Neurophysiological and Urodynamic Study of Sphincteric Disturbances

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ABSTRACT

Incontinence of urine or feces is a devastating disability. It may be found in association with central nervous system disorders or may also develop when there is damage to the motor or sensory pathways in the cauda equine. However, most patients with incontinence have no evident neurological disorders. To assess the integrity of innervations and function of sphincters, different neurophysiological techniques and urodynamic tests were used in patients of spinal cord lesion with sphincteric disturbances (sacral and suprasacral group) and another control group. The results of these tests were compared in these groups to determine their value in assessment of sphincteric disturbances. We found that Electromyography (EMG) of external anal sphincter and Bulbocavernosus Reflex (BCR) were more valuable in assessment of patients with sacral lesion and sphincteric disturbances with detrusor areflexia. While Central Motor Conduction Time (CMCT) and Central Sensory Conduction Time (CSCT) of pudendal nerve were more valuable in assessment of patients with suprasacral lesion and sphincteric disturbances with detrusor hyperreflexia or dysinnervation. (Egypt J. Neurol. Psychiat. Neurosurg., 2006, 43(1): 519-527)

INTRODUCTION

Neurological examination of pelvic floor structures is difficult and although urodynamic studies and ano-rectal manometry may demonstrate the pathophysiological behaviour of an organ, such investigation does not probe the neurological basis of the disorder. Indeed neurophysiological tests may be the only evidence of organic pathological affection to that structures\(^1\).

Electrophysiologic tests of the sacral neuromuscular system and its suprasegmental control may be divided into EMG and methods involving stimulation (i.e., evoked potential and sacral reflex testing). The latter group of methods tests the function of defined parts of the motor or sensory nervous system, or reflex arcs. There already is ample experience with testing the somatic sensory pathways (pudendal SEP) and the (somatic) sacral reflex arc, whereas other methods (testing the motor system and tests involving visceral afferents and sympathetic efferents) need further study to establish their proper place in everyday clinical diagnostics\(^2\).

This work aimed to evaluate the integrity of innervation and function of the sphincters using different neurophysiological techniques and urodynamic studies in a group of patients with sphincteric disturbances and neurological disorders compared to healthy control subjects. Also to determine the value of this methods in assessment of sphincteric disorder in those patients.

SUBJECTS AND METHODS

Seventy adult male patients with sphincteric troubles suspected to be of neurogenic origin were included in this study besides fifteen healthy adult male volunteers comparable in age and height were used as a comparison group who had the mean age of 34.4±5.3 years (range: 23-42 years).
Patients were categorized into two groups:

Group 1:
This group consisted of 35 patients with symptoms and signs of sacral cord affection (conus) or lumbosacral root affection (cauda) with sphincteric troubles and their age ranged from 23 to 43 years (34.3±4.4).

Group 2:
This group consisted of 35 patients with symptoms and signs of spinal cord affection above sacral area with sphincteric troubles and their age ranged from 23 to 37 years (33.4±9.4).

Sphincteric disorders were classified into:
- Emptying disorders including difficult micturition, hesitancy, retention of urine and constipation.
- Storage disorders including urgency, urge incontinence, precipitancy of micturition, incontinence of urine or stool.
- Sexual disorders including erectile dysfunction, ejaculatory dysfunction, orgasmic dysfunction.
- Mixed disorders including more than one of the previous symptoms.

Exclusion criteria
Patients with symptoms and signs of intracranial pathology, diabetes or urinary tract infection, skull defect or prior brain surgery, history of epilepsy, cardiac pace maker or metallic prosthesis as well as peripheral nerve dysfunction were excluded from the study.

All subjects (patients and controls) were subjected to the following:
1. Neurological evaluation with detailed history & physical examination.
2. Urological evaluation with detailed history of voiding and Sexual functions.
3. Neurophysiological assessment of the neurogenic control of sphincter including:
   - EMG of anal sphincter and Bulbocavernous reflex (BCR).
   - Motor evoked potential of external anal sphincter by trans-cranial and trans-sacral magnetic stimulation.
   - Pudendal somatosensory evoked potentials (cortical and sacral).
4. Urodynamic study of the urinary bladder including:
   - Uroflowmetry and Cystometry
   - Pressure flow study with kinesiological EMG recording
5. Other investigations when necessary (Radiological, Penile duplex etc…).

RESULTS

In the first group (sacral group):

Neurophysiological results:
- There is high frequency of emptying disorders in this group in comparison to the suprasacral group (Table 1).
- There is statistically significant abnormal EMG and BCR indices in this group in comparison to the suprasacral group (Fig. 1).
- There is statistically significant high frequency of abnormal EMG (56.2%) and BCR (53.4%) indices in patients suffering from emptying sphincteric disorders than other patients.

Urodynamic results:
There is statistically significant high frequency of detrusor areflexia, high maximum cystometric capacity and compliance with decreased in sensation to micturition desire in this group in comparison to the suprasacral group. Also, there is positive correlation of detrusor areflexia and emptying disorders (Table 2).

In the second group (suprasacral group):

Neurophysiological results:
- There is high frequency of storage disorders in this group in comparison to the sacral group (Table 1).
- There is statistically significant high frequency of abnormal Central Sensory Conduction Time (CSCT) and Central Motor Conduction Time (CMCT) in this group in comparison to the sacral group. Also there is positive correlation between CSCT and CMCT (Table 3).
• There is statistically significant high frequency of abnormal CSCT (48%) and CMCT (48.1%) in patients suffering from storage sphincteric disorders than other patients.

Urodynamic results:
There is statistically significant high frequency of detrusor hyperreflexia, low maximum cystometric capacity and compliance with increased urgent sensation to micturition desire in this group in comparison to the sacral group. Also, there is positive correlation of detrusor hyperreflexia and storage disorders (Table 2).

Table 1. Number and percentage distribution of sphincter disorders among the study groups.

<table>
<thead>
<tr>
<th></th>
<th>Group (2) Sacral (N=35)</th>
<th>Group (3) Suprasacral (N=35)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Emptying disorder</td>
<td>22</td>
<td>62.8</td>
</tr>
<tr>
<td>Storage disorder</td>
<td>5</td>
<td>14.2</td>
</tr>
<tr>
<td>Mixed disorder</td>
<td>5</td>
<td>14.2</td>
</tr>
<tr>
<td>Sexual disorder</td>
<td>3</td>
<td>8.5</td>
</tr>
</tbody>
</table>

Table 2. Comparisons of urodynamic pattern among study groups.

<table>
<thead>
<tr>
<th>Urodynamic pattern</th>
<th>Group (1) Normal (N=15)</th>
<th>Group (2) Sacral (N=35)</th>
<th>Group (3) Suprasacral (N=35)</th>
<th>X²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>%</td>
<td>No</td>
<td>%</td>
<td>No</td>
</tr>
<tr>
<td>Normal</td>
<td>15</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Areflexia</td>
<td>0</td>
<td>0</td>
<td>31</td>
<td>88.5</td>
<td>4</td>
</tr>
<tr>
<td>Dyssenergia</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5.7</td>
<td>8</td>
</tr>
<tr>
<td>Hyperreflexia</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>5.7</td>
<td>23</td>
</tr>
</tbody>
</table>
Table 3. Mean and standard deviation of Central Sensory Conduction Time (CSCT) and Central Motor Conduction Time (CMCT) among study groups.

<table>
<thead>
<tr>
<th>Group (1)</th>
<th>Group (2)</th>
<th>Group (3)</th>
<th>F test</th>
<th>P .value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (N=15)</td>
<td>Sacral (N=35)</td>
<td>Supra sacral (N=35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X ± SD</td>
<td>X ± SD</td>
<td>X ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSCT</td>
<td>29.8±3.4</td>
<td>29±3.8</td>
<td>68.8±10.8</td>
<td>123.58</td>
</tr>
<tr>
<td>CMCT</td>
<td>17.25±1.85</td>
<td>18.77±0.73</td>
<td>26.3±3.09</td>
<td>104.3</td>
</tr>
</tbody>
</table>

DISCUSSION

High frequency of emptying disorders and sexual disorders among sacral group and high frequency of storage disorder and mixed disorder among suprasacral group were in partial agreement with previous study which reported increased frequency of storage symptoms (increased frequency, urgency and urge incontinence) in patients with signs of upper motor neuron lesion. While increased frequency of emptying disorders in patients with signs of lower motor neuron lesion which was correlated with hyporeflexic bladder

Also, Jeffrey and David, Podnar et al., concluded in their study that there was significant sexual impairment in men with lesions of the cauda equina or conus medullaris.

On the other hand, Pavlakis et al., found high frequency of storage disorder among patients with sacral lesion and this finding was supported by the presence of EMG neuropathic changes in the external anal sphincter of such patients. Also Jeffrey and David, Siroky, reported that there is increase in frequency of emptying disorder in patients with supra-sacral lesion and this finding was supported by the presence of detrusor-sphincter dyssynergia on urodynamic study that results in functional obstruction of bladder outlet.

In patients with sacral lesion this debate may be interpreted by presence of different nerve fiber populations that are mainly responsible for each of these functions (storage and emptying). They not only occupy a slightly different position within the sacral area but they also show different resistance to compression (the parasympathetic fibers being thinner than the somatic fibers). Also, in patients with suprasacral lesion the degree and duration of spinal cord lesion affecting the pattern of sphincteric dysfunction. Thus in acute stage (spinal shock) and partial cord injury, the predominant pattern was emptying disorder which was associated with areflexic bladder or detrusor-sphincter dyssynergia, respectively. While in chronic or complete affection of spinal cord the predominant pattern were storage disorder which were associated with hyper-reflexic bladder.

Electromyography:

The anal sphincter EMG in control group which showed no spontaneous activity or polyphasicity with complete interference pattern were in partial agreement with previous study which reported that normal muscle action potential is bi- or triphasic with amplitude up to 3000 μV and duration up to 10 msec.

Also, another study stated that , the normal EMG may produce polyphasic potentials but these should be less than 5 % of all potentials.

Vodusek and Zidar, studied the MUP amplitude and polyphasia in external anal sphincter in 31 normal subjects and found that it was exceptionally exceeds 2000 μV and was never above 3000 μV. While the polyphasic MUPs were up to 12%. They used both single fiber and concentric needle electrodes. Also they considered the normal upper limit = mean value + 3SD. In their control group polyphasic potentials were found most frequently in the external anal sphincter, which might be most exposed to stretch and thus to a lesion of intramuscular nerve twigs.

Also, Mark, found that in a normal muscle, 10-15% of action potentials may have four or more phases.
The difference in percentage of polyphasic potentials may be explained by using of different types of recording electrode (single fiber, concentric needle etc...), or different site of recording in the pelvic floor and external anal sphincter muscle.

Increased frequency of neuropathic EMG changes among patients with emptying disorders than patients with other sphincteric disorders were in partial agreement with study of Podnar et al.6, where they concluded that there was poor correlation of sexual dysfunction and neuropathic EMG changes.

In contrast to our results, Pavlakis et al.7, found that patients with urinary incontinence (storage disorders) as the only manifestation had a 100% incidence of neuropathic EMG changes, where as such an EMG pattern was noted only in 53% of the patients with exclusively obstructive symptoms (emptying disorders).

The understanding of the neuro urologic dysfunction in these cases can provide a rational explanation of the symptomatic manifestations, emptying disorders could be secondary either to bladder denervation (sacral lesions with neuropathic EMG changes) or detrusor sphincter dyssnergy (suprasacral lesions with normal EMG). However, storage disorders could be secondary either to detrusor hyperreflexia (suprasacral lesion with normal EMG) or lack of resistance at the level of striated external sphincter because of perineal floor denervation (sacral lesion with neuropathic EMG changes).

Bulbocavernous Reflex

In the present study the BCR onset latency in the normal control was 36.5 (4.9) ms. This in partial agreement with previous reports2,12-19. Higher mean of BCR onset latency among sacral group than normal and suprasacral group were in agreement with previous studies 3,12,13,14,18,20. Significant prolonged mean of BCR duration among sacral group than normal and suprasacral group and non significant differences as regard BCR amplitude among all studied groups were in partial agreement with Yang and Bradley, who reported high variability in recording BCR amplitude21.

Abnormal BCR onset latency among patients with emptying disorders than patients with other sphincteric disorders were in partial disagreement with previous studies where they reported increased frequency of BCR abnormality among patients with sexual disorder21,22.

Motor Evoked Potential (MEP) from the pelvic floor by magnetic stimulation:

Transcutaneous magnetic stimulation was better tolerated by the patients and can be easily recorded with surface electrodes during mild pelvic muscle contraction. This experience was reported also by others17,23,24. MEP latencies were slightly shorter than those reported previously. Also, there were differences in the amplitudes with these studies2,15,16,17,19,24,25,26,27. The reason is perhaps due to the difference in the intensity and site of the stimulation used or the site and type of recording electrode. In our study we used surface recording electrode which covers a greater number of motor unit.

Higher mean of Tc-PMEPL and CMCT and lower mean of Tc-PMEPA among patients with suprasacral group than sacral and normal group were in partial agreement with others4,17,19,23,28. Also higher frequency of abnormal CMCT among patients with storage disorders than patients with other sphincteric disorders were in partial agreement with some of previous studies4,17,19,28 and were inconsistent with others23,27,29,30.

Pudendal Somatosensory Evoked Potential:

Higher mean of Co-PSEPL and CSCT among suprasacral group than sacral and normal group were in partial agreement with previous studies12,13,14,17,18,20,27,31-35. Strong positive correlation between CSCT and CMCT was consistant with that of Zhu and Shen19 and Mitwaly27.
Higher frequency of CSCT abnormalities among patients with storage, mixed and sexual disorders than patients with emptying disorders were in partial agreement with previous reports. On the other hand, Lucas and Thomas, reported that there is no clear correlation could be shown between bladder function and Lumbo-Sacral Evoked Potential (LSEP) finding. Also, Kalita et al., found no correlation of CSCT and pattern of bladder dysfunction. In addition Mathers et al., reported that central conduction time measurement was not specific for the pattern of sphincter disturbance with incontinence versus voiding dysfunction. Lastly, though some authors have doubts on the validity of the BCR and PSEP study, others stress their value.

Urodynamic results:
Significant higher frequency of areflexia among sacral group and higher frequency of hyperreflexia and dyssnergia among suprasacral group were in agreement with others. Also, Our results went with Amin et al., who studied 20 patients with spinal cord lesion (9 with UMNLS i.e. lesions proximal to the sacral cord, and 11 patients with LMNLs i.e. lesions involving the sacral cord or the cauda equina), and they found that 88.9% of patients with UMNLS had hyperreflexic detrusor, and 11.1% had hyporeflexic detrusor. While, 91% of patients with LMNLs had hyporeflexic detrusor. Significant higher frequency of detrusor hyperreflexia among patients with abnormal Central Motor Conduction Time (CMCT) and Central Sensory Conduction Time (CSCT) than normal Group were in partial disagreement with some previous studies, who concluded that there was a poor correlation of CMCT and pattern of lower urinary tract dysfunction (storage versus emptying) on urodynamic study.

Additionally, Haldemann et al., stated that a hyperreflexic bladder can be seen in patients with normal somatosensory evoked response and BCR. Presumably this is owing to lesions in the basal ganglia, or specific cortical or brainstem nuclei rather than to major ascending and descending pathways.

Significant higher frequency of detrusor areflexia among patients with abnormal EMG and BCR than patients with normal EMG and BCR were in agreement with Pavlakis et al., who stated in their results that the major neuromuscular features in patients with conus medullaris and cauda equina lesions were 1. an absent or substantially diminished bulbocavernosus reflex 2. detrusor areflexia on Cystometrography (CMG) and 3. neuropathic changes on perineal floor EMG. Also, some authors, concluded that there is detrusor areflexia in patients with neuropathic EMG pattern and sacral lesion.

Significant higher frequency of emptying disorder among patients with detrusor areflexia and higher frequency of storage disorder among patients with detrusor were in partial agreement with some previous studies.

Conclusion
- EMG and BCR abnormality are associated with emptying sphincteric disorders in patients with sacral lesion. While CMCT and CSCT abnormality are associated with storage sphincteric disorders in patients with suprasacral lesion.
- EMG and bulbocavernosus reflex are useful in selected patients with involvement of the sacral peripheral nervous system and sphincteric disturbances. While CMCT and CSCT are useful in selected patients with involvement of the suprasacral nervous system and sphincteric disturbances.
- Detrusor hyperreflexia are associated with storage sphincteric disorder and suprasacral lesion. While detrusor areflexia were associated with emptying sphincteric disorder and sacral lesion.

Recommendations
- Specific tests of autonomic innervation involving visceral afferents and sympathetic efferents e.g Perineal sympathetic skin
response (SSRs) or corpus cavernosal electromyography ‘CC- EMG’ needs further study to establish their proper place in everyday clinical diagnosis particularly in patients with sphincter troubles.

- Establishment of a unit and team members consisted of neurophysiologist, urologist and colo-rectologist to study organic and functional disorders affecting bladder, bowel and sexual function by using neurophysiological, urodynamic, manometry and defecography lab. for research and management of these disorders.
- Manometry and defecography in patients with fecal incontinence. Video-urodynamic with study of urethral pressure / flow study of flowmetry and study of EMG of detrusor and sphincter simultaneously in patients with micturition disorders are recommended.
- Using of these neurophysiological tests in the operating room was recommended to help the surgeon in selected procedures involving the pelvis (particularly conus and cauda equina) better to identify neuromuscular structures and to monitor their function throughout the operation in order to prevent subsequent development of lesions.

REFRENCES


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دراسة في سلوكية الأعصاب وديناميكية النبول في مرضى اضطراب العضلات القابضة البولية والشرجية والعقدة

تنتشر اضطرابات العصبية البولية والشرجية في مختلف الأعمار وتمثل عبء كبير في كثير من المرضى، الطبية والنفسية. وقد اعتمدت هذه الدراسة تقنيات تشخيص الجهاز العصبي السقب لتحديد الأعراض وتحديد مكان الإصابة والخلال باستخدام سلوكية الأعصاب وديناميكية النبول. وأيضاً تحقق دور هذه الطرق في تقليم هذه الاضطرابات.

وقد اعتملت الدراسة على 70 مريضاً من الذكور البالغين بعمر 15 من الأعمار المتطوعين كعينة صبابة. وقد تم تصنيف المرضى إلى مجموعتين: المجموعة الأولى (المجموعة العجزية) وتتكون من 35 مريضاً يتراوح من أعراض وعلامات إصابة المنطقة العجزية من الحبل الشوكي أو جدرانها مع اضطراب في العصبات البولية والشرجية والعقدة. المجموعة الثانية (المجموعة فوق العجزية) وتتكون من 35 مريضاً يتراوح من أعراض وعلامات إصابة المنطقة فوق العجزية من الحبل الشوكي مع اضطراب في العصبات البولية والشرجية والعقدة. ولم تشمل هذه الدراسة أي من المرضى الذين يعانون من إصابات الدماغ أو مرضى البول السكري أو عدوو الجهاز البولي.

وقد أسفر البحث عن:

في المجموعة الأولى (العجزية) عن زيادة معدل حدوث اضطرابات التقرح سواء للنثائية أو المستقيم مع خلل في دلائل كل من تخطيط العصبة العاصرة الشرجية وعصب النبول الكهفية مع نقص في نسبة عصبة النثائية على الايقباض المؤثر في تقليل البول مع زيادة في سعة المنثاء ونقص في إحساس الرغبة في النبول وقيمته هذا الخلل ذات دلالة إحصائية بالمقارنة بالمجموعة الثانية.

وفي المجموعة الثانية ( فوق العجزية) عن زيادة حدوث اضطرابات التخزين سواء للنثائية أو المستقيم وحذو زيادة في كل من زمن التوصيل الوريدي للنحاس الشوكي عن طريق الجذع المستثر الحسي والحركي للعصب القرجي مع وجود علاقة طردية بين نظم زمنية، وأيضاً زيادة حذو الانقباضات غير الطبيعية في النكة البولية. وهذه الزيادة مصحوبة باضطرابات التخزين مع نقص في سعة المنثاء مع زيادة الإحساس المطلق للرغبة في الانتبول وقيمة هذا الخلل ذات دلالة إحصائية بالمقارنة بالمجموعة الأولى.