ORIGINAL ARTICLE

Percutaneous radiofrequency sacral rhizotomy in the treatment of neurogenic detrusor overactivity in spinal cord injured patients

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KEYWORDS
Neurogenic bladder; Spinal cord injury; Urodynamics; Sacral rhizotomy; Urinary incontinence; Neurogenic detrusor overactivity; Radiofrequency

Abstract

Introduction: To evaluate the effects of percutaneous radiofrequency sacral rhizotomy in spinal cord injured (SCI) patients on urodynamic parameters (maximum cystometric capacity (MCC) and detrusor pressure at maximum cystometric capacity (PdetMCC)).

Materials and methods: This prospective study assessed eight patients with SCI (four men and four women) with a mean age of 31.3 years (22–41). Mean interval period between spinal cord lesion and rhizotomy was 53.5 months (20–96). All patients underwent an anesthetic block of the 3rd sacral root bilaterally using 0.5% bupivacaine under fluoroscopic control. Those who responded with an increase on bladder capacity were selected to undergo the percutaneous radiofrequency sacral rhizotomy. All patients underwent urodynamic evaluation at 6 and 12 months following the procedure. MCC and PdetMCC were recorded.

Results: All patients presented a significant improvement on MCC after 12 months. The mean vesical volume increased from 100.2 ± 57.1 to 282.9 ± 133.4 ml (p < 0.05). The PdetMCC reduced from 82.4 ± 31.7 to 69.9 ± 28.7 cm H2O (p = 0.2). Three patients with autonomic dysreflexia had complete relief of symptoms after the procedure. Those who responded with an increase on bladder capacity were selected to undergo the percutaneous radiofrequency sacral rhizotomy. All patients underwent urodynamic evaluation at 6 and 12 months following the procedure. MCC and PdetMCC were recorded. At 12 months, recurrence of detrusor hyperactivity was observed in all patients. One patient presented abolishment of reflex erections after the procedure. No major complications related to the rhizotomy were noted.

Conclusions: Percutaneous radiofrequency sacral rhizotomy is a minimally invasive technique with low morbidity able to increase MCC. There is a trend towards the reduction of the PdetMCC in SCI patients at 12 months, although statistical significance was not reached.

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Introduction

Spinal cord injury (SCI) may impair normal function of the urinary bladder and give rise to neurogenic detrusor hyperactivity (NDH). Urinary incontinence is an important aspect of bladder management in individuals with SCI and represents a most unpleasant complication which may severely impact their social relationships and quality of life.1

The management of lower urinary tract in patients with SCI aims to achieve adequate bladder emptying, maintenance of low intravesical pressures whilst storing proper volume and control of urinary incontinence.2 Treatment options for NDH can be didactically divided into two groups: therapy to facilitate bladder filling or urine storage, and therapy to facilitate bladder emptying.3 A combination of clean intermittent catheterization (CIC) and anticholinergic medication is the first-line treatment for NDH secondary to SCI4 and should be fully optimized before considering any surgical intervention. However, in patients who do not respond to clinical treatment or present intolerable side effects, surgical options become necessary. The “gold standard” surgical approach for treating patients with poor compliance high-pressure bladder includes augmentation cystoplasty and detrusor myectomy.5,6

Initially presented in the 1950s by Meirowsky et al.,7 sacral rhizotomy lost popularity due to its frequent associated complications – impotence, urethral and rectal sphincteric dysfunction and lower extremity atrophy.8 However, recent reports have demonstrated that in specific patient cohorts, selective rhizotomies associated or not with anterior sacral root stimulation, may increase bladder capacity and continence can be improved.9,10 The S3 root seems to be the most important trigger point in subservient intermittent clean catheterization.11

We assessed the effects of percutaneous radiofrequency sacral rhizotomy on urodynamic parameters such as maximum cystometric capacity (MCC) and detrusor pressure at the maximum cystometric capacity (PdetMCC) in spinal cord injured patients.

Materials and methods

Eight patients were selected from our Uroneurology Clinic between July 2003 and December 2004. All subjects underwent complete urological and physical evaluations. Complementary assessment included blood urea nitrogen and creatinine, urine culture, cystogram and urinary tract sonography. Urodynamics were performed according to the recommendations by the International Continence Society (ICS).12 Urodynamic parameters maximum cystometric capacity (MCC) and detrusor pressure at the maximum cystometric capacity (PdetMCC) were compared before and
Thermocoagulation was confirmed by aspiration of the needle. Because of the angled aspect of the S3 foramen, the needle must be inserted into the skin 1–4 cm above the anticipated location of the S3 foramen, depending on the size of the individual (thickness of the soft tissue above the sacral periosteum). Three milliliters of 0.5% bupivacaine chloride were injected into the sacral foramen under fluoroscopic guidance a 22 gauge radiofrequency anesthesia needle was inserted on the skin surface as a radiopaque marker to orient lining up of the lumbar vertebral spinous processes for accurate localization of the midline. A second line was drawn to connect the most inferior border of the sacroiliac joint. With the patient in prone position and under fluoroscopic guidance a 22 gauge radiofrequency sacral rhizotomy was performed for 15 s, after which the electrode was progressively withdrawn 5 mm. The procedure was repeated 3 times in each side. All patients were evaluated at 1, 6 and 12 months following the rhizotomy, and urodynamic parameters were recorded at each visit.

Paired Student’s t-test was used for statistical analysis. A significance level of $p < 0.05$ was considered.

Results

Eight SCI patients (4 men, 4 women) with a mean age of 31.3 (22–41) years were initially included in this study (Table 1). The mean interval period between the event of the spinal cord lesion and the date of procedure was 53.5 (20–96) months.

Urodynamic parameters of patients who underwent percutaneous radiofrequency sacral rhizotomy are shown in Table 1. The patients presented a significant increase in MCC from 90.0 ± 25.0 cm H$_2$O to 46.0 ± 21.1 cm H$_2$O ($p < 0.05$).

Urodynamic parameters of patients who underwent percutaneous radiofrequency sacral rhizotomy are shown in Table 2.

Twelve months after the procedure patients presented a sustainable significant increase in MCC from 100.2 ± 57.1 ml to 282.9 ± 133.4 ml ($p < 0.05$) and no significant decrease in $P_{det}$MCC (82.4 ± 31.7 to 69.9 ± 28.7 cm H$_2$O; $p = 0.2$).

Three out of four patients (75%) who presented autonomic dysreflexia had total relief of symptoms after the procedure. In one patient, complete resolution of unilateral grade II vesicoureteral reflux was observed 6 months after the percutaneous radiofrequency sacral rhizotomy. Another patient presented total abolishment of reflex erections after the procedure.

![Figure 1](http://www.elsevier.es) Figure 1 (A and B) S3 foramen localization.
Discussion

In the treatment of NDH, the main goal is to preserve the upper urinary tract function. The use of anticholinergic drugs to promote stabilization of involuntary contractions is the first-line treatment option. However, the striking side effects of anticholinergic therapy, such as dry mouth, constipation, blurred vision, weakness and drowsiness are factors that compromise the patient’s adherence to maintenance therapy. Furthermore, the effects of these drugs on the bladder are frequently not enough to promote a complete improvement on clinical symptoms.

Meirowsky et al. were the first to propose surgical denervation of the urinary bladder with the purpose of improving its function as a reservoir. Nowadays, bladder denervation is accomplished through a dorsal rhizotomy of the sacral nerve roots (S2-S4/5) that is usually performed in combination with the implant of a neurostimulator of the ventral sacral roots.

In order to evaluate the status of the detrusor before sacral rhizotomy, sacral nerve roots blockade has been performed to select patients. After this procedure, there may be a sufficient increase in bladder capacity, improving its function as a reservoir and allowing the performance of a clean intermittent catheterization at regular intervals.

Table 1  Patient demographics.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Lesion</th>
<th>Neurological level</th>
<th>ASIA score</th>
<th>Time of lesion (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>27</td>
<td>Traumatic</td>
<td>T8</td>
<td>A</td>
<td>72</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>28</td>
<td>Traumatic</td>
<td>C6/C7</td>
<td>A</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>40</td>
<td>Traumatic</td>
<td>T9</td>
<td>A</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>41</td>
<td>Traumatic</td>
<td>C5/C6</td>
<td>A</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>22</td>
<td>Traumatic</td>
<td>C5/C6</td>
<td>A</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>37</td>
<td>Traumatic</td>
<td>T12</td>
<td>A</td>
<td>96</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>33</td>
<td>Traumatic</td>
<td>L1</td>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>23</td>
<td>Traumatic</td>
<td>C5</td>
<td>A</td>
<td>24</td>
</tr>
</tbody>
</table>
The sacral anesthetic blockade is a valuable method to select patients for a sacral rhizotomy.\textsuperscript{16} However, the procedure will not always predict the final outcome of the surgery. The analysis of the changes in bladder capacity after the sacral anesthetic blockade does not always correlate with late rhizotomy postoperative follow-up.\textsuperscript{17} In the present study, in which only the third sacral root (S3) was bilaterally blocked, a significant increase of the bladder capacity was observed after the procedure in all patients as well as the reduction of detrusor pressure. These data are in accordance with other authors who reported combined blockade of the S2–S4/5 roots.\textsuperscript{10,16–18}

After 1 month, six out of the eight patients (75\%) presented significant urodynamic parameters improvement. However, at six months follow-up the patients presented recurrence of detrusor hyperactivity.

After total sacral neurectomy, decreased bladder compliance may be found. Some authors suggest the mechanical impact of a stretched wall previously contracted or the effect of some neural component resulting from the denervation as possible causes of the decrease in bladder accommodation.\textsuperscript{19,20} During follow-up, no change in bladder accommodation was observed in our cohort.

After 12 months, all patients presented recurrent detrusor hyperactivity, although all of them maintained a significant increase in their bladder capacity. This problem may have been caused by the development of alternative reflex pathways or due to the proliferation of alpha-adrenergic terminations in the vesical body after the parasympathetic denervation.\textsuperscript{21,22} On the other hand, Kerebroeck et al. reported on 52 patients who underwent a posterior sacral rhizotomy and did not show recurrent detrusor hyperactivity after two years.\textsuperscript{15}

After a percutaneous radiofrequency sacral rhizotomy, three patients showed significant improvement in their symptoms of autonomic dyssynergia during the storage phase, but persistent urinary incontinence episodes. Autonomic dyssynergia is an acute potentially lethal complication peculiar to those with spinal injuries above T6.\textsuperscript{15,19,23} Afferent fibers of the bladder visco-vascular reflex have been shown to involve the pelvic and hypogastric nerves. Therefore, the preservation of the hypogastric nerves may explain why the autonomic dyssynergia does not disappear after sacral rhizotomy, mainly during the voiding phase.\textsuperscript{23}

One patient presented complete resolution of a low grade vesicoureteral reflux at six months follow-up. No patient presented worsening of the upper urinary tract status following the procedure. Other investigators have reported that dilation of the upper urinary tract may disappear six weeks after surgery. In three out of six ureters with preoperative vesicoureteral reflux, there was complete resolution at six months follow-up. Other three presented a reduction in reflux grade. Progression of upper urinary tract injuries was not observed in this series.\textsuperscript{15}

Immediately after percutaneous radiofrequency sacral rhizotomy, one patient showed erectile dysfunction which persisted throughout the 12 months follow-up. Some authors report loss of erection after sacral rhizotomy.\textsuperscript{19} On the other hand, others report preservation of erectile function in all patients submitted to posterior sacral rhizotomy.\textsuperscript{8,24,25}

In the present study, it was possible to note that percutaneous radiofrequency sacral rhizotomy is a simple, minimally invasive procedure associated with a low rate of complications. Its results seem to be temporary nonetheless. This technique may be performed in an outpatient regimen and may even be repeated in cases of recurrent detrusor hyperactivity as well as thermocoagulation of other roots other than S3 (S2 and S4/5 roots).\textsuperscript{16}

We believe that an invasive procedure such as enterocystoplasty must be withheld as the last resource to solve a low compliant high pressure bladder condition. Percutaneous radiofrequency sacral rhizotomy in patients with neurogenic detrusor hyperactivity may not be the end of a therapeutic plan but might be considered a step stage for a definitive treatment.

**Conclusion**

Percutaneous radiofrequency sacral rhizotomy is a simple, effective and safe procedure associated with a low morbidity rate and may be incorporated to the clinical practice. Results at 12 months demonstrate a significant increase in maximum cystometric capacity. Results seem to be temporary and recurrence of detrusor hyperactivity is expected at one year.

**Conflict of interest**

The authors declare that they have no conflict of interest.
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References