

Laparoscopic selective pudendal neuromodulation for neurogenic bladder: a review of literature

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This study presents an alternative technique for neuromodulation in cases where percutaneous sacral implantation is difficult or has previously failed. We aimed to describe a novel technique of selective placement of an electrode over the pudendal nerve (PN), via laparoscopic approach in a patient with urinary retention who previously failed sacral neuromodulation (SNM) treatment.

Key Words: pudendal nerve ↔ neurogenic bladder ↔ neuromodulation

A 34 year-old woman with a tethered cord presented with urinary retention. She was on clean intermittent self catheterization (CIC) for the last 18 years. Her previous history revealed chronic urinary tract infections before the start of CIC. The patient received SNM therapy in 2017 by implanting a permanent electrode (tined lead; Medtronic, Minneapolis, Minnesota, USA) through the sacral foramina [3]. A 3-D bone model was reconstructed and printed out and the virtual bone model showed the patient's anatomical details. There was no access through one site because of previous filling with bone material, therefore a contralateral foraminal access was performed (Figure 1). Since filling sensation improved and the patient was able to empty more than 2/3rd of her bladder during the test period, a permanent pulse generator (IPG, InterStim I or II;

Medtronic) was implanted. SNM therapy continued to be successful for 5 months after which the patient reported the reoccurrence of urinary retention symptoms and need for CIC again. Since percutaneous sacral implantation was impossible to repeat in the contralateral site, the patient was hospitalized for an alternative technique of selective PN neuromodulation.

Using four trocars, we dissected the left side of the urinary bladder and internal iliac vessels as described previously [5]. After visual identification of the left PN, artery and vein beneath the sacrospinous ligament (SSL), we selectively placed the electrode over the left PN, between the PN and SSL (Figure 2), and fixed the electrode using 3-0 Vicryl sutures to the SSL to prevent dislocation. The proximal side of the electrode was removed from

the body by left inguinal puncture to connect to the battery. Selective PN implantation of the electrode yielded high sensation with stimulation of only 0.3 V. After anesthesia recovery at 12th hours post-operative time, we removed the urethral catheter and the patient voided 680 ml without abdominal straining. Unilateral direct implantation on the nerve and stimulation of the PN resulted in continuous and high response. At post-operative day one, the patient was discharged and continued to use the same program. Her frequency volume chart revealed minimum 300 ml and maximum 740 ml voided volumes with 30 and 110 ml residual volumes as measured by CIC. The difference at mid-term follow-up has been shown in the Table 1.

DISCUSSION

The pudendal nerve (PN) is a peripheral nerve that derives its fibers from the second, third and fourth sacral nerve roots. The pudendal nerve has both motor and sensory functions and carries sympathetic fibers. Along its course, the pudendal nerve gives three branches as inferior rectal, perineal and dorsal nerves. The main trunk passes between the sacrotuberous and sacrospinous ligaments and then enters Alcock's canal.

Pudendal nerve modulation is growing in popularity in some cases of sacral nerve modulation failure or as a primary treatment option. Use of the pudendal nerve in modulating pelvic floor function has drawn great interest in those who regularly perform sacral neuromodulation (SNM) for overactive bladder, non-obstructive urinary retention, and pelvic-perineal pain due to pudendal neuralgia [1]. In this clinical case report with review of the literature, we described a novel technique of selective placement of an electrode over the PN with laparoscopic approach (LASE/PN), in a patient with urinary retention due to tethered cord syndrome, who previously failed SNM treatment.

Different percutaneous with perineal or posterior approaches and transgluteal endoscopic and laparoscopic techniques have been described for pudendal electrode placement [2, 3, 4]. Li et al. effectively performed a bilateral placement with stepwise electric stimulation approaches, however, an endoscopic transgluteal minimal invasive (ENTRAMI) technique can not be accepted as a reproducible approach in practice. Recently, based on our previous laparoscopic approach technique to the pudendal nerve, the Istanbul technique [5], Korschake et al. described the same laparoscopic approach for placement of an electrode over the pudendal nerve in a cadaveric study [6].

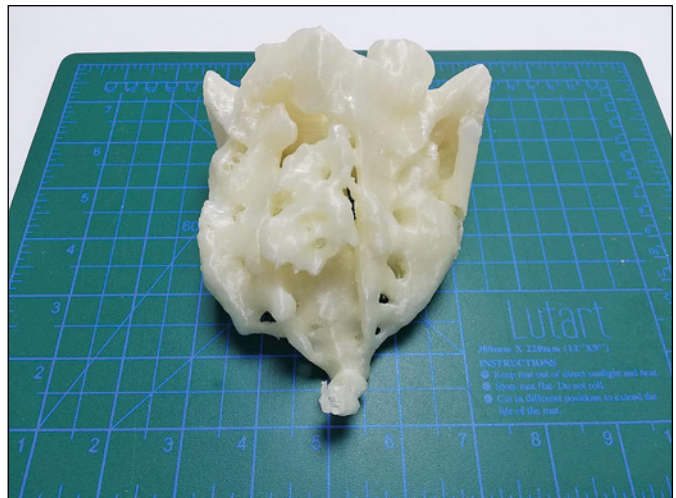


Figure 1. 3-D print of the sacral bone structure depend on CT imaging of the patient 564 x 423 mm (72 x 72 DPI).

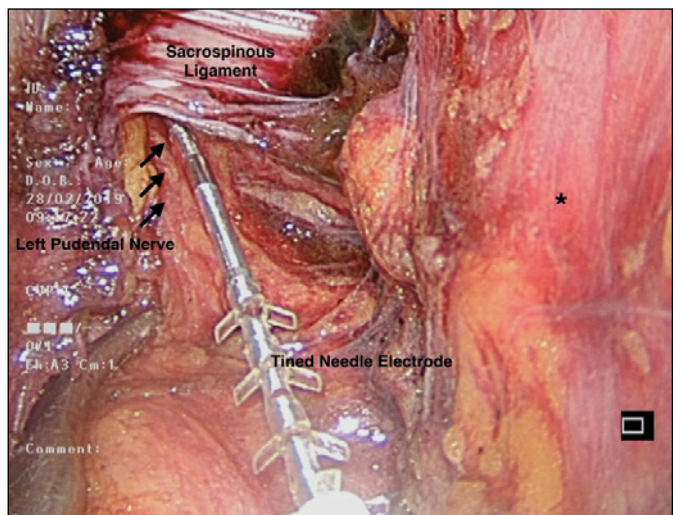


Figure 2. Laparoscopic view of the tined needle electrode over left pudendal nerve 361 x 270 mm (72 x 72 DPI).

SNM has become a viable and accepted treatment alternative for non-obstructive urinary retention. However, due to the complexity of the pathophysiology of neurogenic deficits and unpredictability of the affected neural network, the success rate in this subgroup of patients is highly variable. Moreover, patients with sacral bone abnormalities and/or congenital spinal cord lesions might be more difficult candidates for the proper placement of electrodes. This study presents an alternative technique for neuromodulation in cases where percutaneous sacral implantation is difficult or has previously failed. To our knowledge, we describe LASE/PN for the first time in literature to treat non-obstructive urinary retention with low pressure voiding.

It has previously been shown that unilateral and bilateral electrical stimulation of PN afferents with high frequency bipolar stimulation improved voiding efficiency in animal models following spinal cord injury (SCI) or PN transection [7, 8]. This is consistent with the important role of pudendal urethral afferents activating the augmenting reflex to produce efficient voiding. There is also evidence suggesting that the augmenting reflex operates in humans and use of electrical stimulation to amplify the sensory feedback from PN urethral afferents provides a means to enhance bladder emptying with low pressure in persons with retention [9]. Our implantation technique is unique, since it was performed under laparoscopic vision of the PN, and selective stimulation resulted in afferent transmission to sacral roots and restored voiding function in a woman with a severe sacral bone anomaly who previously failed sacral nerve stimulation for treatment of urinary retention.

In our presented case, we have achieved excellent functional results using unilateral LASE/PN with normal urinary urgency and normal micturition with no abdominal straining and low micturition pressure. There are important advantages to a laparoscopic approach with our technique for peripheral neuromodulation in the pelvis: i.) it is possible to place the electrode directly on the PN under a magnified view, ii.) bilateral electrode placement can be performed without additional incisions, iii.) this

Table 1. Functional results of the patient at preoperative status and postoperative 6th month follow-up

	Before LASE/PN	LASE/PN 6 th month
Urine desire	Weak	Satisfied
CIC / day	6x	1x (before bed, preventive)
Incontinence /day	2–3x	None
Voided volume (ml)	50–100	400–500
Residual urine (ml)	500–900	<200
Urinary tract infection	2–3 x/month	None
Battery voltage (volt)	2.2	0.3
Orgasm during SI*	+	+++

LASE/PN – laparoscopic selective pudendal neuromodulation; CIC – clean intermittent self catheterization

method is much easier to teach and implement for a surgeon who has basic laparoscopic skills, therefore LASE/PN is easily reproducible.

As a result, selective pudendal neuromodulation is perhaps settling into the unique role as an alternative approach to those who have failed sacral neuromodulation, not only for non-obstructive urinary retention due to neurologic deficits, but also for managing some forms of chronic refractory pelvic pain.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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