New Surgical Evolutions in Management of Sacral Radiculopathies

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Neurophysiological investigations and neurosurgical procedures of the sacral plexus are not especially well developed, because the sacral plexus is difficult to access. Awareness that sacral radiculopathies may exist is still lacking and the incidence of these pathologies is widely underestimated. Since the recent introduction of laparoscopy in the field of pelvic nerves, the situation has changed considerably: laparoscopy not only permits a precise morphological and functional exploration of the entire sacral plexus, but also offers new therapeutic options: In lesions to the sacral nerve roots by compression, infiltration, or surgical damages, the laparoscopy offers an adequate access for micro-neurosurgical procedures; whereas in neurogenic pathologies or situations of failure of neurosurgical treatments, the technique of laparoscopic implantation of a neuroprosthesis – the LION procedure – permits the neuromodulation of all sacral nerve roots in different combination with only one electrode for simultaneous control of pelvic/lower limb pain and pelvic visceral dysfunctions. Regarding the dramatically increased incidence of sacral radiculopathies, especially secondary to pelvic prolaps surgeries by blind mesh-material implantation, this field of pathologies has to come in the focus of medical interests. Also, physicians involved in pelvic pathologies/surgeries have to be trained in clinical neuropelveology.

INTRODUCTION

The pelvis contains not only different organs such as the bladder, rectum, or genital organs, but also blood vessels and nerves. Different specialties have focused on the pathologies of all these different anatomical structures: gynecology and urology focus on diseases of the uro-genital organs, whereas diseases of the gastro-intestinal tract are the domain of general surgeons and gastroenterologists. However, no specialty deals exclusively with pathologies of the pelvic nerves.

¶This is even more astounding considering the fact that after the central nervous system and spinal cord, no other part of the body contains so many, and such important, nerves: pelvic nerves are not only involved in sexuality, voiding, and storage functions of the bladder and rectum, standing up, and walking, but also in the
transport of all sensitive information coming from the lower limbs and pelvis. Thus, damages to the pelvic nerves and plexuses can lead to pelvic dysfunctions and problems with locomotion, but also to pelvic pain and/or neuralgia from the lower extremities.

¶However well-known is that pathologies without a clear diagnostic and therapeutic management result in oblivion of the problem, an indication that these pathologies do not exist in daily clinical practice. The most probable reason for omission of the pelvic nerves in the field of neurosurgery (but also in the field of pelvic surgery) may be associated with anatomy of the pelvic nervous system. This is difficult to understand, considering the limitations of open surgery, which is inadequate to dissect pelvic nerves and plexuses hidden deep into the retroperitoneal space behind the pelvic vessels.

¶This Chapter reviews the technological developments in management of sacral radiculopathies’ different etiologies, and focuses on the laparoscopic approach to the sacral nerve roots.

DIAGNOSIS

The sacral plexus is composed of the last lumbar spinal roots L4-L5 and sacral nerve roots S1-S4/5, which innervate the pelvic structures and perineum as well as the buttock and lower limb. Sacral radiculopathies may induce abnormal sensation in the posterior surfaces of the lower limb and buttock according with the sacral dermatomes, but also dysfunctions of the lower limb, bladder, terminal intestine, and sexual functions.

¶In massive lesions of the plexus (plexopathy), loss of strength in hip extension, knee flexion, and dorsal plantar flexion of the foot can be detected. In radiculopathies, the semeiology is much more subtle and may combine different “pelvic symptoms” such as pelvic pain, dys/apareunia, troubles/loss of vesical and/or rectal sensation with “non-pelvic symptoms” such as low-back-pain (lumbosacral trunk, L5), pudendal pain (S2-4), sciatica, distal pain, and/or abnormal sensations in the legs or buttock. Problems concerning erection and vesical continence are in favor to a lesion of S2, whereas intestinal incontinence, bladder overactivity, or in contrary, vesical hypotonia, speak strongly for a lesion of S3/4.

A precise anamnesis, with a clinical examination that includes a neurologic, gynecologic, urologic and proctologic examination, permits determination of the neurologic level of the lesion in the majority of patients. Apparition of the symptoms after a pelvic surgery, even with a free interval of several months, is a strong argument for possible nerve damages, whereas catamenial pain in women is favorable to endometriosis or a vascular entrapment of the sacral nerve roots (1).

¶In surgically induced sacral radiculopathies, further correlation of clinical information with the surgical steps of the procedure permit a precise anatomical localization of the neural lesion, which is essential for adapting the therapeutic strategy: In a patient suffering from a “pudendal pain” secondary to a vaginal sacro-spinal fixation
for vaginal prolaps, an evoked pudendal neuralgia is from the anatomical-surgical point of view logic (2), whereas in the same pain situation secondary to an abdominal procedure such as sacral rectopexy, radical prostatectomy, or hysterectomy, surgical lesion to the sacral nerve roots S3 S4 is much more probable than a pudendal lesion (3). In patients with associated vertebral pathology, the unilateral character of the symptoms and absence of “supra-sacral” symptoms speak more for a sacral etiology than for a spinal one.

Ultrasound is a simple method for evaluation of the filling and emptying status of the bladder, whereas urodynamic testing provides the exact neuro-urologic information required before planning a surgical treatment. Pelvic imaging is useful in massive pelvic lesions, but negative results cannot permit exclusion of pathologies of the sacral plexus. An electromyogram (EMG) can lead to misdiagnosis, especially in the direct postoperative period, because it does not permit one to easily distinguish peripheral nerve lesions from plexus lesions (4).

Introduction of the laparoscopy in the field of the pelvic nerves has revolutionized the diagnostic approach to sacral radiculopathies, because it offers a unique diagnostic method to explore the entire sacral plexus by minimal invasive surgical approach: Not only a morphologic exploration of the sacral nerve roots is feasible this way, but also a functional exploration using the technique of laparoscopic nerve stimulation, LANN technique (Laparoscopic NeuroNavigation), by simultaneous recto- and urodynamic testing (5-7). This, in turn, may result in an exact diagnosis of the neurologic lesion, in an etiologic diagnosis and a possible curative treatment.

INCIDENCE OF SACRAL PLEXOPATHIES

Sacral radiculopathies develop as a result of lesions to the sacral nerve roots that compose the sacral plexus. The most common causes may be idiopathic in metabolic diseases such as diabetes and autoimmune diseases that progress with vasculitis (8-11). Lesions by external traumas are rare because the plexus is situated within the relative protection of the pelvic wall. Single reports that address acute sacral radiculopathies after surgery on the retroperitoneal area or after gynecological operations have also been reported in the literature (12). Numerous etiologies have been reported in the literature, but the incidence of sacral radiculopathies is still estimated to be low. This is surprising if one considers how many surgical procedures into the pelvis in direct proximity to the sacral nerve roots are performed every day over the world, as well as how many pelvic pathologies exist that could potentially induce a compression, irritation, or invasion of the sacral nerve roots. In reality, the incidence of sacral radiculopathies is widely underestimated, which may be due to the difficulty of such diagnosis, difficulties of surgical approach of the sacral plexus, and lack of awareness that such lesions may exist (13).

Since the laparoscopy has been introduced in the diagnostic assessment of neural pelvic pain and dysfunctions, awareness about sacral radiculopathies is expanding quickly. Neurogenic dysfunctions of the lower
urinary/intestinal tract (14,15) and chronic neural pelvic pain (16,17) secondary to pelvic surgery, which are commonly encountered problems in many medical offices (18), have been considered as a consequence to damages to the pelvic splanchnic nerves over decades (19-21).

In contradiction to this acceptance, the authors have demonstrated, in the largest reported worldwide series of patients managed by laparoscopy for postsurgical pelvic pain, that not only surgical damages to the pelvic splanchnic nerves, but also injuries to the sacral nerve roots, can be responsible for pelvic pain and pelvic visceral dysfunctions (22). The same evolution is observed with sacral radiculopathies by infiltrative or compressive pelvic pathologies: Lumbosacral neoplastic radiculopathy has been reported in the literature (23), but endometriosis, one of the most prevalent gynaecological disorders that affect millions of women and young girls around the world, has been reported only one time in the literature as a possible etiology for sacral radiculopathy (24).

Since we began to perform systematic laparoscopic exploration of the sacral plexus in all women in reproduction age with catamenial “infra-pelvic pain (e.g., sciatica, pudendal pain, neuralgia of the obturator nerve…) we have collected more than 130 patients suffering from an “endometriotic sacral radiculopathy,” as well as 31 patients from a vascular entrapment of the sacral nerve roots over the last four years (1,25).

All patients of these series were treated previously by suspicion of a pyriformis syndrome, pathologic findings of the vertebral column, or by “idiopathic neuralgia”. In a further series of 134 consecutive patients explored by laparoscopy for intractable “pudendal neuralgia”, a pathology of the sacral nerve roots S3/S4 was detected in 116 patients, as well as a true pudendal neuralgie diagnosed only in 18 patients (3).

The “reported” incidence of sacral radiculopathies will increase in the future, because the laparoscopic approach permits one to make diagnoses of pathologies not expected in the past. Also, the incidence will increase because surgeries with mesh-material implantation for rectum or uro-genital prolaps – the most frequent etiologies for surgical-induced sacral radiculopathies – are actually spread widely in all countries over the world (22). As a logical consequence, all specialists involved in pelvic pathologies and pelvic surgery should be trained in clinical neurology to be able to recognize a lesion of the sacral nerve roots in all situations of postsurgical atypical or persistent pain and dysfunctions, before the nerve damages are becoming irreversible and the process becomes chronic.

LAPAROSCOPIC PELVIC NEUROSURGERY

According to the rules of the classical peripheral nerve surgery, different therapeutic options do exist: nerves with loss of continuity will need to be reconstructed, whereas techniques of neurolysis/decompression by removal of a clip, suture, vessel (vascular entrapment), mesh, or fibrosis tying the nerve are effective treatments. In
lesions of the sacral nerve roots, the problem is the surgical approach to the nerves placed deep into pelvis. Two open-surgical approaches had been described by neurosurgeons: the anterior transperitoneal approach via a xifopubical incision for reaching the sacral plexus, and posterior approach via a L5 laminectomy and sacrectomy for reaching the nerve roots and the deep intrapelvic origin of sciatic nerve (26).

Both surgical approaches are laborious and expose the patients to risk of infection, visceral injury, and hemorrhage because the hypogastric vessels and their collaterals cover the sacral plexus. Management of such vascular injuries is one of the most difficult situations to manage in pelvic surgery and tentative control can induce further nerve lesions. Furthermore, neurosurgical instruments and classical microscopes are inappropriate for procedures at such deep retroperitoneal places.

¶ All these limitations have now been overcome with laparoscopy: development of video endoscopy and microsurgical instruments enables good access to all areas in the retroperitoneal pelvic space, providing the necessary visibility with magnification of the structures and possibility to work with appropriate instruments (27). Thus, all classical techniques of peripheral nerve surgery are feasible to the sacral nerve roots by laparoscopy, are safe procedures and induce significant improvement in pain in 62% of the patients with post-surgical nerve damages, in 78% of the patients with neural endometriosis, while complete pain relief can be obtained in all patients with vascular entrapment (3,22,25).

SACRAL LAPAROSCOPIC IMPLANTATION OF NEUROPROTHESES

The “LION Procedure”

In axonal nerve pathologies, or in event of failure of the classical peripheral nerve surgical techniques, the neuromodulation is a well known option to control both neural pain (28) and dysfunctions of the lower intestinal and urinary tract (29). The surgical procedure is designed to implant an electrode in contact to the injured nerve proximal to the lesion, which is connected to a pacemaker that produces continuous low-level electrical current. Simultaneous control to the pain and both bladder and rectum dysfunctions can be obtained, since the newest generation of pacemakers offers several different programs of stimulation. For implantation of the electrodes, the original open surgical approach to the sacrum (30) has been superseded by the dorsal minimally invasive percutaneous alternative under local anesthesia with implantation to the sacral nerve roots (sacral nerve stimulation) (31) or to the spinal cord (spinal cord stimulation) (32).

¶Sacral nerve stimulation has the disadvantage of permitting the neuromodulation of only one sacral nerve root (or at last two if a twice pace maker is used), which is not enough for neither control of the pain passing through several sacral nerve roots (pudendal, pain form the lower limb, sciatic pain…) nor treatment of simultaneous rectal
and vesical dysfunctions. The spinal cord stimulation permits, in contradiction, a larger field of neuromodulation, but with less selectivity and without any impact to pelvic visceral dysfunctions.

Only two techniques of implantation offer a stimulation of the entire sacral plexus with only one electrode: the first consists in the placement of tined leads into the caudal epidural space in a retrograde approach (33-35). The second is in the laparoscopic implantation of an octipolare electrode perpendicularly and in direct contact to the sacral nerve roots — the LION procedure (36). This technique also showed positive results for treatment of neurogenic pelvic visceral dysfunctions and pain in patients suffering from neurogenic pathologies such as multiple sclerosis, spinal cord injured paralyzed, Fowler syndrome, and/or interstitial cystitis even after failure of previous sacral nerve stimulation (37), and presented the advantage comparing to all other techniques of implantation, to permit a functional exploration of the nerves before making the decision whether or not an implantation is really required.

The same LION procedure to the sacral plexus had also been used for recovery or control of pelvic functions (bladder and intestinal functions, standing, and locomotion) in patients with spina bifida and spinal-injured paralyzed patients (38, 39, 40), whereas a more distal implantation to the sciatic nerve may be indicated for treatment of intractable stump residual pain/phantom pain of the lower limb after amputation, polyneuropathy of the lower extremities, peroneus neuralgia (36).

CONCLUSIONS

Sacral radiculopathies are frequent pathologies of the nerve system and the recent introduction of laparoscopy in this field as a diagnostic and therapeutic method may modify the prognoses of patients affected by these pathologies considerably. In sacral radiculopathies caused by pelvic pathologies or surgical damages, the laparoscopy not only permits precise localization and diagnosis of the lesion, it also offers a possible etiological treatment. In axonal lesions or neurogenic pathologies of the sacral plexus, the neuromodulation of the sacral plexus by laparoscopic implantation of a neuroprothesis is an effective method to control pain and dysfunctions of the lower urinary and intestinal tracts.

The dilemma with sacral radiculopathies is that the etiologies, diagnosis, and therapies of such pathologies are dispersed into completely different speciality areas, which usually have nothing in common. Nonetheless, because of the huge number of patients who may profit from this new development, which we have summarized under the term “neuropelveology”, teaching and training of physicians in this medical field become mandatory.
REFERENCES


