The „Neuro-Pelveology“: A new speciality of medicine based on the “Laparoscopic Pelvic Neurosurgery” for management of intractable conditions

Univ.-Prof. Prof. Marc Possover MD, PhD

Introduction

The pelvis contains not only different organs such the bladder, the rectum or the genital organs but also blood vessels and nerves. Different specialities have focused on the pathologies of all this different anatomical structures: Gynecology deals with the pathologies of the uro-genital organs in women and urology in men while the pathologies of the intestinum are the field of the general surgeons but no speciality deals electively with the pathologies of the pelvic nerves! This is even more astounding as following the central nervous system and the spinal cord, no other part of the body contains so many and such important nerves: Pelvic nerves are involved in sexuality, voiding and storage functions of the bladder and of the rectum but also in standing up and walking function. The most probable reason for this omission is that the anatomy of the pelvic nervous system is difficult to understand and open surgery is inadequate to dissect pelvic somatetics nerves which are hidden deep in the retroperitoneal space behind the pelvic vessels; Thus it is not at all surprising that the field of pelvic neurosurgery is not well developed.

This situation changed after the introduction of laparoscopy into the field of pelvic surgery. Since the developments in videoendoscopy and microsurgical instruments, laparoscopy permits good access to all areas of the retroperitoneal pelvic space and in turn offers a unique and reproducible surgical approach to all pelvic nerves that could never be reached by classical open surgery (Possover M. 2004. Laparoscopic exposure and electrostimulation of the somatic and autonomous pelvic nerves: a new method for implantation of neuroprothesis in paralysed patients? Journal Gynecological Surgery – Endoscopy, Imaging, and Allied Techniques 2004; 1:87-90).

Due to the magnification effect and the possibility of a bloodfree dissection even in the deepness of the pelvis, laparoscopic surgery in the retroperitoneum is becoming one of the most usefull and important instrument for learning the pelvic retroperitoneal anatomy. Laparoscopic surgery do not just incite the surgeon for learning the pelvic anatomy but oblige him to learn it: The combination of a good knowlegde about the pelvic neuroanatomy
with the optimal magnification of the structures due to the endoscope allows us quite the same quality of dissection as on cadaver but we less time since the tissue are fresh and all the structures have their own aspect and color.

1. **The LAparoscopic pelvic Neuro-Navigation – the LANN technique**

While the functions of the pelvic somatic nerves is wellknowned, the laparoscopic exposure of the autonomous pelvic nerves alone cannot give informations about their functions. Thus to gain intraoperative information in regard to the motoric function of the exposed nerves, we developed the new concept of **Laparoscopic Neuro-Navigation – the LANN technique** (Possover M, Rhiem K., Chiantera V. The „Laparoscopic Neuro-Navigation“ - LANN: from a functionnal cartography of the pelvic autonomous神经系统 to a new field of laparoscopic surgery. Min Invas Ther & Allied Technol 2004;13:362-7): During surgery, the nerves are stimulated with a laparoscopic bipolar forceps giving a current with a square-wave pulse duration of 250 μs, a pulse frequency of 35 Hz, and a electric potential varying between 1-12 V. For a successful intraoperative electrostimulation, the general anesthesia have not to contain any myorelaxants. The stimulation of the pelvic somatic nerves induce motoric muscle reactions mostly visible by naked eyes. Since the autonomous pelvic motoric nerves - the pelvic splanchnic ners - are originate from S2, S3 and S4/5, identification of this sacral nerve roots is of importance: Stimulation of S3 nerves is confirm visually by a deepening and flattening of the buttock groove as well as a plantar flexion of the large toe and to a lesser extent of the smaller toes. Stimulation of S2 produces an outward rotation of the leg and plantar flexion of the foot as well as a a clamp-like squeeze of the anal sphincter from anterior/posterior (Brindley GS, Polkey CE, Rushton DN, Crdozo L. Sacral anterior root stimulators for bladder control in paraplegia: the first 50 cases. Journal of Neurology, Neurosurgery and Psychiatry 1986; 49: 1104-1114). For the intraoperative assessment of the pelvic splanchnic nerves during their electrostimulation, the intravesical, intrarectal and the urethral pressures habe been measured: A microtip rectal probe and a 8F dual sensor microtip transurethral catheter with filling channel are used for intraoperative urodynamik testing. The sensor at the tip of the rectal probe is placed 7cm proximal to the anal sphincter while the transurethral catheter is inserted in such a manner that the urethral and the intravesical pressure can be measured concomittantly but separately while the bladder have to been filled during neurostimulation with 150 to 200cc Ringer´s solution. Neurostimulation of the splanchnic pelvic nerves is performed with the same bipolar forceps and the same current as in stimulation of the sacral roots: Electrostimulation of the vesical nerves induce a contraction of the detrusor with a rise of the intravesical pressure, while stimulation of the rectal parasympathetic nerves induce a contraction of the terminal rectosigmoide with a isolated rise of the intrarectal pressure (Possover M, Chiantera V. Baekelandt J. Anatomy of the sacral roots and the
pelvic splanchnic nerves in women using the LANN technique. Surg Lap Endosc Percut Tech 2007; 17(6):508-10;
Stimulation of S2 induce also a contraction of the gluteal muscles and in men a erection.

Based of our founding by using this LANN technique during laparoscopic radical pelvic surgery for
gynecologic cancer or for deep infiltrating endometriosis of the retroperitoneal space, we elaborated a functional
cartography of the inferior hypogastric plexis and demonstrated that it is not a anarchic patchwork of sympathetic
and parasympathetic neural fibers as it is always reported in the literature but it present three functional levels
(Possover M, Rhiem K., Chiantera V. The „Laparoscopic Neuro-Navigation“ - LANN: from a fonctional
cartography of the pelvic autonomous neurosystem to a new field of laparoscopic surgery. Min Invas Ther & Allied
Technol 2004;13:362-7): The upper part is constitue by the sympathetic fibers coming from both inferior
hypogastric nerves which are responsible for the wetness of the vagina and the feeling of pain/pleasure to the cervix
and the vagina. More caudally of this fibers, the anastomoses sprouting out of both sympathetic trunks are
anastomosing with the plexus and are responsible for the sensation of fullness of the bladder and of the rectum.
Sprouting much more deeper from S2 and first of all from S3 and S4/5, the parasympathetic nerves are lies upwards
to the pelvic plexus and anastomose to him just caudal and lateraly to the precedent sympathetic nerves.

2. The “Splanchnic Nerve Sparing” technique in laparoscopic pelvic radical surgery

Based on this findings about the functional pelvic neuro-anatomy , we have developed the technique of
„laparoscopic splanchnic nerves sparing radical pelvic surgery“ which is not based on the sparing of the ligaments
or pelvic compartments which contain the motoric autonomic pelvic nerves, but on the elective exposure of the
pelvic parasympathic nerves starting at their emergence outof the sacral nerve roots S2, S3 and S4/5 to their
anatomosis in the inferior hypogastric plexus not during but befor the transection or resection of the parametries is
done: In a prospective serie of 163 consecutive patients who underwent a laparoscopic assisted vaginal radical
hysterectomy Piver 3 radicality for cervical cancer and 91 further consecutive patients a laparoscopic deep anterior
rectm resection/anatomosis for a deep infiltrating endometriosis of the rectum, we reported on a reduction in the rate
of postoperative bladder dysfunction from up to 40% reported in literature (Junginger T, Kneist W, Heintz A.
Influence of identification and preservation of pelvic autonomic nerves in rectal cancer surgery on bladder
dysfunction after total mesorectal excision. Dis Colon Rectum 2003; 46: 621-8) to less than 1% (Possover M,
Quakernack J, Chiantera V. 2005. The „LANN-technique“ to reduce the postoperative functional mobidity in
Therefore the classical functional morbidities of radical pelvic surgery can no longer be accepted as common side effects of the procedure, and appropriate knowledge of the neuro-functional anatomy of the pelvis must become mandatory for all surgeons involved in radical pelvic surgery (rectum resection, radical prostatectomy...)

3. The “laparoscopic pelvic neurosurgery” to treat neural somatic pelvic pain

Chronic pelvic pain is a commonly encountered problem in many medical offices and it is estimated that 12% of all women around the world suffer from chronic pelvic pain (Walker EA, Katon WJ. The prevalence of chronic pain and irritable bowel syndrome in two university clinics. J Psychosom Obstet Gynecol 1991; 12: 66). As one of the first steps in pelvic pain management in women is to find an etiology to be treated, laparoscopy has become standard for diagnosis and treatment of classical etiologies such as adhesions, endometriosis or inflammatory pelvic disease. However lesions to pelvic nerves themselves can also led to pelvic pain: Lesions to the somatic pelvic nerves during surgery to the lateral pelvic wall can lead to “somatic pelvic pain” while lesion of sympathetic nerves especially those contained in the inferior hypogastric plexi during radical pelvic surgery or „less-radical“ procedures such as simple hysterectomies or prolapse surgery (Lowenstein L, Dooley Y, Kenton K, Mueller E, Brubaker L. Neural pain after uterosacral ligament vaginal suspension. Int Urogynecol J Pelvic Floor Dysfunction 2007; 18: 109-10) can induce chronic “visceral pelvic pain” (Brandsborg B, Nikolajsen L, Hansen CT, Kehlet H, Jensen TS. Risk factors for chronic pain after hysterectomy: a nationwide questionnaire and database study. Anesthesiology 2007; 106: 1003-12). The management of neuropathic pelvic pain is mostly very confusing first of all for the patients: Because on one hand gynecologists are not trained neither in clinical neurology nor in operative techniques of neurosurgical procedures and on the other hand neurosurgeons and neurotraumatologists are not trained in pelvic surgery - especially in laparoscopic pelvic surgery – but also are not trained in gynecologic pathologies, the patients with neural pelvic pain are mostly referred from one specialist to another and a variety of different but ineffective treatments are attempted.

The most frequent „somatic pelvic pain“ is the sciatica: This pain can be due to a irritation of the sciatic nerve itself or its roots – sacral radiculopathie - and produce a pain started low in the pelvis and than shoots down the buttock and the leg. The second most frequent somatic pelvic pain is the pudendal neuralgia; This pain is typically located in the genito-anal regions with (but not always) increasing of the pain by sitting or riding a bicycle. The welknown Alcock’s canal syndrome is just one of its etiologies (Amarenco G, Savatosky I, Budet C, Perrigot M. Nevralgies perineales et syndrome du canal c’Alcock. Ann. Urol 1989; 6:488-492); Lesions to the endopelvic portion of the pudendal nerve or a sacral radiculopathie especially from S2 and S3 can also led to perineal or perianal pain similar to a pudendal neuralgia.
Since in lesion of somatic, the treatment of the underlying cause of the irritation of the nerve(s) is the first option with the most effective course, exploration of the pelvic nerves have to be done in first line in order to exclude and treat some pathologies of the pelvic nerves: We demonstrated in the largest reported worldwide serie of sometic pelvic pain, that the endometriosis of the pelvic retroperitoneal space (Possover M, Baekelandt J, Flaskamp C, Dong Li, Chiantera V. Laparoscopic neurolysis of the sacral plexus and the sciatic nerve for extensive endometriosis of the pelvic wall. Minim Invas Neurosurg 2007;50(1):33-6 - Possover M, Chiantera V. Isolated infiltrative endometriosis of the sciatic nerve: about three cases. Fertil Steril, 2007; 87(2): 417-9), and the postsurgical pelvic nerve damages (Possover M. Laparoscopic management of neural pelvic pain in women secondary to pelvic surgery. In press in Fertil Steril) are the two most frequent etiologies for somatic pelvic pain followed by vascular entrapment of the sacral nerve roots. In such situations, the laparoscopic approach to the pelvic nerves must be considered as an option in the management of pelvic neuropathia both for an etiologic and a therapeutic approach since classical neurosurgical techniques such as the technique of nerve-decompression or of intrafascicular neurolysis are feasible to the pelvic nerves by laparoscopic approach (Possover M, Baekelandt J, Chiantera V. The laparoscopic approach to control intractable pelvic neuralgia: from laparoscopic pelvic neurosurgery to the LION technique. Clin J Pain 2007; 45-36-39).

Since then and maybe because we have reported on this technique, a further increase in the number of patients with „non-gynecologic“ indications such as pelveo-abdominal neuralgias secondary to radical prostatectomy, rectum surgery, prolaps/incontinence surgery, pelvic traumas or pelvic radiotherapy have been sent to us for laparoscopic management. The spectacular increase in number of patients who underwent our technique of laparoscopic pelvic neurosurgery since then is definitely not caused by an increase in the incidence of such pathologies, but due to the increased awareness of doctors that this pathology exists, that there is an explanation for these patients’ pain, and that it can be treated by laparoscopy.

4. The “LION procedure” to control pelvic and abdominal neural pain

Not all damages to the nerves are only surrounding the nerves, but can also involved the structures of the nerves themselves: In axonal lesions, simple nerve-decompression or neurolysis cannot improve the pain. Medical treatment can block the information of pain, but not electively so that side effects have to be accepted. A wellknowed method to control neural pain is the used of electricity, the s.c. Neuromodulation: The neuromodulation to control neural pain is based on the implantation of a pacemaker and electrodes to cover the electrical information of pain by using low energies of electricity. However since open surgery is unsuitable to expose the pelvic nerves, application of neuromodulation to control pelvic neuralgia is limited to the implantation of electrodes much higher
at the level of the spinal cord (spinal cord stimulation) or the at the level of just one sacral nerve root through the back (transforamen sacral nerve stimulation –Interstim therapy). We developed the technique of *Laposcopic Implantation Of Neuroprothesis - LION procedure* - to control pelvic neuralgia using elective neuromodulation of injured pelvic nerves (*Possover M, Baekelandt J, Chianteras V. The Laparoscopic Implantation of Neuroprothesis - LION technique - to control intractable abdomino-pelvic neuralgia. Neuromodulation 2007; 10:18-23*).

Laparoscopy is the only technique which enables the implantation of electrodes on all pelvic nerves and plexi even on those normally placed deep in the pelvis inaccessible for classical techniques of implantation. Thus the LION procedure permits extension of the neuromodulation to control pelvic neuralgia or pelvic axonal neuropathic pain such as:

- Treatment of intractable neuralgia to the pelvoabdominal nerves, the genitofemoral, the ilio-inguinal, the ilio-hypogastric or the lat. Femoral cutane nerves for exemple after a herniorrraphia,
- to the endopelvic portion of the sciatic nerve to control refractory phantom pain of the lower extremity after amputation or to control polyneuropathy of the lower extremities,
- to the entire sacral plexus to control pudendal neuralgia or sacral nerve roots neuralgias,
- to the superior hypogastric plexus to treat complex pelvic visceral pain syndromes and/or bladder atonia for example following pelvic surgery.

The LION procedure does not offer a new kind of pain-treatment, but permits extension of the neuromodulation to control pain in a large number of patients who were not candidates for neuromodulation before the development of the LION procedure on the pelvic nerves.

5. **The sacral LION procedure to control or restore pelvic nerve functions**

Finally the next logical step was to introduce the LION procedure into the field of electrical stimulation to control or recover neurological pelvic functions. The technique of sacral nerve root neuromodulation to treat sphincter dysfunction is well established, but the LION procedure is the only one which permits with the implantation of just one electrode placed tangentially to the entire sacral plexus, the neuromodulation of all sacral nerves roots together or separately. Thus this has opened absolute new ways to control bladder atonia (after radical pelvic surgery, cauda equine...), detrusor hyperactivity or detrusor-urethral-sphincter dyssynergy in patients with interstitial cystitis, multiple sclerosis, spina bifida or in completely paralyzed patients following spinal cord injury: Our group has performed the first reported laparoscopic implantation of a Finetech-Brindley bladder controller onto the endopelvic sacral nerve roots in a Th8 completely paralysed woman for recovery of bladder and rectum function (*Possover M, Baekelandt J, Kaufmann A, Chianteras V. Laparoscopic endopelvic sacral Implantation of a Brindley...*)
Controller for recovery of bladder function in a paralyzed patient. Spinal Cord 2008;46(1): 70-3. Since then, the LION procedure to the pelvic nerves permit to paralyzed patients control to the bladder overactivity without need of a dorsal deafferentation, without need of cutting any nerves, but also a electrical-induced micturition, defecation, erectin and ejaculation. That the laparoscopic approach to the pelvic nerves has clear advantages for the management of paralyzed patients as it avoids the classical laminectomy with risk of meningitis, encephalitis or liquor leakage, this approach represents the only option for implantation of electrodes to control bladder functions in children with spina bifida as the dorsal approach is generally not feasible. As laparoscopy also offers a selective approach to all pelvic somatetic nerves, new options for selective implantation of neural electrodes by laparoscopy are further open new paths to recover locomotion in paralysed patients...

6. Conclusion

The innovation of the „Neuro-pelveology“ which includes all these different new aspects, is based on the feasibility of laparoscopic dissection of all pelvic autonomous and somatetic nerves. It offers definite absolutely new therapeutic options – and very often the only one - for a huge number of patients with pathology of the pelvic nerves themselves or with a pathology of the pelvis which involves the pelvic nerves. The problem in this new clinical field is that the etiopathologies, indications and therapeutical concepts are dispersed into completely different speciality areas which usually have nothing in common. It is clear that this concept should have a significant impact on all specialities involved in the treatment of pelvic pathologies, but in view of the huge number of patients who really should profit from such an evolution, the creation of speciality covering all required knowledge for an optimal management of these patients is becoming mandatory. This new speciality, the „Neuro-Pelveology“ should also focus on the improvement of patient care through research and education of the specialists involved in pelvic surgery including anesthesiologists, neurologist, orthopedists, neurotraumatologists and neurosurgeons.