Is section of the sympathetic rami communicantes by laparoscopy in patients with refractory low back pain efficient?

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Abstract

Objective The objective of this prospective innovative treatment is to section the pain pathways carried by sympathetic lumbar rami communicantes to achieve lasting pain relief of refractory low back pain.

Methods From December 2005 to September 2008, nine patients were operated by bilateral section of rami communicantes for a refractory low back pain. As a diagnostic and predictive test, all patients had, before surgery, a local anaesthetic infiltration of the sympathetic trunk at L2 performed with computed tomography guidance. Surgery is indicated if the tests lead to a reduction in pain of at least 50 %. The procedure, using a retroperitoneal laparoscopic approach, consisted to identify the sympathetic trunk and to section all lumbar rami communicantes from L1 to L2.

Results No intraoperative complications were observed. The mean postoperative follow-up was 29 ± 15 months. At the last follow-up, only 22 % (2/9) patients had an improvement of their low back pain with this surgery but with a minimal effect (30 and 50 % reduction of pain). An improvement of quality of life was observed in 33 % (3/9) of

cases. Due to persistent pain, four patients had a spinal cord stimulation after this surgery.

Conclusions Section the pain pathways carried by sympathetic lumbar rami communicantes for refractory low back pain improved 22 % of patients at the last follow-up of 29 months.

Keywords Low back pain · Laparoscopy · Sympathetic · Rami communicantes

Introduction

The management of patients with low back pain must be based on a multidisciplinary approach comprising first-line medical and physical therapy, sometimes followed by surgery. However, surgical management with or without spinal fusion is not always successful. Some patients continue to experience pain and are referred specifically for pain management. Chronic low back pain has a major impact on the daily life of patients with alteration of quality of life, prolonged sick leave and a high socio-economic cost in terms of both direct costs (healthcare) and indirect costs (social costs, sick leave).

Innervated pain structures of the spine are the intervertebral disc, the dorsal longitudinal ligament and the ventral surface of the dura mater. These structures of pain innervation of the spine were described by Hubert Von Luschka in 1850. Low back pain presents as diffuse, multimeta-meric, visceral, autonomic pain, associated with reflex contractures and autonomic signs.

Pain pathways arise in intervertebral disc and ligamentous structures. The pain impulse is relayed by sympathetic ganglia of the paravertebral sympathetic trunk at various levels and then ascends to the L2 sympathetic ganglion.

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Fig. 1 Pain pathways of lumbar spine via rami communicantes, sympathetic trunk and spinal cord

Fig. 2 Anatomical dissection of rami communicantes

It reaches the dorsal roots of L2 somatic spinal nerves via rami communicantes and finally ascends to the brain via somatic ascending pathways, especially the spinothalamic tract [1–3] (Figs. 1, 2). These data have been confirmed by anatomical and histological studies in rats [4–6].

Several interventions on L2 rami communicantes of the sympathetic trunk have been proposed as treatments for refractory low back pain, such as infiltrations [7], radio-frequency [8].

The purpose of this prospective study was to evaluate the functional results of section of L1–L2 rami communicantes as treatment for refractory low back pain in man. The objective of this innovative treatment is to section the pain pathways carried by rami communicantes to achieve lasting pain relief with no harmful somatic or autonomic effects.

Materials and methods

Population

From December 2005 to September 2008, nine consecutive patients (five women and four men) with a mean age of 50.8 ± 13 years (41–80) were operated by bilateral section of rami communicantes in a prospective study. During this period, two patients refused the surgery because of its innovative character. All patients had a long history of low back pain with radicular pain for an average of 5.3 years (2–9). All patients had a CT-scan and MRI of lumbar spine without an indication of surgery. All patients had an indication of spinal cord stimulation.

All patients attended a multidisciplinary pain clinic before deciding on the operation. They were informed that this is an innovative prospective surgical treatment and they give an agreement for the surgery.

L2 infiltration

Before performing section of the rami communicantes, twice bilateral infiltration of L2 rami communicantes was performed with computed tomography guidance as a diagnostic and predictive test in all patients. The test infiltration of the sympathetic trunk at L2 was considered to be effective when the VAS (Visual Analogue Scale) pain score was decreased by at least 50 % in both cases. In all cases, pain was recurred after the effect of the local anaesthetic. There was no long-term effect of the infiltration with recurrence of pain 2–3 weeks after infiltration in all cases. Surgery was contraindicated in patients with less than 50 % reduction of pain or no improvement.

For the infiltration, patient was placed in the prone position. A first series of horizontal CT slices visualized the transverse processes of L2. The ideal course of the needles, just above the transverse processes and directed towards the middle part of the lateral surface of the vertebral body, was plotted on the computed tomography console. After disinfection of the skin and local anaesthesia of the injection site, needles were positioned in the predicted site of the rami communicantes. The correct position of the needles over the sympathetic trunk was checked by a series of CT slices after injecting contrast agent into the needle tips.

Once the needles were correctly positioned, a total of 4 cc per needle [local anaesthetic (Ropivacaine) (2 cc at 0.75 %) and corticosteroids (2 cc)] was injected (corticosteroids were used in order to expect a long-time effect of the infiltration). Needles were then removed and the patient's pain was evaluated by VAS (Visual Analogue Scale) and compared with the pain experienced immediately prior to infiltration.

The test infiltration of the sympathetic trunk at L2 was considered to be effective when the VAS pain score was decreased by at least 50 %. Surgery was contraindicated in patients with less than 50 % reduction of pain or no improvement.

Surgical treatment

All patients were informed before the operation about the innovative nature of the procedure and the theoretical risks related to even selective sympathectomy, particularly orthostatic hypotension, gastrointestinal disorders, retrograde ejaculation or vaginal dryness. The retroperitoneal laparoscopic procedure was performed bilaterally (right and left) under general anaesthesia. The patient was placed in the lateral supine position with a block under the last ribs in order to widen the space between the last ribs and the iliac crest. A first 10-mm trocar was inserted in the costovertebral angle. The working space behind the kidney was insufflated with gas at a pressure of 12 cm of mercury. Three 5-mm operating trocars were positioned in the iliac fossa, posterior to the iliac crest and at the tip of the 12th rib. After exposure of the surgical field by retracting the kidney superiorly and after identifying the psoas muscle inferiorly, the sympathetic trunk was identified in the angle between the spine and the medial insertions of the psoas muscle (Fig. 3). The dissection was ascended cranially as far as the superior part of the psoas muscle and the inferior insertion of the crus of the diaphragm. The sympathetic trunk was identified between the psoas muscle and the crus of the diaphragm at its passage from the abdomen to the thorax and was dissected over its abdominal course from L1 to L2. During dissection, rami communicantes were identified (Fig. 4) and sectioned with scissors using electrocautery as little as possible, as this section also involved afferent nerve fibres derived from the ventral surface of the intervertebral disc. The main abdominal sympathetic trunk extending from the pelvic floor to the thoracic floor was entirely preserved in every case. At the end of the operation, marker clips were positioned along the sympathetic trunk at the caudal and cranial limits of the section to identify the levels of section of the rami communicantes. A suction drain was left in place for 24 h. Trocars were removed and the same procedure was performed on the opposite side during the same general anaesthesia after

Fig. 3 Section site of rami communicantes by a retroperitoneal laparoscopic approach (Arrows show the site of section of rami communicantes)

Fig. 4 Intraoperative view of rami communicantes dissection with a hook before sectioned with scissors

placing the patient in the contralateral lateral supine position.

Preoperative and postoperative evaluation

All patients were seen in the multidisciplinary pain clinic before deciding to perform the operation and were reviewed 1 month after the operation and then at 3 months, 6 months and annually thereafter. All patients were evaluated by auto-questionnaire. At each follow-up visit, the

mean VAS score over the previous week was recorded and the discomfort and percentage improvement were estimated by the patient. Only four patients were evaluated by quality of life questionnaire (SF-36) and the Dallas pain questionnaire (DPQ) before the operation and then during follow-up.

Results

Perioperative period

The mean total operating time was 172 ± 34 min (range 132–228) with a mean operating time per side of 70 ± 19 min (range 50–112). Blood loss was insignificant (<100 ml) in every case. No intraoperative or early postoperative complications were observed. No patient experienced any immediate postoperative or long-term motor or sensory deficit. The mean length of hospital stay was 4.8 ± 1.3 days (range 3–7).

Long-term adverse effects

After surgery, the first patients described an initial improvement of pain for the first 2–3 weeks, followed by an increase of pain that sometimes became more severe than before surgery requiring higher doses of analgesics. This recrudescence of pain lasted an average of 2–3 months. The subsequent course was favourable with improvement and progressive resolution of pain, initially affecting the thighs and described as contractures or paraesthesia. This pain then descended towards the legs and then the feet before completely resolving.

No patient reported orthostatic hypotension or gastrointestinal disorders such as diarrhoea. No woman complained of long-term vaginal dryness. One man (patient 1) with no sexual activity prior to surgery due to pain regained

sexual activity but with retrograde ejaculation. One man (patient 8) reported retrograde ejaculation in first months but with improvement during follow-up. The two others men (patients 7 and 9) reported no sexual activity either before or after surgery. All patients reported a feeling of plantar dryness following surgery.

Long-term pain evaluation

The mean postoperative follow-up was 29 ± 15 months (range 14–58 months). The preoperative, 3-month and last VAS pain scores are shown in Table 1. At last follow-up, only two patients (22 %) had an improvement of their low back pain with this surgery but with a minimal effect (30 and 50 % reduction of pain). The overall percentage improvement of quality of life estimated by the patient was significant in 33 % of cases (3/9) with an indirect improvement of walking distance.

Table 2 shows the correlation between the percentage improvement of pain estimated by the VAS score, the SF-36 quality of life score and the DPQ score for the four patients evaluated. No correlation was observed between improvement of the VAS score and the course of the SF-36 score. Inversely, deterioration of the DPQ score was observed in patients with no improvement of the VAS score.

The last four patients (patients 6, 7, 8 and 9) had recurrence or persistent of pain and were oriented for a spinal cord stimulation.

Discussion

With a mean follow-up of 29 months, our results concerning section of rami communicantes of the sympathetic trunk in the context of management of low back pain refractory to standard treatments are disappointing.

Table 1 Course of the pain score before and after surgery

	Follow-up (months)	Preoperative VAS score	VAS score at 3 months	VAS score at last visit	Improvement of pain (%)	Improvement estimation of QoL (%)
Patient 1 (RC)	58	8	3	4	50	50
Patient 2 (FL)	14	8	8	8	0	0
Patient 3 (MJN)	41	8	7	8	0	0
Patient 4 (SG)	38	7	5	3	30	25
Patient 5 (OM)	21	8	8	8	0	0
Patient 6 (PG)	20	8	6	8	0	0
Patient 7 (LG)	35	7	4	7	0	30
Patient 8 (MA)	17	7	4	7	0	0
Patient 9 (AB)	15	7	7	7	0	0

VSA Visual Analogue Scale, QoL quality of life

Table 2 Correlation of the percentage change of Visual Analogue Scale (VAS) score, SF-36 score and Dallas Pain Questionnaire (DPQ) score

	Change of pain score (VAS) (%)	Change of SF-36 score (%)	Change of DPQ score (%)	
Patient 3 (MJN)	0	5	Daily activities	+6
			Work/leisure activities	+35
			Anxiety	+35
			Sociability	+20
Patient 4 (SG)	30	10	Daily activities	−18
			Work/leisure activities	−45
			Anxiety	−40
			Sociability	−35
Patient 5 (OM)	0	0	Daily activities	−15
			Work/leisure activities	+15
			Anxiety	+20
			Sociability	+15
Patient 6 (PG)	30	−5	Daily activities	−21
			Work/leisure activities	−5
			Anxiety	−15
			Sociability	−5

Only 2/9 (22 %) patients were improved by this surgery without spinal cord stimulation.

Infiltration and section of the sympathetic tract for the treatment of low back pain is based on anatomical knowledge of the innervation of structures potentially responsible for spinal pain in the context of degenerative disease. Two sites are known to be sources of pain: facet joints with metameric innervation and the intervertebral disc associated with the surrounding ligamentous structures (sympathetic innervation).

Two types of pain are distinguished clinically, but they may co-exist. Acute, sometimes unilateral pain related to facet syndrome is treated by intra-articular and therefore *loco dolenti* infiltration. The metameric somatic innervation of facets has been clearly demonstrated and justifies this treatment [9, 10].

Pain related to disco-ligamentous degeneration is different and the very painful nature of dorsal structures around the intervertebral disc has been demonstrated in man [11]. This pain is multi-metameric, bilateral, and diffuse, and can be accompanied by autonomic signs and is essentially autonomic.

Only the sympathetic component of the autonomic nervous system is known to possess sensory fibres and is therefore able to transmit pain. The anatomy of the sympathetic nervous system is well known [12]: in the case of the spine, it arises in the intervertebral disc and travels in the sinuvertebral nerve described by Luschka and the paravertebral sympathetic trunk, and enters the dorsal roots of spinal nerves via rami communicantes. Somatic and autonomic fibres travel together to the dorsal grey horn and are subject to gate control but transmit the nociceptive

impulse when the stimulus is sufficient. The localization of intervertebral disc pain covers a large region involving all of the lower lumbar regions, and extends well beyond the localized pain of facet syndrome. However, the pain remains the same even when only one disc is involved. As somatic fibres act as a guide for autonomic fibres to reach the spinothalamic tract, the somatic innervation of the lumbar skin must be studied to detect a possible site of preferential convergence of fibres of the two systems.

Lazorthes et al. [13, 14] demonstrated gaps in cutaneous innervation. In the lumbar region, dorsal sensory branches of spinal nerves do not innervate all of the skin. Various anatomical studies have demonstrated a high frequency and marked variation in the number of lumbar sympathetic ganglia (mean 3.9) [15] and a very variable and non-segmental distribution of rami communicantes [15, 16]. The L2 ramus appears to be largely predominant and covers the sensory territory of the underlying sensory nerve roots. The L2 nerve root can therefore be expected to have very abundant rami communicantes which constitute the relay between the two systems, allowing autonomic fibres to transmit pain to consciousness via somatic fibres. Studies that we have conducted on this subject confirm the presence of numerous rami communicantes at L2 [1]. Finally, a concordance is observed between the predominance of a somatic nerve root and the abundant projection of autonomic impulses via the large number of rami communicantes, rungs of the ladder uniting the somatic and autonomic components of the nervous system.

Due to the major role of the sympathetic nervous system in transmission of pain impulses, several studies have tried to demonstrate a reduction of pain following intervention on this

system. Radiofrequency treatment [17, 18] or infiltration [17, 19] of the sympathetic trunk has therefore been performed for the management of complex regional pain syndrome, demonstrating a reduction of baseline pain but with no difference between these two modalities [17]. Continuous infiltrations of the sympathetic trunk for 1–8 days with CT-guided insertion of catheters have also been performed for complex regional pain syndrome and nonspecific neuropathic pain. A marked short-term reduction of pain was obtained in 65 % of cases, but with a lasting result in only 7 % of cases [20]. Phenol neurolysis has been performed in another indication, that of plantar hyperhidrosis. In a study based on 69 patients, this treatment was partially or completely effective in 80 % of cases. However, 89.9 % of patients relapsed after 6–18 months, indicating a transient effect of phenol neurolysis [21]. One of the advantages of these treatments (infiltration or radiofrequency) acting on the sympathetic trunk is that they are minimally invasive. However, the disadvantage is that their effect appears to fade in the long term and sometimes remains incomplete.

Another alternative would be complete section of the sympathetic trunk but with a risk of inducing more severe adverse effects related to complete sympathectomy. Another approach would therefore consist of section of the rami communicantes. This approach has been shown to be effective in the thoracic spine for the treatment of hyperhidrosis with a reduction of adverse effects with the limited procedure, although with a slightly lower success rate [22]. Chen et al. [23] evaluated the role of selective transection of the L2 ramus of the nociceptive pathway in the lumbar intervertebral discs in rats. The results of this study indicated that the L2 ramus communicantes played an important role in the afferent pathway of the lumbar disc.

It therefore appeared logical to use the L2 rami communicantes as the target for management of chronic low back pain [24], as various anatomical studies have demonstrated that these rami predominantly transport nociceptive impulses. Also spinal ganglia can give off branches that travel to caudal or more often cranial somatic roots, which was the basis for initial section of branches of the lumbar tract. Due to the possibility of anastomoses, we decided to perform bilateral infiltration followed by bilateral surgery.

Before starting this surgery, we thought by cutting the pain pathways we could improve pain with lasting results compared to infiltration. In fact, infiltration and section improved the pain during the first week but effects appeared to fade in the long term. And after section only, an increasing pain was observed. The explanation could be an equivalent of “partial” post-sympathectomy neuralgia after the section with renewed intensity of pain, like it was already described [25]. Also, maybe the pain pathway was not exclusively by the sympathetic trunk, even if we think that most information go through this way, but with

transmission to the central nervous system/spinothalamic tract via the dorsal ramus of the spinal root. This reason could explain the failure for some patients.

Furthermore this laparoscopic approach, compared to radiofrequency or phenol neurolysis, allows to be sure that we have an action on all rami communicantes from L1 to L2 because all of them were seen before sectioning with respect of lumbar trunk. One other explanation of this disappointing effect is the fact that pain pathway of lumbar pain, by sympathetic innervation, is a complex collateral network with plasticity. Maybe the stimulation of the sympathetic trunk could be more efficient than section due to this plasticity.

Finally, another important point is the selection of the patients for this surgery. Indeed, all patients in this study had a long history of low back pain with many spine surgeries. In cases of lumbar pain with a stable spine, this surgery could be interesting after a refractory medical pain management and before repeated operations of the spine. The objective of this approach is to treat the pain and not the spine.

Conclusions

The conventional management of low back pain is based on medical and physical therapy. Surgery can be proposed when these measures are no longer sufficient. Surgery is essential in the case of instability, but is more questionable when the spine is stable. The various proposed surgical solutions have not been validated.

Due to failure of these techniques, it seemed logical to consider that chronic refractory low back pain primarily required pain management, while avoiding repeated operations that very often lead to permanent disability. A new approach considering pain as the symptom justifies direct intervention on the pain pathways. This approach opens the way to an original approach to chronic refractory low back pain, as they identify a new therapeutic target: the sympathetic nervous system and more precisely the rami communicantes. This innovative surgery was interesting but our results, even if encouraging, are not sufficient to propose this surgery for everybody. We think that this surgery must be done in some centres for validation with a long follow-up and on a greater number of patients.

Conflict of interest None of the authors has any potential conflict of interest.

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