in the bladder immediately following the completion of micturation. The measurement of residual urine forms an integral part of the study of micturation. Under normal circumstances, the bladder should evacuate its content of fluid completely following normal voiding. Some patients with disc prolapse who develop bladder dysfunction have large capacity bladders that may also empty incompletely. This can coexist with initially high voiding pressure and an overactive detrusor (9).

In the present study, comparing the two groups of patients as regard the residual urine preoperatively, only 4 patients (23.6%) in group I, baseline P.V.R. urine volume was high (>30 ml), but in other patients in the same group, the volume was (<30 ml). On the other hand, P.V.R urine volume in group II patients was abnormally high in 11 patients ( >100 ml) and only 7 patients had residual volume (<100 ml). The difference in P.V.R. volume in both groups was significant.

Follow up of patients at least three months postoperatively, for patients in group I the residual urine was normal (< 30 ml) in all patients. The difference between the residual volume pre and postoperative in group I was insignificant. For patients in group II there was also improvement in P.V.R. volume towards the normal side and the difference was significant. Deen et al. found that P.V.R urine volume is one of the most sensitive indicators of bladder function and its response to decompressive laminectomy (10).

Uroflowmetry is the only noninvasive urodynamic test available (24). It is a reflection of the final result of the act of voiding and is therefore influenced by a number of variables. These include the effectiveness of the detrusor contraction, the completeness of sphincter relaxation and the patency of the urethra (9). Because of these variables, Uroflowmetry cannot be used as a diagnostic study, but together with the measurement of residual urine it provides an estimate of the effectiveness of the act of voiding and is a rapid and economic screening tool (56).

In the present study, there was insignificant improvement in maximum urinary flow rate (Q max) in group I patients postoperatively. But, in group II patients there was significant improvement in Q max postoperatively. Maximum urinary flow rate and post voiding residual urine volume are indicators of detrusor function. Thus, improvement in these two factors may be considered as evidence of improved bladder function. Our results regarding the Q max improvement correlates with that found by Deen et al and Bartolin et al (4,10) in their work.

Cystometry remains the most accurate tool for evaluating the filling component of bladder function. During the course of cystometry information is sought regarding, the bladder's sensation, capacity, compliance and the occurrence of involuntary contraction (18). First sensation of bladder filling is the filling the patient has, during cystometry, when he/she first becomes aware of the bladder filling (26). Cockayne et al (9), reported that, vesical sensation could be, hypersensitive (volume at first sensation <150 ml) or hyposensitive (volume at first sensation > 250 ml) bladder.

In the present study, the first sensation to void preoperatively in group I patients ranged from (180 to 250) ml saline, while in the postoperative cystometry, the first sensation was ranged from (195 to 230) ml saline and it is insignificant improvement in bladder sensation. On the other hand in group II patients, the first sensation preoperatively ranged from (80 to 900) ml saline, postoperatively the first sensation was ranged from (150 to 700) ml saline and there is significant improvement in the first sensation.

In the present study, the cystometric capacity in group I patients preoperatively was ranged from 350 to 560ml saline and postoperatively it was ranged from 400 to 620 ml saline. It was insignificant as the cystometric capacity was within the normal limits pre and postoperatively. In patients in group II the range was 250 to 1600 ml saline preoperatively and ranged...
from 480 to 1150ml saline postoperatively, but here the difference is significant.

Deen et al. (10) found that bladder capacity do not change significantly after operation. Bartolin et al. (3) reported that there is a significant improvement of bladder capacity postoperatively in both groups of patients with or without bladder dysfunction.

Preoperative pressure-flow studies were conducted for all patients and according to its results we classify the patients into 2 groups: Seventeen patients (48.5%) had normal pressure flow parameters and were diagnosed as normal as regard to the voiding function and named group I. Their maximum detrusor pressure was within the normal range, it was ranged from 13 to 30 cm H2O, while their maximum flow rate (Q max) ranged between 11 and 20 ml/sec. Bartolin et al (3) reported more or less similar parameters for the patients with preoperative normal urodynamic studies.

Eighteen patients (51.5%) were diagnosed as abnormal as regard to the voiding function with abnormal pressure-flow parameters. Their maximum detrusor pressure ranged from 3 to 10 cm H2O, while their maximum flow rate (Q max) ranged from 6 to 12 ml/sec, for 12 patients with areflexic and underactive bladder, while the maximum detrusor pressure for the remaining 6 patients with neuropathic detrusor overactivity was ranged from 25 to 48 cm H2O. Bartolin et al (3) found nearly the same, as maximum detrusor pressure in patients with detrusor dysfunction ranged from 6 to 24 cm H2O, while their maximum flow rate Q. max ranged from 2 to 16 ml/sec.

Detrusor areflexia correlates with obstructive voiding symptoms and stress incontinence due to overflow or lack of resistance at the level of the external sphincter. In the case of detrusor overactivity, patients usually complain of urgency and urge incontinence, and in some cases these symptoms are observed even when urodynamic testing is normal (3). In the present study, among those 18 patients in group II areflexic bladder was the most frequent urodynamic diagnosis encounters in (66.6%) of patients and (33.4%) of patients with detrusor overactivity.

Bartolin et al. (3) found detrusor areflexia was noted in 47.2% of the patients with lumbar intervertebral disc protrusion, detrusor overactivity was noted in cases with lumbar spinal stenosis. O’Flynn et al (19) found 65% of patients had detrusor areflexia and, voided by straining. Sandri et al. (2) reported detrusor overactivity in 3 of 54 patients operated on for lumbar intervertebral disc protrusion but provided no data on preoperative urodynamic finding of those 3 patients. Bartolin et al (4) concluded that bladder function usually remain unchanged after surgery for lumbar intervertebral disc protrusion, normal cystometric findings often remain normal postoperatively.

In the present study, follow up of the 18 patients who had preoperative abnormal pressure-flow parameters (group II) for at least three months after surgical interference. We found that areflexic bladder was encountered in twelve patients out of eighteen preoperatively, 6 patients postoperatively showed improvement of the cystometric findings. Patient group with preoperative neuropathic detrusor overactivity became normal postoperatively.

Bartolin et al (4) reported that bladder function recovered in a small proportion of his patients with detrusor dysfunction namely areflexia (6 patients improved out of 27 after laminectomy).

The present study suggests that lumbar decompression contributes to relieving neurogenic bladder dysfunction in patients with lumbar compression disorders. Buchner and Schiltenwolf (5) reviewed 22 patients who underwent surgical decompression following a diagnosis of cauda equina syndrome due to LDH, 17 of whom (77%) recovered complete urinary function following surgery. Radulovic et al. (21) reported that 89% of patients with cauda equina syndrome, caused by disc herniation, achieved good or excellent results in bladder function recovery. No patient with normal urodynamic results in the present study developed abnormalities after surgery, which demonstrated that decompression surgery was an effective treatment with a good safety profile.

There were some inherent limitations to the present study, including the relatively small number of patients and the short follow-up period. Data from a larger patient population that include long-term outcomes are necessary to determine whether the results remain consistent.

CONCLUSION

Complete evaluation of the neural activity of patients with lumbar intervertebral disc prolapse and lumbar canal stenosis should include an examination of both somatic and visceral components. Preoperative normal bladder function in patients with LDD and L CS often remains normal after decompressive surgery. Decompression surgery had a beneficial effect not only
on urological symptoms but also on urodynamic study of bladder function.

REFERENCES


