

ENDOSCOPY IN THE PERIDURAL SPACE - PERIDUROSCOPY -

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PERIDUROSCOPY (MYELOSCOPY): A HISTORY

Devised in 1931 by Burman (1), this technique was used in a clinical practice by Pool in 1937 (2-3).

It was then rediscovered in the Eighties. Blomberg (4) used it in 1989 for anatomical studies.

The first clinical application dates back to 1989, when Sabersky (5) administered cortisone to 10 patients with a caudal endoscopic approach.

There was a pause until the mid-Nineties, when clinicians started to use this technique again, perfecting its process and indications.

The Italian experience starts in 1996, when Raffaeli (6-7) started to practice this technique with adapted bronchoscopes. The development of clinical experience led to detailed descriptions of the various morphological features of patients with spinal stenosis pain and *failed back surgery syndrome*, as well as the treatment validity of the endoscopic peridurolysis (7-8).

The limits of this procedure are due to the presence of fibrotic septa that limited its use or the benefits, and were finally overcome by the perfecting of a new periduroscope-guided surgical procedure for the lysis and dissection of the fibrous and scar tissues with a resonance probe with tissue vaporization (9).

DIAGNOSTIC-THERAPEUTIC SYNOPSIS

Clinical indications: Persistent chronic pain, motor sensory neuropathy without acute motor deficits

From a clinical point of view, indications for peridural endoscopy, in order of frequency, are:

- 1) Failed back surgery syndrome (FBSS).
- 2) Spinal stenosis due to listhesis or osteo-degenerative processes.
- 3) Low back pain with or without radiation, no diagnosis
- 4) Coccydynia, origin to be determined
- 5) Revision of spinal neuroimplants (Spinal Cord Stimulation) due to development of tolerance of the clinical effect.

PATIENT SELECTION MODALITIES

In order to increase the success of this technique, patients need to be chosen accurately on the basis of stringent defined criteria. The main selection criteria are:

- Pain must have an identified organic origin, with objective signs of neurological deficit
- All other pain medical treatments, including physical therapy, must have already been tried.

PAIN CHARACTERISTICS

Clinical assessment

Type of pain, with differential diagnosis with regard to psychogenic pain: specialist assessment.

Exclusion criteria

Absolute

- signs of surgical and/or internal medicine emergencies
- unstable central and/or peripheral nervous deficits
- previous brain surgery for vasculopathies
- primary or secondary epilepsy
- cerebral vasculopathies such as aneurysm or angioma
- under study and/or progressive eye pathologies
- retinal pathologies, glaucoma
- non pharmacological coagulopathies
- pregnancy
- response to placebo trials
- evidence of severe psychic disorders
- the patient cannot understand the informed consent protocols.

Relative: cautionary

- persistent chronic headache (menstrual manifestations excluded)
- cervical stenosis with myelopathy.

PREDICTORS OF SUCCESS

The correct patient selection is a predictor for success.

- 1) patients with non mechanical or non-osteogenic pain in the back part of the spine
- 2) spinal-radicular pain with functional-ambulation impairment
- 3) pathologies with functional stenosis not due to scar tissue.

OPERATING TEAM EXPERIENCE

Diagnostic applications of periduroscopy

The specific diagnostic properties of peridural endoscopy, allow the qualitative and quantitative identification and classification of intraspinal pathologies of the back peridural and sacral area, often overlooked, and the identification of anatomic anomalies. Periduroscopy has several applications in diagnostic field, which can be differentiated between "elective" and "complementary".

"Elective" diagnostic applications concern:

- patients who cannot undergo radio diagnostic tests (RMN);
- patients with pathologies of uncertain origins, namely, with disagreements between clinical and diagnostic tests (typical situation in the case of "psychically unstable" patients or patients looking for false pathologies within the context of labour or medical legal proceedings).

Therapeutic applications of periduroscopy

Therapeutic applications are very important and represent the main innovation of this technique. The specific therapeutic properties of peridural endoscopy make it possible to:

- unbend the abnormal structures adhering to the surrounding tissues;
- inflate liquids intraforaminally to distend tissues and free nervous fibres from a neurostructural "conflict";
- target topical medication, through drug administration;
- remove scar tissue adhering to peridural anatomical structures, as in the case of FBSS (Failed Back Surgery Syndrome);
- extend the stenotic structures;
- reduce secondary vascular stasis.

In short, the main therapeutic applications of peridural endoscopy are:

- targeted medication of back dural pathological sites.
- lysis of post-surgery adhesions, with the relief of structures of the perineurium.

Endoscopic equipment

Sterile instruments:

- 1 videocatheter, for optic fibre insertion
 - some models do not require a support for the optic part
- 1 optic fibre
- connection wires between the optic fibre and the video-camera column - insertion with sterile cover
- 1 3F Fogarty, long type - 45 cm
- 1 surgical probe Resaflex-type: connection to the Resablator 50 device (MRI energy for tissue ablation)

MRI Resablator - Quantic Molecular resonance: Q- δ high-frequency waves generator - 4 MHz

Operation: temperature < 50°C, in cutting mode

Temperature = 63°C in coagulation mode (fibrin-fibrinogen).

Technique name: RESABLATION (Molecular resonance technology). The quantum energy value depends from the frequency of the source it was generated from. This device uses the emission of quanta to vaporize the bonds of biological structures. Molecules maintain their original kinetic status and molecular bonds break without global increase in the temperature of the structure.

The bonds absorb the energy quanta completely, reducing dispersion to the molecules to a minimum, and the molecules do not increase their kinetic agitation. No temperature increase of the operating structures.

Periduroscopy

Phase 1: General preparatory phase

Identification of the sacrococcygeal anatomical marker with radiological instrumentation.

Introduction of the dilator into the guide wire: it is necessary to slide into the dilator with care, in order to avoid damaging the dilator edges.

Open the dedicated video-catheter and introduction of the optic fibre in the dedicated channel; focusing of the optics and start of operation recording.

Sacro-lumbar intracanalicular space visualization technique

Access to the peridural space is obtained with the direct visualisation distension technique, in which the operator injects saline, with a 20 ml syringe, in 2-3 ml boluses each time. Why to use microdoses: to assess any resistance to the injection - whether there are barriers or excess pressure or whether fluids disperse without finding any obstacle - the presence or absence of pain upon distension (localisation of the painful area/evidence of nuchal pain). Time intervals, with 1/2 m stops every 3-4 boluses, to facilitate the exit and reflux of liquids from the foramina.

Do not inject quickly, use slow-injection boluses. Possibility of using the device to view the environment without solution loss, during the intervals of the procedure.

In order to proceed in the peridural space without trauma, a subcontinuous peridural irrigation with saline is required, at an infusion pressure not exceeding 60 mmHg.

Total dose of liquids: do not exceed 350 ml Average dose: 220ml

Video-guided progression of the catheter, cleaning of the sacral channel from fat and low adhesion synechia. Warning: if it is impossible to identify the anatomical markers, proceed with caution because anatomical anomalies might be present, with adhesion of the meningeal germ layers and consequent risk of dura tearing, especially in the case of patients who have undergone several surgeries and have a short sacrum.

Surgical lysis of adhesions with a MRI Resablator - Raffaelli - Righetti (RR) Technique (8-9)

Preparation of the endoscopic space and surgical exposure according to the Raffaelli-Righetti technique, endoscopic exploration and treatment of pathological areas, mechanical lysis/targeted medication.

First phase: preparation of the surgical field

Surgical exposure of the channel and dura tissue.

Instruments for the preparation of the surgical field:

- 1 3F fogarty, long type: 45 cm.

The purpose of the first exploratory phase is to make the dura tissue and pathological areas visible, isolating the fibrotic structures and/or the pathological adhesion areas: avoid absolutely the blind progressing or exploring.

Second phase: dissection of adhesions

Specific character

Surgical instruments: resablator/resaflex

Second phase: resection with Resaflex probe

After isolating and exposing the individual fibrous septa or adhesions at the base of the dura, it is necessary to identify the area of minimum resistance by exerting a slight pull with the tip of the fogarty and by introducing the tip of the Resaflex probe at the base. The probe is positioned to replace the fogarty, which is removed after leaving a track that shall be use to position the probe. The probe is oriented towards the septum base by rotating the tip, which is angled just so that it can be identified when on site and rotated to be pointed to the base of the site to be treated.

After positioning the tip in the identified point for the cut, the I lesion is made, using a treatment intensity of 25-35 V for a few seconds, twice; after retracting the tip a few millimetres and repositioning the tip, further lesions are made (3/5 times), applying the treatment for a few seconds at 5V intensity increases each

time. The process continues until the full or partial (it suffices to remove the dura pulling effect by the pathological tissue) ablation of the connective tissues and their disconnection from the base of the septum or pathological segment.

Then the surgical field is cleaned with liquid infusion and a balloon, to progressively isolate the fibrosis.

RR-TECHNIQUE LYSIS INDICATIONS

The introduction of this new technique for the lysis of epidural adhesions brought considerable therapeutic benefits; the technique must be used in all so-called "functional instability" conditions, where the connective tissue fibrotic tissue fill the epidural space and pull the dura on, the perineural structures during intracanalicular pressure increases and on the nerve roots.

The calibration phase of this technique permitted to identify its limits and advantages and to define the characteristics that facilitate the execution of the technique.

MRI myeloscopy is a further development that allows to increase and streamline positive results obtained by traditional myeloscopy, especially with regard to long-term pain recurrence reduction.

As against traditional surgical procedures, this method offers the benefit of easy execution and repeatability, besides the therapeutic advantage of "pain relief".

Procedure duration: 35 minutes.

Intraoperative clinical signs to be monitored

Nuchal or frontal pain. The injection is suspended and restarted after a few minutes with 2 ml. If the nuchal pain or headache recurs, stop the procedure.

Chest axial pain and/or feeling of constriction of the front band. Reduce fluids and monitor each bolus.

RESULTS

Patients treated with this procedure from 1996 to 2006: 487

Epidural space morphology

The following types of outcome have been recorded: band-adhesions, stenosis, stasis, flogosis, hyperaemia, adhesions, fibrosis, scars. The presence of functional stenosis was detected in 60% of patients with surgical pathologies and in 62% of patients without surgical pathologies. Indirect signs of inflammation, with flogosis and hyperaemia were present in 36% of patients with surgical pathologies and in 43% of patients without surgical pathologies. Microcirculation anomalies with vascular stasis were present in 18% of patients with surgical pathologies and in 37% of patients without surgical pathologies. It was possible to carry out the lysis of adhesions with the epiduroscopy.

Effectiveness

Patients in the group with a history of surgeries (FBSS) received benefit in terms of pain reduction in 67% of cases, only 33% having received no benefit from the procedure. At the same time, patients in the group with no history of surgery (Osteodegenerative spinal stenosis) received benefit in terms of pain reduction in 82% of cases, only 18% having received no benefit from the procedure (See Table 2).

COMPLICATIONS

As in all invasive procedures, epidural endoscopy, too, may present some side effects, even though it is a minimally invasive technique. The professional experience and skill of the operator, a complete and certified training, the strict compliance with the asepsis/antiseptis rules, the certification of the reference centre and the careful selection of patients are all essential factors for the success of this procedure.

The main complications of this technique are: accidental air/saline injection in the

subarachnoid or subdural space, pneumocephalus and/or cerebral complaints due to central hypertension, visual field alterations with retinal microhemorrhages, epidural haematoma, and epidural or sacral infections.

The accidental injection of saline in the subarachnoid space can cause heart arrhythmias and epileptic convulsions.

Generally speaking, it can be said that there are few complications associated with periduroscopy, thanks to the improvement of methods, with the consequent reduction of accidents of this kind, and infectious sequelae, such as meningitis, are equally rare,

and, when present, answer well to antibiotic therapy.

Sphincter and bladder or intestinal disorders, too, are very rare, for the most part connected with medullar compression (haematoma). Any neurological disorders (convulsions and spasms) are in any case temporary and resolve spontaneously in two days.

GENERAL CONSIDERATIONS

Our work demonstrated that low back pain cannot be placed in a single pathological category, as it presents with different morphological scenarios whose

Table 1
Epidural space morphology

<i>Morphology</i>	<i>Pts. with surgical pathology % values</i>	<i>Pts. without surgical pathology %values</i>
Stenosis	60	62
Flogosis	41	47
Hyperaemia	32	40
Band-adhesions	42	35
Stasis	18	37
Pain upon injection of 1/2 ml of saline vs placebo	34	17

Table 2
Pain relief

<i>Pain relief</i>	<i>Patients after FBSS surgery % values</i>	<i>Patients without Osteodegenerative Spinal Stenosis surgical issues %values</i>
Yes	67	82
No	33	18

role in the genesis of the pathologies has not been defined yet, but oblige us to increase our study about the role of the dura and the epidural area in the specific genesis of some neuroinflammatory and mechanical pathologies.

The pathological situation whereby the dura adheres to the surrounding areas or is inflamed, can generate pain by temporary strain that generates stasis and the release of pain-generating neuromediators, as well as mechanical instability: a local non-mechanical, but rather neurochemical cause is assumed, since the patient reports relief from pain after a simple injection of liquids, with no elimination of scar tissue.

Several authors report that low back pain can have a neurochemical and neuroinflammatory origin (Goup - Siddal) that can be caused either from the disc or from vascular events (stasis-ischemia) (Oystein - King) and that such events emerge also after the nerve is damaged (secondary to bacterial contamination, suture irritation, pH alterations), with a hypersensitivity of the structures caused by the cytokine and glutamate system (Watkins). Our data are consistent with such theories and we believe that the instability of the dura meninges with frequent mechanical stresses generates vascular (ischemia and vascular stasis) and neuroinflammatory phenomena which define the pain symptomatology, mechanical from direct traction and subacute flogistic biochemical, of the pain.

According to which origin prevails, the response to the therapy may vary. The possibility to obtain pain relief simply by injecting an antibiotic and some liquids justifies a neurochemical - bacterial pathogenesis generated by structural stresses, as the pain returns after intervals of various lengths.

The same pain-free interval with a return after intervals of various lengths leads to suspect the presence of biochemical phenomena generated by stresses in an anatomically predisposed space.

The different morphological scenarios detected in conditions generally classified under the umbrella of *low back pain* can explain the extreme variability of the results of every technique used, be it an invasive one, such as the injection of drugs in the epidural space, or a manipulation-rehabilitative one (Deyo 83 - Spitzer).

Our data show that spinal syndromes are an heterogeneous category that suggests systemic, rheumatic and neuroinflammatory origins that influence the dura structure and the perineural tissue in the epidural area.

Non surgical Patients - Basic LBP

The effectiveness of this therapy in patients with persistent chronic pathologies derived from both hernia and *disc bulging* or undiagnosed that are resistant to the pharmacological therapy cannot easily be compared with the effectiveness of other techniques. The literature shows that several techniques, such as rehabilitation or *back school* ones or spinal manipulations (Koes-Deyo) are quite effective, and that some non-conventional techniques, such as percutaneous nucleolysis in non surgical disc pathologies (Iliakis) are also fairly effective, reporting, in some cases, benefits for 66-75% of patients for 6-12 months.

Data from different works are hardly comparable (Deyo 83 - Spitzer), due to both the difficulty of identifying the exact type of pain syndrome, due to scarce descriptions and the absence of objective elements, and the different pathological situations that can be present.

Our data can be compared to those of other procedures, except the fact that the patients treated by us were selected among the subjects that had not responded to any other previous therapy and that had already tried physical therapy, peridural blocks and often also non-traditional procedures. Our data, instead, refer to chronic pain pathologies and to patients that had already been treated with traditional physical therapy

and peridural blocks, without any benefit: in this light, our data show that the periduroscopy technique is fairly good and has results that last for a satisfactory period of time.

The diagnostic opportunities associated with this technique, together with the therapeutic ones, make it more appropriate for patients who do not respond to I level practices.

FAILED BACK SURGERY SINDROME (FBSS)

Anatomic Morphological and diagnostic considerations

The literature clearly shows a generic terminology employed to define pain after various therapies on the spine.

The term *failed back surgery syndrome* is an umbrella that collects very different clinical presentations (pain in the axial-lumbar area, radicular pain with or without claudication, instability of the back area) which have in common only the persistence of pain and a RMN characterised by the presence of fibrous tissue. Some authors (Burton) think that fibrosis is the cause of pain only in 24% of patients and our experience seems to confirm this, as the morphological pictures are much more complex and heterogeneous than we thought, and that fibrosis has only a partial role in the genesis of pain.

This relationship, furthermore, does not depend on the amount of scar tissue present, as Ross maintained, thinking that there is a linear correlation between the presence of peridural scars and radicular pain when fibrosis is quite advanced, but rather by the distribution of scar tissue inside the peridural space and by the stressed that such scar tissue generates on the surrounding tissues. Indeed, our experience shows that there are several different morphological scenarios, which can however be divided on the basis of the presence or absence of inflammation and vascular alterations, that usually generate an axial lumbar pain, or of scars and band-adhesions without flogosis.

