The Laparoscopic Implantation of Neuroprothesis - LION technique - to control intractable abdomino-pelvic neuralgia.

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Introduction

Our previous reports demonstrated the feasibility of laparoscopic exposure and preservation of all autonomous and somatic pelvic nerves during laparoscopic pelvic surgery (1,2,3). In a further work we showed that laparoscopy can not only be used to preserve the pelvic nerves but can also be used for neurosurgical procedures. We reported on our first experiences with laparoscopic neurolysis of the pudendal nerve in Alcock’s Canal Syndrome (4), and of the sciatic nerve in endometriotic infiltration (5,6). In this manuscript, a short series of our technique of laparoscopic implantation of electrodes for neuromodulation to pelvic and/or abdominal nerves in patients with intractable neuralgia, is presented.

Methods

We report on our first three clinical cases of pelvic intractable neuralgia where laparoscopy was used for the implantation of electrodes on pelvic or abdominal nerves for peripheral neural stimulation (PNS). Preoperative anamnesis and neurologic examination, as well as laparoscopic surgery, in all patients was performed by the author MP himself. A graduated scale from 0 „no pain“ to 10 „worst pain imaginable“ was used for standardisation (Visual Analog Scale – VAS) to quantify pain. Patients were requested to describe their pain with the use of the Mainz Pain Centre Questionnaire (7) and to keep a record of their consumption of analgesics. All patients appeared highly motivated. They reported complete or partial failure to respond to all other treatments and no longer accepted the side effects of the various medications.

All laparoscopic procedures were performed under general anaesthesia. To explore the functionality of the exposed nerves, a laparoscopic bipolar forceps and a conventional stimulator, 0-6 volts and 2.5Hz, were used for electrostimulation. In all three patients a „On-Point PNS Electrode – Model 3987“ electrode and an Interstim Modell 3023 Neurostimulationssystem (Medtronic GmbH Germany) permanent stimulator were implanted.
All patients were clinically evaluated at the time of discharge from our department, and on a monthly basis for the first 4 months following surgery. Patients living far away were followed up by telephone or by mail.

**Case report #1**

HR, a 58 year old woman, was referred to our department having suffered for three years from a neuralgia of the right genitofemoral nerve secondary to a laparoscopic inguinal herniorrhaphy, and/or to pelvic radiation for endometrial cancer. Due to direct postoperative onset of inguinal pain, a general surgeon diagnosed injury to the genitofemoral nerve and performed a neurotomy of this nerve through a small abdominal incision. This procedure decreased neither the frequency nor the intensity of the pain. Upon further neurological examination, it became evident that the patient was not only presenting with a neuralgia of the right ilioinguinal nerve, but also with neuralgia of the right pudendal nerve. The patient described her pain as a permanent burning sensation with paroxysmus to an intensity of 10/10. Neuropathic medication including Gabapentin and Opioids and spinal cord stimulation had not been effective and she was permanently off work for medical reasons. The iliohypogastric, ilioinguinal and lateral femoral cutaneous nerves were exposed laparoscopically using a retroperitoneal approach. An electrode for PNS (On-Point PNS Electrode – Model 3987) was implanted in direct contact with all three nerves ensuring that all the nerves contributing to the neuralgia were included. During the same procedure the right sacral roots S2 to S4 were dissected and a second quadripolar electrode was implanted. It was fixed on the lateral side of the sacral roots with two non resorbable sutures. The entire procedure took two and a half hours and no complications occurred. Stimulation on the first postoperative day relieved the pain completely over the entire area. The paresthesia were considered pleasant by the patient. An implantation of the permanent peripheral stimulator was therefore performed two days later under a short general anaesthesia. Two months post-implantation, HR rated her pain 0-2/10 in intensity. She had resumed normal activities without medication with the exception of an anxiolytic drug taken out of anxiety for a reoccurrence of pain.

**Case report #2**

KKH is a 72-year-old male who in 1968 underwent an amputation of the right leg. He presented a long history of phantom limb and stump neuroma pain combined with a neuralgia of the right posterior cutaneous nerve. He rated his pain as 10/10 and neuropathic medication (Gabapentin 1600mg/day, Oxycodon 15-20mg/day and occasionally Morphine) had not been effective and had resulted in many side effects. A full laparoscopic exposure of the sciatic nerve from the level of the fusion of the different sacral roots to its exit into the sciatic foramen was performed on 24th March 2006 without removing any lymph nodes or transecting any lymph channels. The same electrode type as
used on the previous patient was inserted and fixed between the pyriform muscle and the sciatic nerve just proximal to the emergence of the superior and inferior gluteal nerves. By the second trial day, the pain intensity had decreased to 1-2/10 and we thus proceeded with the implantation of the permanent peripheral stimulator two days later. The patient was followed up two months after the procedure and reported that use of the neurostimulator for at least six hours per day had resulted in complete disappearance of the pain.

Case report #3

FS, a 44 year old woman with Multiple Sclerosis, presented for consultation with left sided sciatalgia and bladder hyperactivity. The patient reported spontaneous and uncontrollable bladder voiding 30-40 times per day and classed her sciatalgia at 7/10 despite medication consisting of Tretrazepam 50mg/day, Gabapentine 3x 900mg/day, Pregabalin 300mg/day, Trosiumchlorid 3x 50mg, Triamteren 50mg/day and Valproinic Acid 2x 600mg/day. A hysterectomy, indicated by hyper-pylomenorrhoea refractory to medical treatment, had been planned and was included in the procedure performed on 13th February 2006. The procedure began with a supracervical hysterectomy and continued with an elective left sided exposure of S1, S2, S3 and S4 deep in the pararectal space according to our laparoscopic technique as previously described (3). Function of the sacral roots was confirmed using the LANN technique (8) and an electrode was passed between the pyriform muscle and the sacral roots S2 to S4 (Figure 1). Fixation of the electrode was performed on the pyriform muscle with two non resorbable sutures 5/0. The cable of the electrode was passed laterally to the internal iliac artery in order to avoid any contact with the ureter. It was then passed from the obturator space to the lumbosacral space lateral of the external vessels avoiding direct contact with the obturator nerve and was finally passed retroperitoneally before connecting it to an external test-stimulator. The entire procedure took two hours and no intra- or postoperative complications occured. The neuromodulation was started on the afternoon of the surgery. After removing the bladder catheter on the first postoperative day the patient documented bladder activity. She reported micturation between 300ml and 500ml without any episodes of spontaneous voiding of the bladder. She also described a „tickling in the area of the vulva on the left side“ and rated her sciatalgia at 0/10. On the same day she ceased taking Spasmex,Gabapentine and Triamteren. One week later there had been no episodes of hyperactivity and we therefore proceeded with the implantation of the permanent stimulator. The sciatalgia score has remained 0/10 until now. Upon follow up the patient reported no recurrence of sciatalgia or bladder overactivity. She is able to void her bladder in a completely normal manner with a bladder compliance varying between 300 and 400 ml and without any residual urine.

Discussion
The principle of peripheral neuralgia treatment using neuromodulation is based on direct electrical stimulation of the involved nerve proximal to the perceived injury site. Although most lower extremity neuralgia are treated with spinal cord stimulation techniques, a mononeuralgia can also be treated by a peripherally placed electrode. One of the main limiting factors for this option however is still the requirement for extensive surgical dissection. It is therefore not surprising that the most common peripheral nerves treated with PNS by open dissection techniques are superficial nerves such as the ulnar, median, radial, posterior tibial, and common perineal nerves. In order to avoid the required surgical dissection for exposure of the nerve, percutaneous or subcutaneous implant techniques for PNS to the lower extremity have been developed (9,10). In most of these techniques however, the electrode is placed bluntly and hopefully in the proximity of the nerve. As for spinal cord stimulation (11), percutaneous epidural electrode placement can be accomplished quickly and easily, thereby avoiding extensive nerve dissection surgery. It however has the same disadvantage: the blunt punction technique for electrode placement makes it unspecific. When pain relief is not obtained, it is uncertain whether this is due to a non-response of the nerve to electromodulation, or to a non-stimulation of the nerve due to wrong placement of the electrode. On the other hand it can also happen that not only the target nerve but also surrounding nerves are being stimulated.

A literature review of PNS revealed that not a single technique of electrode implantation on pelvic nerves by abdominal approach has been reported. It is clear that some pelvic nerves, such as the pudendal or sciatic nerves, are very difficult to access by laparotomy. Anatomically however, neuromodulation in the pelvis makes sense as all the nerves of the lower extremity and of the pelvic viscerae pass through the pelvis before entering the spine. The real innovation of our work is therefore using laparoscopy to access the pelvic nerves which allows us, in routine conditions, to gain optimal exposure of all the somatic and autonomous pelvic nerves, even those very deep in the pelvis. Furthermore, the endoscopic magnification in all areas of the pelvis, in combination with techniques of laparoscopic microsurgery which are quite similar to some neurosurgical techniques, allows us to safely and reproducibly implant electrodes under direct visual control and without extensive and aggressive surgical dissection. We have demonstrated that exposure of pelvic nerves, such as the sacral plexus, the sciatic nerve or its branches (pudendal and gluteal nerves), can be accessed by laparoscopy without extensive dissection but just by simple detachment of the fat and lymph tissue from the lateral pelvic wall. This is important since extensive dissection requiring a lymph node resection and transection of lymph channels could cause severe perineural fibrosis or development of lymphorrhoe or lymphocele, which could disturb the function of the neuroelectrodes. Since all the nerves of the lower limbs are now easily accessible, chronic regional pain syndrome of the pelvis or of the lower limbs, or even combinations of different neuropathies, can be relieved by a laparoscopic approach. For example in the case of phantom limb and stump neuroma pain of patient #2, the usual treatment would have been based on
spinal cord stimulation techniques, possibly in combination with the insertion of an electrode on the sciatic nerve by gluteal approach. With this technique the neuralgia of the posterior cutaneous nerve could not be treated. Using the laparoscopic approach, however, a single electrode was placed on the stump of the sciatic nerve including both gluteal nerves and we were able to cover all the pain. If the patient had also had pain originating from the femoral nerve, a second electrode could have been placed during the same procedure directly on the femoral nerve in order to cover the complete innervation of the leg.

In cases of pudendal neuralgia, one could electively implant an electrode on the pudendal nerve itself. An alternative option would be to implant an electrode on the sacral roots, especially in cases where further lesions of the sacral plexus are responsible for bladder dysfunction or for sciatalgia, as is not uncommon in patients with multiple sclerosis.

Other nerves higher in the abdominal cavity such as the ilioinguinal, the hypoinguinale, or the lateral cutaneous femoral nerve, can also be exposed laparoscopically without major surgical difficulties. In cases of intractable postoperative inguinal pain, where percutaneous implantation is commonly used (9), laparoscopy could also become an alternative. Laparoscopic implantation of the electrode on the nerve can easily be performed as shown in patient #1.

We also strongly believe that laparoscopy will open new indications for use of the PNS. Combinations of different nerves involved in pain or a combination of different forms of neuropathies are no longer to be considered exclusion criteria for surgical treatment or neuromodulation as demonstrated in patient #3.

**Conclusion**

A laparoscopic approach to the pelvic nerves must be considered as an option in the management of pelvic or abdominal neuralgia both from an etiological and a therapeutic point of view (12). To the best of our knowledge, this is the first report of laparoscopic electrode implantation on pelvic or pelvi-abdominal nerves for PNS.

In the present series we have clearly demonstrated the application of laparoscopy in the therapy of pelvic somatic nerve pathology. The laparoscopic approach to the pelvic autonomous nervous system could however open further options for management of pelvic pain or pelvic pathologies, even beyond the gynecological field.

**References**


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