The laparoscopic implantation of neuroprothesis to the sacral plexus for therapy of neurogenic bladder dysfunctions after failure of percutaneous sacral nerve stimulation

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Introduction

Sacral nerve stimulation (SNS) is a technique for the treatment of chronic pelvic voiding dysfunctions to be considered after failure of medical treatments. It has become established as a treatment option for patients suffering from idiopathic detrusor overactivity leading to symptoms of urinary frequency, urgency and urge incontinence (1) and in women with Fowler’s Syndrome (2). In the field of the colo-proctology, the same technique of neuromodulation is used for treatment of lower bowel motility dysfunctions such as severe constipation (3) and resistant incontinence (4). For implantation of the neural electrodes, the original open surgical approach to the sacrum (5) has been superseded by the minimally invasive percutaneous alternative under local anaesthesia (6). However this transforaminal technique of implantation has some limits as one electrode can only offer stimulation of one sacral nerve root. In contradiction to this very minimal invasive technique of implantation, we returned to a surgical technique of implantation, also a minimal invasive one but not based on the dorsal approach to the sacral nerve roots but on the ventral approach, the laparoscopic transperitoneal approach: Since we have demonstrated that laparoscopy permits an easy and reproducible exposure of all pelvic motoric and autonomous nerves and plexi (7), implantation of neural electrodes onto the pelvic nerves also became feasible this way. Therefore we developed the laparoscopic technique of implantation of neural electrodes which we have called “LION procedure” (Laparoscopic Implantation Of Neuroprothesis) and found different new applications for the treatment of refractory pelveo-abdominal neuralgia/neuropathia (8,9) and to recover bladder function after spinal cord injury (10) or pelvic nerve destruction (11). In the present manuscript, we report on a further field of application of this technique, the treatment of different neurogenic bladder dysfunctions after failure of the classical percutaneous technique of SNS.

Material and Methods
We report here on our first series of consecutive patients referred to us for a LION procedure for refractory neurogenic bladder dysfunction in all these after failure of a percutaneous SNS performed by neuro-urologists or neurosurgeons.

For the laparoscopy, one 10mm trocar is placed in the umbilicus to introduce a 10mm/0° optic and three further 5mm-trocars are placed in the lower abdomen, one on the middle line and two lateral beyond the epigastric arteries to introduce an atraumatic forceps, scissors and bipolar forceps to control the hemostasis. For intraoperative electrostimulation, we use a 5mm bipolar laparoscopic forceps producing a current with a square-wave pulse duration of 250 µs, a pulse frequency of 35 Hz, and a electric potential variable from 1 to 12 Volts. The procedure begins with the incision of the left pararectal peritoneum medial of the left ureter followed by the expansion of the anatomic pararectal space by absolute blunt dissection downwards to the level of the coccygeal bone. After exposure of the left sympathetic trunk, the sacral hypogastric fascia is transected parallel to the sacral bone opening an anatomic plane lateral from it. In this relatively avascular anatomical space, the sacral nerve roots S1 to S4/5 are selectively exposed after their emergence out of the sacral foramen until the emergence of the pelvic splanchnic nerves; Confirmation of the motoric functions and integrity of the dissected nerves is gained using the LANN technique (12,13). Implantation is usually performed on the left side as it is easier because the surgeon stands on the left side of the patient but when bladder dysfunction is combined with neural pelvic pain or other painful neuropathies such a pudendal pain, a sciatica or a radiculopathy, the side of the implantation is chosen depending on the side of the associated painful neuropathy. In cases of a right sided implantation, the procedure is then performed in the same way starting with the dissection of the right pararectal space. The electrodes used for implantation are multipolare electrodes. The electrode is introduced into the abdominal cavity through the 10mm umbilical trocar and is placed perpendicular to the sacral nerve roots S2, S3 and S4/5 between them and the pyriform muscle (figure 1). The electrode is then fixed proximally and distally with a monofil non-resorbable 5.0 suture while the cable is passed by a strict retroperitoneal way lateral to the iliac vessels (figure 2) avoiding any contact with the obturatoric nerve and the ureter. Intravenous antibiotic treatment is systematically started the day before the surgical procedure for a period of three days.

In all patients, bladder filling and micturition conditions are postoperatively controlled by inspection and abdominal sonography in a two hour interval alternatively with and without neuromodulation (15-30 Hz, 250µs, 0.5-4 volts). A permanent generator is implanted only when efficacy of the neuromodulation have been proven with alternative periods of switch-off and on phases over several days: In patients suffering from a bladder overactivity or from a interstitial cystitis, the procedure is considered having been successful when the mean bladder capacity could be augmented to at last 350 ml with less than 8 micturitions per day, without any incontinence and no bladder pain
during the filling phase. In patients suffering from a Fowler syndrome, the procedure is considered successful and the permanent generator implanted when all micturitions could be obtained voluntarily and spontaneously without any kind of abdominal press and rest urine is considered less than 50ml by abdominal sonography.

All patients are clinically evaluated at the time of discharge and on a three-months basis for the first 6 months following surgery. Thereafter they are followed up every 6 months. Patients living abroad are followed up by telephone or by mail and the urodynamic control were performed in all patients first three weeks following the procedure in their centre of origin.

All the trials were performed in accordance with the 1975 Declaration of Helsinki, and every patient provided written informed consent.

Results

We performed the first sacral LION procedure of this series on a patient with multiple sclerosis and left sided sciatica on 13th February 2006 (14). After a short required learning curve for the handling of the electrode by laparoscopy, the actual mean time for a unilateral sacral LION procedure is 32 minutes. No major or minor complications occurred and no conversion to laparotomy was required. The mean postoperative hospital stay was 2.8 days (1-4 days). Table 1 shows the different kind of indications, procedures and results with an actual mean follow-up varying between three months and 28 months.

Postoperative neuromodulation during the test-phase was successfully in all patients except in two of them:

(i) A 37 year-old man with a multiple sclerosis underwent in March 2006 a left sided sacral LION procedure for bladder overactivity (BO) and left sided pelvic floor pain. In this patient also intravesical injection of botulinum failed. Postoperative neuromodulation during the test-phase did not show any improvement neither in regard to the pain symptoms nor in regard to the bladder overactivity. As last therapeutic option, a the laparoscopic coagulation-destruction of the left S3 and S4/5 was performed in May 2006 at the patient’s request. This second procedure induced complete and durable disparition of the BO but the pelvic floor pain still remained.

(ii) In a 32 year women suffering from a Fowler’s syndrome and pelvic pain secondary to three abdominal procedures with hysterectomy for endometriosis. Preoperative urodynamic testing confirm the diagnosis and the patient reported about systematic intermittent selfcatheterisation by a bladder capacity not exceeding 500ml. Laparoscopic implantation on the left side was combined with a extended intestinal pelveo-abdinoal adhesiolysis. Postoperatively, no improvement neither in regard to the pain symptoms nor in regard to the bladder dysfunction could be obtained; after several tests over five days, we decided in accordance with the patient to remove the electrode by simple traction. Before release from hospital, the patient requested that we certify a non function of the
neuromodulation for her pension application and admitted that prior to surgery she voided 1 L from the bladder every day, and had not mentioned this before the operation out of fear that she would not be operated on.

Three patients suffering from multiple sclerosis also presented with unilateral sciatica: Control of the sciatica could be obtained in all three patients – this includes the above mentioned patient who underwent the first procedure in 2006 – with a reduction of the VAS of more than 50%. A further multiple sclerosis patient presented a combination of the BO with left sided pudendal neuralgia: Postoperative neuromodulation (actual follow-up 8 months) permitted a reduction of the VAS from preoperative 10/10 to postoperative 2/10 without further medical pain treatments.

The patient who suffered from a diabetic cystopathy with about 60 micturitions per day, presented also pelvic pain L>R and a left sided painful neuropathy of the sciatic nerve; Intraoperative stimulation of S1 shows a reduced motoric answer while the stimulation of the further sacral nerve roots do not shows any motoric reaction. However postoperative neuromodulation permit reduction of the BO to 5-7 micturitions per day and a reduction of the VAS score preoperatively from 10/10 to 5/10 postoperatively.

In the patient suffering from a neurogenic bladder incontinence by a Parkinson syndrome, the recovery of both the bladder and the rectal continence could be obtained.

At date of the manuscript, no any complication such a lead migration, a wound problems or infection did occurred.

Discussion

Efficacy data from both randomized controlled trials and case series studies show that about 70% of the patients who received sacral neuromodulators for bladder dysfunction showed improvement in their main symptoms (15,16). For the 30% of patients where the SNS shows no improvement, the non-response is still a really problem of interpretation: As the percutaneous technique is a blunt method of implantation, even when the position of the electrode is radiographically controlled, a “non-response” can be due to a “non-response” to the stimulation or to a “non-optimal” implantation of the electrode. The laparoscopic approach permits in contrary the implantation of the electrode in direct contact to the nerves under direct visual control so that if postoperatively no any improvement can be obtained, a “non-optimal” implantation of the electrode can be excluded. This can eventual explained the result in our series but a second reason for the efficacy of the LION procedure to the sacral nerve roots despite the failure of the previous transforaminal SNS could be also due to the number of sacral nerve roots included in the electrical field: In the classical percutaneous transforaminal technique of implantation only one sacral nerve root can be reached by one implanted electrode while in the LION procedure, as the electrode is placed perpendicular to the
sacral plexus, all sacral nerve roots involved in the urethra-vesical neurocontrol on one side (S2→S4/5) are reached by the electrical field of the electrode. In all patients in our series, the failure of the previous “Interstim-Therapy” was not due to a wrong placement of the lead since urodynamic testing and examination of the lower extremities had confirm the proper stimulation of the sacral nerve root S2 or S3, but was due obviously to the number of the roots reached by the stimulation; Recent studies seem to confirm this hypothesis that the efficacy of neuromodulation could depend on the kind and/or amount of afferent fibers included in the electrical field (17,18,19). Pudendal stimulation also shows promising results for treatment of bladder overactivity (20) and interstitial cystitis (21); Elective implantation of a electrode to the pudendal nerve is also feasible the laparoscopic way in routine conditions (22), but we opted for the sacral nerve root stimulation for two reasons:

- This permits not only the neuromodulation of the pudendal afferent fibers passing through the pudendal nerve but also permits neuromodulation of all urethral and vesical afferent fibers, those passing through the pudendal nerve and those passing through the pelvic splanchnic nerves.
- It also permits also the control to visceral pelvic pain (splanchnic afferent fibers), sciatica and neuralgia of the posterior cutaneous nerve (sciatic afferent fibers), pudendal neuralgia but also painful sacral radiculopathy as shown in our series.

It is beyond discussion that percutaneous techniques of implantation are less invasive than the LION procedure, but even when our follow-up is still short, the well known risk of lead migration of 16% (23), of wound problems (7%) and infections (5%) (22) appear to be less by laparoscopy especially may be because the cable and electrode are placed in a safe position deep in the pelvis optimally protected by the pelvic bone where no any motion does occured.

Conclusions
These preliminary results suggest strongly that the technique described is effective and safe for treatment divers neurogenic bladder dysfunctions even after failure of the classical percutaneous technique of implantation. To the best of our knowledge, this is first report about ventral implantation of electrode in a spina bifida patient in whom the dorsal approach is generally not feasible while the laparoscopic approach offer quite normal anatomic situation.

Literature


Figure 1: Left sided sacral LION procedure on the left side: A octipolar electrode is placed in direct contact to S3 and S4 between the these roots and laterally the pyriform muscle.
Figure 2: Left sided sacral LION procedure: The cable of the electrode is passed extraperitonealy through the lumbosacral space laterally to the external iliac vessels

<table>
<thead>
<tr>
<th>Neurogenic situation</th>
<th>n</th>
<th>Laparoscopic procedures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractory interstitial cystitis</td>
<td>4</td>
<td>Left sided sacral LION procedure</td>
<td>Success 4/4</td>
</tr>
<tr>
<td>BO in multiple sclerosis patients</td>
<td>8</td>
<td>Unilateral sacral LION procedure *</td>
<td>Success 7/8</td>
</tr>
<tr>
<td>BO in spina bifida patient</td>
<td>1</td>
<td>Left sided sacral LION procedure</td>
<td>Success</td>
</tr>
<tr>
<td>BO in incomplete Th-paraplegia</td>
<td>2</td>
<td>Left sided sacral LION procedure</td>
<td>Success 2/2</td>
</tr>
<tr>
<td>BO in diabetic cystopathy</td>
<td>1</td>
<td>Left sided sacral LION procedure</td>
<td>Success</td>
</tr>
<tr>
<td>Fowler`s syndrome</td>
<td>4</td>
<td>Left sided sacral LION procedure</td>
<td>Success 3/4</td>
</tr>
<tr>
<td>BI by Parkinson syndrome</td>
<td>1</td>
<td>Left sided sacral LION procedure</td>
<td>Success</td>
</tr>
</tbody>
</table>

*Side depending from a eventual combination of BO with further neuropathia such as a pudendal pain or a sciatica

BO: Bladder Overactivity – BI: Bladder incontinence

**Table 1:** Indications and laparoscopic procedures of implantation performed for treatment of bladder dysfunction after failure of medical treatments and classical SNS