PERCUTANEOUS RADIOFREQUENCY THERMAL LUMBAR SYMPATHECTOMY AND ITS CLINICAL USE

PERCUTANEOUS RADIOFREQUENCY THERMAL LUMBAR SYMPATHECTOMY AND ITS CLINICAL USE

Thermische lumbale sympathectomie door middel van percutane radiofrequency en zijn klinische toepassing

PROEFSCHRIFT

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CONTENTS

PART TWO : OWN INVESTIGATION AND FINDINGS

ABBREVIATIONS

ADB	Algemene Dagelijkse Behoeften
CT	Computer Tomography
EMG	Electromyography
LDH	Lumbar Disc Herniation
PRTLS	Percurtaneous Radiofrequency Thermal Lumbar Sympathectomy
RSD	Reflex Sympathetic Dystrophy
SLR	Straight Leg Raising Sign
TENS	Transcutaneous Nerve Stimulation or Transcutaneous Electro-stimulation

To Gerard

I INTRODUCTION

Percutaneous radiofrequency thermolesion techniques are commonly used in the treatment of chronic pain in different pain syndromes.

There are many reports describing techniques of percutaneous radiofrequency thermolesion for denervation of central & spinal nerves (Mullan 1963), 1965, 1971; Rosomoff, 1966, Sweet 1974, Uematsu, 1974). Apart from the report by Pernak (1985) no other clinical studies concerning the use of the radiofrequency electrocoagulation technique for denervation of sympathetic nerves have been reported in the literature. For sympathetic denervation, neurolytic agents or surgical sympathectomy are still commonly performed and these techniques may provide prolonged pain relief (Swerdlow, 1978). Poor results occur when technical difficulties result in an incomplete sympathectomy. Neurolytic sympathectomy, using phenol or alcohol, offers the advantage of short hospitalisation and avoids the risk of surgery and need for anesthesia. Nevertheless, following both surgical and chemical sympathectomy the possibility of complications is always present (Swerdlow, 1978; Rutherford, 1977).

Taking this into consideration, we have performed and developed the technique of radiofrequency thermal sympathectomy from 1982 to date. The first presentation of this technique took place at the Ist International Symposium 'The Pain Clinic' (Delft, 1984) and is described in the Proceedings of that symposium (Pernak and v.d. Berg, 1985). Slight modifications to this technique have since been made which will be outlined in this report. Knowledge of the course of the sympathetic innervation provided the idea to perform thermal radiofrequency sympathectomy at the 4th lumbar level only. However, in different pain syndromes radiofrequency sympathectomy can be performed at every level of the spine.

Thermal sympathectomy can be used in those pain syndromes where hyperactivity of the sympathetic nerves is obvious. To date, more than 500 percutaneous radiofrequency thermal sympathectomies have been performed in patients with varying pain syndromes. In this study, 210 patients with different pain syndromes were selected and one criterion for selection was that all patients had obvious sympathetic hyperactivity. Percutaneous radiofrequency thermal lumbar sympathectomy (PRTLS) was performed in all these patients. This technique is described and its clinical use in the combined pain treatment of these patients in the Pain Clinic of the Reinier de Graaf Gasthuis in Delft during the period 1983-1986 is discussed. The results and conclusions are presented.

II AIMS OF STUDY

The aims of the study are:

1. A description of the radiofrequency thermal lumbar sympathectomy and its application in medical practice with special emphasis on its clinical use in patients with sympathetic reflex dystrophy following lumbar disc surgery.

2. A comparison of radiofrequency thermal sympathectomy with surgical and chemical techniques with reference to:

   a. selection of patient (including high-risk patients),
   b. safety,
   c. complications,
   d. ease of use,
   e. costs,
   f. short and long term results.

3. The use of radiofrequency thermal sympathectomy in pain treatment of different pain syndromes in three groups of patients:

   a. a first group of patients with low-back pain and sciatica following lumbar disc surgery,

   b. a second group of patients, also with low-back pain and sciatica following lumbar disc surgery but confined to a wheelchair. In this group the influence on neurological, peripheral (e.g. ulcers) is also discussed,

   c. a third group of patients with a variety of pain syndromes without lumbar spine operation but with sympathetic hyperactivity.

PART ONE :
LITERATURE REVIEW

CHAPTER 1

DIFFERENT THERAPIES IN THE REFLEX SYMPATHETIC DYSTROPHY (RSD)

I INTRODUCTION

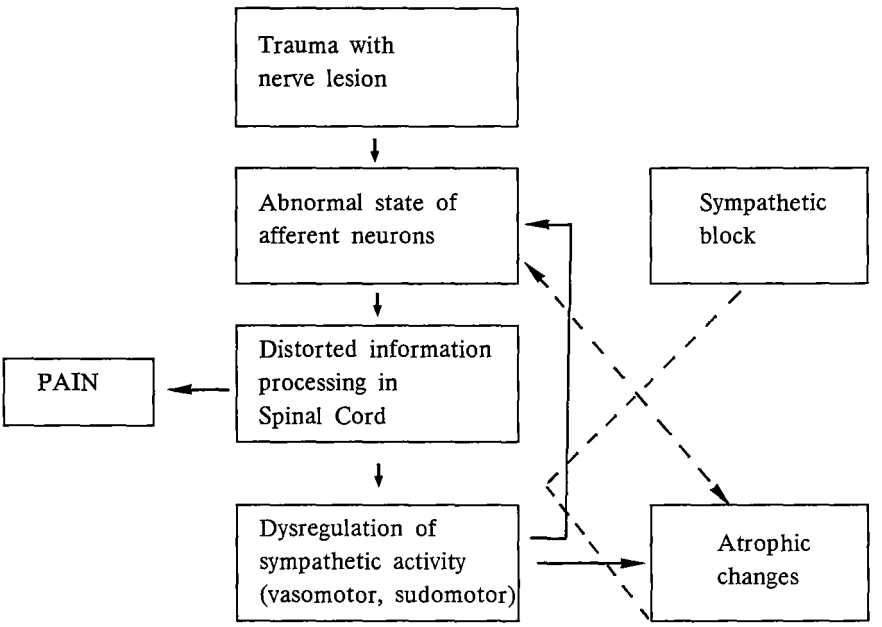
It is well known that the sympathetic innervation represents an important factor in the pathogenesis of many different pain syndromes. In post-traumatic dystrophies, causalgia syndromes, visceral pain and vascular diseases, involvement of the sympathetic nervous system has been shown to be of primary importance (Tamoush, 1981, Nathan, 1983 Wittmoser, 1985, Churcher, 1986). Certain disturbances in the autonomic innervation give rise to these painful conditions, but the pathophysiology of these conditions has not yet been fully clarified.

A hypothesis for the pathophysiology of this clinical syndrome, described by Janig in 1985, consists of four interconnected components:

1. A lesion of peripheral nerves leads to abnormal activity and further changes in other slower ower processes of the primary afferent neurons.
2. Changes in the primary afferent neurons induce alterations in the synaptic processing of information in the spinal cord.
3. The latter process affects the thoracolumbar sympathetic outflow, resulting in a change in the discharge pattern of sympathetic neurons to the lesioned extremity and, consequently, to abnormal regulation of cutaneous blood flow, and sweating.
4. Sympathetic postganglionic activity influences activity in the primary afferent neurons in the lesioned region.

Abnormal afferent activity and an alteration in the processing of the afferent information in the spinal cord elicits pain. The pathological discharge pattern in sympathetic neurons, probably associated with changes in the primary afferent neurons, produce the atrophic changes. These four components may establish a vicious circle of pain that can be therapeutically interrupted by sympathetic blocks or denervation.

Reflex Sympathetic Dystrophy



Schematic and simplified expression of a hypothesis about the neuronal mechanism of a generation of Reflex Sympathetic Dystrophy (Janig, 1985, with permission).

Thus, the sympathetic nervous system is an important factor in the clinical course of various pain syndromes. In the vicious circle of pain the autonomic sympathetic pathways, both efferent and afferent, are involved. This pain can be therapeutically interrupted by blocking of the autonomic system through central or peripheral blocking of the sympathetic pathways.

Certain disturbances in autonomic innervation give rise to painful conditions such as:

1. reflex sympathetic dystrophy (including posttraumatic)
2. causalgia
3. Sudeck's atrophy - posttraumatic painful osteoporosis
4. peripheral vascular diseases
5. visceral pain

Special attention in this study has been given to the posttraumatic reflex sympathetic dystrophy group.

II REFLEX SYMPATHETIC DYSTROPHY (RSD) AND ITS TREATMENT

This group includes a variety of painful disorders applied to conditions which follow less specific trauma, such as infections etc. No direct damage to peripheral nerves is evident and the condition, which generally affects a limb, can arise following minor injury. These minor reflex dystrophies are more frequent than causalgia. Pain in this syndrome is accompanied by coolness, and a slightly cyanotic extremity, sometimes with hyperaesthesia and often with vascular changes, excessive sweating, atrophic changes, muscle oedema and cutaneous dysthesia. If slow spontaneous resolution does not occur the condition progresses to atrophic changes which may lead to contracture and osteoporosis with permanent deformity.

In the posttraumatic dystrophy syndrome (algodystrophy) fine nerve terminals are involved. Causalgia (White and Sweet, 1974), with its typical burning pain following partial nerve injury, is at the opposite end of the same spectrum in which major nerve trunks are involved. There are marked similarities in the clinical condition: such as pain, swelling, hyperpathia, oesteoporosis and atrophic changes. The alerting symptom is pain accompanied by signs of sensory abnormality of the skin. The pain is described as "burning" or "cutting" and sometimes the pain sensations are provoked by normally non-noxious stimuli. Hypersensitivity, vasomotor changes with abnormal regulation of blood flow and sweating can also occur.

In some patients with low-back pain following lumbar disc operation, reflex sympathetic dystrophy (RSD) can develop. Cayla and Rondier (1974) described 23 patients with reflex dystrophy with different pathology of the spinal column, including 3 patients with hernia nuclear pulposi. In 1977, Carlson and coworkers described 2 cases with RSD following lumbar herniotomy and suggested that the surgical intervention caused this condition. Reflex sympathetic dystrophy is characterized by a persistent burning low-back pain with radiation to one, or both, legs and with hyperactivity of the sympathetic system.

Manifestations include:

1. progressive stiffness
2. progressive atrophic changes (see Figure 1 and 2)
3. cutaneous dysthesia
4. decrease in skin temperature
5. excessive sweating
6. muscle cramps
7. vasospasm in the extremities

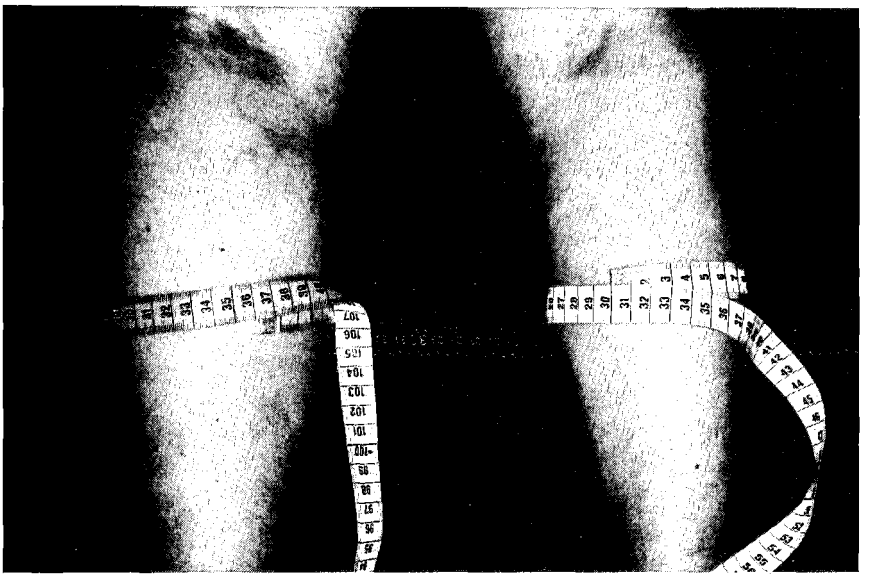


Figure 1 Atrophic changes in the right leg in the patient with RSD.

Figure 2 Skin colour changes in the right leg in the patient with RSD.

Many different therapies (White and Sweet, 1955; Brena, 1980; Lagas, 1985; Moesker, 1985) are applied for treatment of this pain condition, including:

1. physical therapy
2. pharmacological intervention
3. transcutaneous nerve stimulation (TENS)
4. dorsal spinal cord stimulation
5. acupuncture
6. laser
7. cryoanalgesia
8. percutaneous facet joint denervation
9. epidural blocks
10. sympathetic blocks
11. intravenous sympathetic blocks
12. sympathectomy: surgical and chemical

1. PHYSICAL THERAPY

Mobilisation of an individual who has been confined to bed rest due to pain is one of the most important factors in the treatment of all patients with low-back pain. In RSD patients, the use of active exercises plays a major role in the multi-disciplinary approach to pain treatment. Flexion and extension exercises are advantageous (Davies *et al.* 1978), but there has been great controversy concerning the use of manipulation or mobilisation of the spine. The use of mild mobilisation or mild manipulative procedures can help initially to "loosen" the patient. In addition, the judicious use of temperature modalities is extremely important. RSD patients with chronic low-back pain may respond to diathermy, ultrasound or warm showers, but the response is often temporary. Massage and electrical stimulation are also reported to be beneficial. "Back-school" programs, such as reported by Zachrisson (1981), offer education concerning anatomy, causes of pain and details of ergonomic exercises.

2. PHARMACOLOGICAL INTERVENTION

The short-term use of analgesic, anti-inflammatory or muscle relaxing medications can help relieve back or leg pain. Chronic use, even in moderate or therapeutic dosage, exposes the patient to the risk of addiction and to undesirable side effects. The use of narcotics should be avoided in all chronic non-malignant pain.

Aspirin: this effective analgesic, anti-inflammatory drug can induce many side effects, including gastritis and ulcers. In the presence of emotional and social stress associated with the back pain, the anti-coagulant

effect of aspirin can lead to gastrointestinal haemorrhage.

Paracetamol: (Acetaminophen USA) is widely used for a pain treatment mostly as a solo-agent or with combination with codeine or diazepam. Paracetamol has a good an analgesic and an anti-inflamatory effect, however with regular use or by overdose - severe hepatic damage can occur. Skoglund (1987) has shown that paracetamol in dose above 1 g does not increase the analgetic efficacy of the drug.

Brufen: (Ibuprofen USA) it is a one of the several non-steroidal antiflammatory drugs commonly used in a pain treatment. Brufen, the 2-(p-isobutylphenyl) derivate of proprionic acid has an analgesic efficacy more effective than acetaminophen (paracetamol).

Antidepressants are often prescribed for treatment of low-back pain, either because depression is seen as a consequence and aggravating factor in the pain experience, or because pain can be considered as a depressive equivalent. However, Pilowski and coworkers (1982) found that the anti-depressant amitriptylene had no effect on pain, level of depression or social interaction in a sample of patients with, predominantly, back pain.

Muscle relaxants Diazepam was found to be no better than a placebo in one study, but reported to be a successful drug in another study (Hingorani, 1966).

Anti-inflammatory agents, especially steroid injections, are reported to be effective if spinal nerve inflammation is present (Green *et al.* 1980).

In summary, the use of medication cannot be considered a solution in the treatment of chronic low-back pain. Moreover, with the possibility of development of tolerance, danger of addiction and undesirable side effects, the value of medication remains questionable. When necessary, it is often advisable to alternate medication weekly or monthly in order to minimise tolerance yet maintain effectiveness.

3. TRANSCUTANEOUS ELECTROSTIMULATION

Stilz *et al.* (1977) and Richlin *et al.* (1978) have reported effective results in the treatment of RSD using transcutaneous nerve stimulation (TENS) which involves the application of pulsed square wave electrical current through surface electrodes on the skin. The current is generated by a small portable battery-operated apparatus. This technique has been used mainly as a treatment for chronic pain and works through both the "gate control theory" and also via the release of endogenous opiates or endorphins into specific areas of the central nervous system (Long, 1976; Shealey and Maurer 1974; Liebeskind *et al.* 1976). TENS stimulates the large myelinated nerve fibres and also causes an increase in cerebrospinal fluid endorphins (Salar *et al.* 1981). Both these physiological actions decrease perception of pain and provide a firm scientific basis for use of the technique.

Most TENS equipment allow adjustment of frequency and amplitude. In most transcutaneous electrostimulators the frequency varies from 2-200 Hz (Hertz), but the ideal frequency and amplitude parameters have not yet been established. The amplitude is usually adjusted by the patient until a comfortable tingling sensation is felt and the stimulator may be used almost continuously, or intermittently. The degree of analgesia obtained is controlled by the patient and the treatment is almost free from side effects. It must be realised, however, that a significant effect occurs in only 50-60% of patients with chronic pain (Meyer and Fields 1972; Rutkowski *et al.* 1977).

In order to obtain the maximum benefit from this form of therapy it is important to use a variety of frequencies, electrode placement methods and also to change the duration and frequency of treatment. Often, small differences in these parameters will produce large alterations in the clinical effect. No specific contraindications have been found for TENS treatment, but several safety procedures are recommended for use during pregnancy, in patients with a demand cardiac pacemaker and in patients with heart disease. In addition, carotid nerves should not be stimulated in order to avoid autonomic stimulation.

The most common problem confronted is that of skin irritation at the electrode site due to an allergic reaction to the electrodes. In addition, the prolonged use of an electrode at high output intensity may also cause skin irritation, but periodical changing of the electrode position can solve this problem.

Dougherty (1979) described results of TENS treatment in 600 chronic pain patients (including patients with postlumbar laminectomy syndrome) in which 60% of all patients achieved good results. Other authors (Loeser *et al.* 1975; Ray 1975; Eriksson *et al.* 1979) have reported long-term results with low success rates ranging from 12.5 - 60%.

4. DORSAL SPINAL CORD STIMULATION

One of the most useful treatments for post-laminectomy pain seems to be direct stimulation of the spinal cord. This method of pain control was first introduced by Shealy *et al.* (1967) who thought that its mechanism of analgesic action was based on the "gate theory" propounded by Melzak and Wall (1965). Since that time many studies have been performed, aided by advanced knowledge in the field of neurophysiology. Stimulation of the spinal cord appears to be effective through three principal actions:

1. by producing local effects on the spinal "gate" network, where nociceptive signals are blocked.

2. by producing distant effects higher in the central nervous system, primarily the release of endogenous antipain substances and the competitive "jamming" of pain signals.
3. by initiating an ascending-descending anti-pain control loop terminating in the spinal "gate" area.

Spinal cord stimulation can be performed via the percutaneous method or via laminectomy for more permanent implantation. Patient selection is of key importance in the use of this method, which should be considered when the pain problem has proven resistent to other kinds of therapy (Long, 1981). The most effective results with spinal cord stimulation (Ray, 1981) occur in patients with:

1. failed back surgery
2. limb pain due to a neuropathy (diabetes, postischemia, posttraumatic)
3. phantom-limb pain
4. postcordotomy dysthesia
5. pain responding to TENS

In 1981 Winkelmuller reported 89 patients suffering from persistent low-back pain and sciatica following one (or more) multiple lumbar disc procedures. Of these patients, 87% achieved pain relief following spinal cord stimulation. Although the relief was not always sustained, 69% of the patients maintained good results during a follow-up period of 7 years. De la Porte and Siegfried (1983) reported successful treatment in 35 patients (60%) suffering from spinal arachnoiditis by use of spinal cord stimulation.

The implantation procedure is easy and safe, generally performed under local anaesthesia with the use of an x-ray image amplifier. An electrode is implanted to lie just behind the spinal cord, usually just outside the dura mater. The electrode is connected with subcutaneous leads to a radio receiver which is implanted under the skin at a convenient site, usually just under the clavicle or in the side of the abdomen. The patient controls the stimulation by means of a battery-powered radio transmitter. This transmitter is connected by a lead to a small paddle-shaped antenna which is taped to the skin covering the receiver. The implanted portion does not contain a battery, but is passively powered by the radiofrequency energy transmitted through the skin.

Dorsal cord stimulation can be employed for pain in the body or lower extremities. Stimulation must be applied to the spinal cord above the level at which the innervation occurs and the patient's response can be tested without being subjected to an operative procedure. Wire electrodes are available which can be inserted through a needle to lie in the epidural space and extend through the skin to be connected directly to the stimulator for a trial period. If the patient responds well to trial stimulation, the wires are so designed to enable the portion extending through the skin to be cut off and discarded. The radio receiver can then be attached to the portion of the wires that remain implanted, thereby allowing implantation of the

electrodes without the need for surgical laminectomy. If necessary, the percutaneous test leads can be removed and a dorsal column electrode can be surgically implanted via laminectomy and suturing of the electrode to the dura. Gildenberg and De Vaul (1984) have reported the surgical procedure to be more reliable than the percutaneous technique. Surgical implantation should only be performed by neurosurgeons in selected patients who respond positively to the trial stimulation.

5. ACUPUNCTURE

Acupuncture is the application of certain stimuli through the use of stainless steel needles, on or through the skin, at acupuncture points. Acupuncture increases the endorphin level in the body following stimulation (Sjolund *et al.* 1977; Pomeranz and Chiu, 1976) and probably stimulates the autonomic nervous system.

In 1976 Fox and Melzak reported the use of acupuncture in the treatment of low-back pain. They compared this kind of stimulation with TENS and found both these techniques to be equally effective in the relief of chronic low-back pain. The present data suggests that both acupuncture and TENS fall into the category of "hyper-stimulation analgesia" and are simply methods of producing brief, low-intensity pain to relieve chronic, intense pain. Since acupuncture and TENS seem to be equally effective in the relief of low-back pain, the advantages and disadvantages of each technique should be considered when deciding on the choice of treatment. In this respect, TENS seems to be more practical since it can be administered under supervision of paramedical personnel.

6. LASER

In the last few years the use of the laser has gained popularity throughout the world adding new perspectives in medicine, including that of pain treatment.
The word laser means: (Light Amplification by Stimulated Emission of Radiation).

The development of the laser technique dates from the 1960 (Goldman, 1967). A laser is a light, the amplification of the light takes place in the active medium such as: CO_2, Ar^+, He-Ne and others.

According to:

1. the type of the active medium
2. the wave length
3. the heating effect of the laser light

there are different kind of the lasers.

In the practice mostly are used:

1. Power lasers - for surgical use.
2. Medium power lasers (mid-laser).
3. Soft laser.

The two latter types are mostly used in the treatment of acute and chronic pain however there have been recent reports(Shrötner and Ascher, 1986) concerning use of the power laser for the treatment of chronic pain including:

a. phantom and stump pain
b. myelotomy
c. transsphenoidal destruction of the pituary gland

Soft lasers carry out their activity in the upper layers of the derma and is mostly used in esthetic medicine.
Mid-lasers reach a depth of 20 - 30 millimeters and because of this parameter are widely use in the pain treatment.
The basic principle of the soft- and mid-laser is induced emission, a process which is initiated by the radiation field of other energy sources.

Laser penetration can activate and normalise the basic regulatory function of the connective tissue. The intensity of the laser beam is reduced by the tissue, but the mechanism of action is not yet completely understood. The most interesting and puzzling phenomenon seems to be the interaction between the infrared laser beam and pain receptors. The supposed theories of pain relief in mid-laser therapy are:

1. increased vascularity of tissues by vasodilation
2. reduction of oedema ((of inflamation)
3. elevation of the pain threshold
4. acceleration of a.d.p. - a.t.p. transformation
5. alteration of cell membrame permeability to electrolytes
6. modification of immunosuppression/immunostimulation
7. acceleration of cell partition and collogen formation
8. stimulation of the release of various chemical transmitters and endorphines

ad. 1. By *vasodilatation* of the arterioles and capillaries there is an increased vascularity of the treated tissues, which in turn will be partly responsible in increasing the cell metabolism which presumably will tend to if anything help reduce the pain.

ad. 2. By modification of the hydrostatic and intercapillary pressures, there is also a *reduction in oedema* locally i.e. reduction of inflamation i.e. obviously positive towards pain.

ad. 3. There is said also to be an *elevation of the pain threshold*, which has been shown experimentally by double blind trials, (on humans).

ad. 4. Mester (1976) show experimentally that there was a stimulation of the *convertion of A.D.P. - A.T.P.* i.e. again a stimulation of cell metabolism.

ad. 5. There is also said to be an *alteration in the cell membrane permeability* to electrolytes which of course alters the electrical potentials accross the membrane towards normalization of the cell and thus stimulation of cell metabolism, also this mechanism is suggested to have a direct effect on peripheral nociceptive stimulation.

ad. 6. It was by Goldman (1980), that the mid-laser causes a modification of both the immunosuppression/immunostimulation mechanism when he observed amongst other things the circulating immude complexes measured by platetet aggregation after lasing. As we know, there are a group of chronic painfull syndromes which have their pathological basis in this mechanism.

ad. 7. Mester (1976), also showed the acceleration of cell partition and collagen formation experimentally after lasing i.e. stimulation of healing.

ad. 8. It seems also that various chemical transmitters such as acetylcholine are released and also probably endorphines. Fornezza (1986), reported that the urinary secretion of 5-hydroxy-indol acetic acid is increased, which is a serotonin derivative, which we know is associated with some forms of chronic pain.

Concerning clinical results by using laser treatment Meissner *et al.* (1985) reported satisfactory pain relief in 76% of 302 treated patients. Porges *et al.* (1986) reported good results in 50 patients (64%) using the mid-laser. this group included patients with low-back pain following disc surgery but, Bryant and Pernak (1986; 1987) reported good results only in 33% of 15 patients with low-back pain following disc surgery. Memelauer *et al.* (1986) employed soft laser therapy using a 5 mW He-Ne-laser with a defocalised beam. In 74 treated patients the best results were achieved in those patients with arthrogenic and pseudoradicular pain.

7. CRYOANALGESIA

Cryotherapy has been used as a treatment in chronic pain and is clinically applied to relieve pain using a new cryosurgical probe to block peripheral nerve function to achieve analgesia. Cryoanalgesia produces an effective reversible nerve block with an average duration of 11 days, but it is often accompanied by sensory and motor loss.

The nature of the nerve block is reversible, which ensures a return to normal nerve function.

This treatment has an advantage over the use of local anaesthetic solutions which are generally not effective for more than 12 hours. For prolonged analgesia, neurolytic agents (such as alcohol, phenol) can be employed, but in contrast to cryotherapy, phenol and alcohol produce incomplete peripheral nerve destruction and often cause painful neuritis.

The Spembly-Lloyd nerve blocking unit incorporates a cryosurgical system which is coupled to a nerve stimulator for accurate positioning of the probe. An electrical connection is made at the tip of the probe from the nerve stimulator. The probe is connected by flexible tubing to a console which has a gas pressure regulator switch, a nerve stimulator socket and dials for recording gas pressure and probe tip temperature. The refrigerant is nitrous oxide and at an operating pressure of 600 p.s.i. a minimum temperature of -60°C can be rapidly achieved within the iceball generated at the probe tip.

Closed or open application can be performed. In open application the nerve is exposed surgically and the cryoprobe is applied under direct vision. With closed application a "Size" introducer is used to create a track through the tissues, through which the probe is inserted. Using the electrostimulator, maximum response with a minimum current indicates that the tip is lying adjacent to the target tissue. A cryolesion is then produced and confirmed by the temperature. As the iceball cannot be visualised, temperature monitoring is the only check on the probe function. It has been shown that repeated freeze-thaw cycles increase the destructive effect and produce pain relief (Lloyd *et al.* 1976). Generally two freeze-thaw cycles are carried out, each cycle for 2 min after the establishment of a steady low temperature of approximately -60°C. After each freeze, the temperature returns to above O°C before refreezing or withdrawal of the probe. Lloyd *et al.* (1976) reported the use of this technique for treatment of low-back pain. 17 patients with low-back pain, in which sciatic distribution of pain was predominant, were treatedwith a closed application via the sacral hiatus or the relevant sacral foramen. Pain relief was obtained over a period of 10-40 days: 5 patients obtained no pain relief and in 12 patients good pain relief was reported.

The cryoanalgesic technique can be used for facet denervation. Cryofacet denervation is used in patients with low-back pain or in patients with lumbar disc syndrome. Cryoanalgesia is a very acceptable technique and is particularly useful in the treatment of chronic pain of any origin, especially where other methods are contraindicated. There are no absolute contraindications to cryoanalgesia except the patient's own refusal. Repeat treatment may be indicated and there is no evidence of permanent neurological damage resulting from multiple treatment.

8. PERCUTANEOUS FACET JOINTS DENERVATION

The term "Facet Syndrome" was used first by Ghormlev in 1933. Nowadays, the facet syndrome is often defined as a pain syndrome due to facet joint changes, associated with degenerative changes occurring in the facet joints which are secondary to changes in the vertebral disc. Understanding of anatomy is essential in this area. For example low-back pain emanates from a number of sensitive structures in the vertebral column (Bradly 1974) including, the vertebrae, intervertebral disc, posterior facetal joints, intervertebral ligaments and nerves. Apart from the cauda equina and spinal nerve roots it is important to consider the sinu vertebral nerve (Von Luschka) and the posterior primary ramus. The sinuvertebral nerve has connection with a sympathetic branch from the ramus comunicantes. The posterior primary ramus appears to be related to structures in the posterior compartment of the back, which are related to stability of the vertebral column. This branch comes from the spinal nerves lateral to the intervertebral formaen and divides into medial and lateral branches. It is important to note that primary ramus supplies two levels and there is considerable overlap in sensory innervation in this region.

Thus, pain in this region can be caused by a variety of disturbances. If we exclude nerve root compression, then we should consider pain caused by changes in mechanical ligaments and joints of the posterior compartment, posterior to the level of the intertransverse ligamentum.

The facet syndrome can be treated with percutaneous facet joints denervation (posterior rhisotomy) (Shealy, 1974; 1976, Lora and Jong, 1976; Bogduk and Long, 1980; Sluyter, 1981). The procedure is always performed under continuous X-ray control and is only performed after confirmatory stimulation.

A radiofrequency-induced thermal lesion is traditionally performed under x-ray, anterio-posterior and lateral control. The electrodes are inserted near the dorsal-surface of the root of the processus transversus, immediately below the most medial end of its superior edge. After x-ray control the nerve is stimulated. First a sensory stimulation at 50-100 Hz, followed by motoric stimulation at 2-5 Hz. After local anaesthetic infiltration, denervation of the posterior primary ramus of the appropriate nerve is performed by this simple and safe method. Shealy (1975) reported 88% pain relief in patients without previous operations but only 67% relief in patients having undergone laminectomy.

9. EPIDURAL BLOCKS

The role and use of local anaesthetics, with or without steroids, applied to nerve roots in the epidural or sub-arachnoid space is a controversial topic that has been discussed for almost 80 years.

Sicard and Cathelin (1901) used cocaine for lumbago and sciatica treatment, Viener (1925) and Evans (1930) used 20 ml of 1% procaine with 50-100 ml of Ringer's solution in the sacral epidural route for the treatment of sciatica. Many authors have reported the use of corticosteroids for epidural blocks in patients with low-back pain (Kelmann, 1944; Gardner *et al.* 1961; Cho, 1970; Green, 1975; Benzon, 1986). In 1959 Bonica introduced continuous epidural block, providing temporary pain relief, in patients with severe segmental or peripheral nerve pain due to either herniated intervertebral disc, root-sleeve fibrosis or osteo-arthritis.

To date, there have been many reports concerning the use of corticosteroids in the epidural or spinal space, also for conditions other than back pain, Pernak (1985). Corticosteroid treatment by injection into the epidural space is based on its anti-inflammatory effect on the relevant nerve roots. Olsen (1941) found that the size of the disc prolapse and the amount of compression were less important than the accompanying inflammation and symptomatology. He suggested that inflammatory changes are dynamic factors and that treatment of these factors could be more successful than surgical removal of the protrusion. Lindahl and Rexed (1951) biopsied and examined posterior nerve roots during laminectomy. They observed that the affected nerve roots were inflamed, oedematous and showed proliferation response. They postulated that the loss of negative pressure in the epidural space was a symptom of an exudative inflammatory process and a cause of pain. Acknowledging this theory, injection of corticosteroids into the epidural and spinal space began in France and this form of treatment quickly spread to other countries.

Greenwood *et al.* (19) found that in 30% of the patients following failed disc operations, extradural adhesions occurred which produced neural entrapment and fixation of the dural sleeve of the spinal nerve. The nerve can no longer move freely in the intervertebral foramen. Inflammation also increases capillary permeability. Corticosteroids influence circulatory dynamics around the affected nerve roots and can reduce nerve root swelling. Green *et al.* (1980) reported decreased nerve root swelling, with no change in size of the herniated disc, after the use of dexamethasone observed on myelograms before, and 6 days after, treatment.

Another theory to explain pain following lumbar disc herniation is that of muscle spasm. Compression of nerve roots may cause spasm of the innervated adjacent interdigitating erector spinal muscles. Lipton (1979) recommended epidural injections of local anaesthetics and steroids in cases of pain following a prolapsed disc. The injection can lead to complete pain relief by breaking the vicious circle of pain and muscle spasm.

The most commonly used corticosteroids for epidural or spinal injection are long-acting corticosteroids such as methylprednisolone acetate (Depomedrol) or triamcinolone diacetate (Aristocort). These corticosteroids are used with a mixture of

0.5%, 1% or 2% of lidocaine. Beneficial results have been reported which range from 20%-98%, decreasing with longer-term follow up (Warr *et al.* 1972; Winnie and Ramamurthy, 1976; Pawl *et al.* 1985; Cohn *et al.* 1985). The volume injected and methods used vary between individual physicians and no standard has been established. More effective results have been reported with the epidural route, in preference to the spinal or intramuscular route. In many patients, a single epidural block gives excellent pain relief, in others repeated injections are necessary. Patients not responding to the first injection rarely improve with repeated injections. Those patients who receive no benefit from epidural steroids may respond to sub-arachnoid injections.

10. SYMPATHETIC BLOCKS

Sympathetic blocks can be used as both a diagnostic and therapeutic tool. In patients with low-back pain following lumbar surgery with clinical hyperactivity of the sympathetic nerve, a lumbar sympathetic block should be performed.

Brena *et al.* (1980) used lumbar sympathetic blocks with morcaine and saline for the treatment of chronic low-back pain in 20 patients, including 10 patients with pain following one (or more) surgical procedures for disc diseases. He reported significant reduction in subjective pain intensity, up to one month following treatment, the results of which were not significantly different from that achieved with bupivacaine and saline injections.

Bernini and Simeone (1981) reported that sympathetic reflex dystrophy associated with low lumbar disc herniation can be treated by herniotomy combined with therapeutic sympathetic blocks. The most commonly used technique for lumbar sympathetic block is that described by Moore (1978). In this paravertebral method a single needle is used at the second lumbar level. 10-20 ml of 0.25% bupivacaine, or an equivalent concentration of another local anaesthetic, is injected. The spread of the local anaesthetic within the psoas muscle sheath can lead to involvement of neighbouring somatic nerves causing temporary paresis and analgesia in the lower limbs. In addition, temperature in the lower limbs may increase.

The efficacy of a local anaesthetic agent should always be determined before performing paravertebral sympathetic block with a neurolytic agent. A neurolytic block is usually performed with 2-4 ml of 7% aqueous phenol, or 2-5 ml of absolute alcohol. A complication often observed is that of neuritis of the somatic nerves, especially those of the genitofemoral and ilio-inguinal nerves. It is important to note that lumbar sympathetic blocks should be performed with special care in patients using anti-coagulants in order to avoid the risk of a large haematoma forming.

11. INTRAVENOUS SYMPATHETIC BLOCKS

A sympathetic block can be performed by intravenous infusion of a sympatholytic drug into an extremity, isolated from the general circulation by a tourniquet. This enables the agent to be fixed in the tissues before being spread throughout the body. Hannington-Kiff (1974) reported dramatic pain relief and increase in skin temperature in several patients, after use of guanethidine in a wide variety of concentrations, and also mixed with other drugs. The intravenous regional sympathetic block technique appears to be useful in patients who show signs of return of sympathetic tone. This procedure is also useful for patients using anti-coagulants, as it provides an effective alternative to neurolytic or surgical sympathectomy.

As already mentioned, one of the first drugs used in pain treatment is guanethidine, which acts on the sympathetic synapse. Guanethidine is fixed at a cellular level, 90% within 3-4 minutes. The effect of this regional intravenous sympathetic block lasts for 4 days, and the blocks can be repeated. Side effects such as allergic reactions and hypotension can occur.

Moesker *et al.* (1985) reported on 16 patients with post-traumatic sympathetic dystrophy (Sudeck's type) and their treatment with intravenous ketanserin. Ketanserin is a new specific 5-HT_2 receptor blocking agent. 10 mg ketanserin has been injected intravenously under blood pressure, heart rate and skin temperature control. Treatment can be sustained orally with ketanserin, 60-80 mg per day, in three divided doses. In a group of 10 patients, all reported significant pain relief in the first 6 weeks, and 7 of the patients reported total pain relief during the trial.

12. SYMPATHECTOMY

In patients not achieving prolonged pain relief with local anaesthetic sympathetic blocks, surgical or neurolytic sympathectomy usually provides prolonged pain relief. Poor results can occur when technical difficulties result in an incomplete sympathectomy. If permanent sympathectomy is necessary, a diagnostic local sympathetic block has to be performed.

CHAPTER 2

SYMPATHECTOMY

I HISTORICAL REVIEW

The brilliant work of Claude Bernard on the peripheral autonomic sympathetic nervous system, including its anatomy and physiology, provided a sound historical background for the beginning of surgical intervention. The first neurosurgical sympathectomy was performed at the cervical level in the management of epilepsy by Alexander in 1889. In the following years, many other surgeons used this technique for varying diseases including epilepsy, exopthalmic goiter and angina pectoris (Jonnesco, 1923). Rene Leriche in his monograph "La Chirurgie de la Douleur" (1927) described and summarised the efficacy of sympathectomy in the relief of varying visceral and vascular pain syndromes. Leriche described periarterial sympathectomy and its effect of increasing blood flow to the extremities.

In 1924 both Hunter and Royle developed and reported on the technique of lumbar ganglionectomy for reduction of excessive muscle tone in paralysis, especially in spastic hemiplegia. In vascular diseases, sympathetic denervation has been used initially for vasospastic disorders of the upper extremities. In the 1940's lumbar sympathectomy became the preferred form of management in the treatment of arteriosclerotic occlusive disease of the lower extremities. With the development of the arterial reconstructive techniques, lumbar sympathectomy is now performed only in very selective circumstances in the field of vascular diseases. Sympathectomy increases total resting blood flow in a normal extremity. In the peripheral arterial occlusivediseases, duration of response to sympathectomy can vary widely. It has been established that in the upper extremities the duration of effect is much shorter than in lower extremities. Sympathectomy does not significantly increase the blood flow in exercising muscle, distal to arterial obstruction.

II LUMBAR SYMPATHECTOMY

a. Surgical sympathectomy - technique

Surgical lumbar sympathectomy can be performed under spinal, epidural or general anaesthesia. The positioning of the patient is very important and the anterolateral surface of the lumbar spine must be exposed. In the paravertebral approach the most effective approach is with the patient in the lateral oblique position.

The table must also be broken in the lumbar region to widen the distance between the iliac crest and the lowest rib. The incision is made over the line of attachment of the abdominal muscles to the longitudinal sacrospinalis muscle group. First it is necessary to divide the fibres of the latissimus dorsi and open the lumbar fascia. The lumbar fascia unites three abdominal muscles to the quadratus lumborum and sacrospinalis. The retroperitoneal compartment is entered and the anterolateral surface of the bodies of the lumbar vertebrae is exposed.

The lumbar chain lies anterolaterally to the bodies of the lumbar vertebrae and can be easily identified by palpation. It is important not to mistake the genitofemoral nerve for the chain - this nerve runs more laterally to the chain (1-2 cm). White's (1955) advice concerning the painful conditions associated with vasospasm is to resect the chain at a point not higher than its second ganglion. In cases of causalgia due to injury of the sciatic nerve it is also important to perform ganglionectomy at a higher level. After ganglionectomy has been performed, the table should be straightened and flattened to permit an easy approximation of the muscle, fascia and skin.

An alternative method is the anterior-muscle-splitting incision. This technique was devised by Pearl (1937) and described and modified by Shumacker (1947). An oblique incision is made from the tip of the 11th rib to the lateral edge of the rectus and the three lateral abdominal muscles divided in the plane of their fibres and retracted. The peritoneum is peeled laterally from the inner surface of the quadratus lumborum, the transversolis and psoas muscles, retracting the peritoneum with its contents towards the midline to expose the paravertebral gutter and the lumbar chain. This method is well adapted for exposure and resection of the lower lumbar chain.

Complications can include:

- retroperitoneal bleeding, generally from a punctured vena cava (right side) with paralytic ileus as an ensuing complication (Verschuyl, 1986; Rutherford, 1977).

Other common complications are:

- postsympathectomy neuralgia, which can occur in up to 50% of the patients following surgical lumbar sympathectomy. This condition develops between the fifth and twentieth days following the procedure, but the pain usually recedes spontaneously after a few weeks. Analgesic therapy can be useful (Rutherford, 1977).
- disturbances in sexual function in the male.

  Sympathectomy at the L_1 level is a "forbidden zone". Following bilateral removal of the first lumbar ganglia, inability to ejaculate occurs in 50% of patients (Rutherford, 1977).

- paradoxic gangrene. A 4% incidence of paradoxic gangrene following lumbar sympathectomy has been reported (Atlas, 1942).

- genitofemoral neuralgia can occur as this nerve lies close to the sympathetic chain (this complication occurs more frequently with chemical sympathectomy.
- aortoiliac "steal" effect. First suggested by Kountz (1966) as the cause of intestinal necrosis following lumbar sympathectomy and iliofemoral bypass operations.
- ureteral injuries. Because of its close proximity, the ureter can be injured. Vesicle ureteral reflex may also follow lumbar sympathectomy. In experimental animals this has been observed 3 weeks after sympathectomy.
- sciatic pain (Rose, 1978).

b. Chemical sympathectomy - technique

The technique of chemical lumbar sympathectomy has been described by Reid *et al.* (1970). Performing a chemical lumbar sympathectomy with phenol, it was observed that a sympathetic neurolytic block improved blood flow and temperature in the superficial tissues, but had no beneficial effect on intermittent claudication. Reid described more than 5000 chemical sympathectomies with minimal complications. Hugh-Davies and Rechman (1976) performed chemical lumbar sympathectomies in 124 patients, including 97 patients with distal ischaemia due to arteriosclerosis. All patients complained of rest pain associated with foot ischaemia or incipient gangrene. From the 124 patients, 85 had a good response following sympathectomy, including relief from rest pain, feeling of warmth and reversal of pregangrenous skin changes. Unsatisfactory results were reported in 39 patients.

The lumbar sympathetic chain runs along the anterolateral aspect of the lumbar vertebrae, lying in the groove between the vertebral bodies and the psoas major. The right sympathetic chain is overlapped by the vena cava and the left chain by the aorta.

Many different techniques for lumbar sympathetic block (so-called chemical sympathectomy) have been described. The most preferred techniques are those described by Swerdlow (1978) and by Lofstrom (1979). The patient is placed in the lateral position with the waist supported by a pillow or breaking table. The vertebral column is curved in a lateral plane and the spaces between the transverse processes are widened out on the upper side.

The skin of the lumbar region is prepared and towelled. The spines of the 1st - 4th vertebrae are identified (the iliac crest marks the level of the space between L_4 - L_5 spines). Wheals are raised opposite the processus spinosus of the third lumbar spine, approximately 7 - 10 cm lateral from the midline. Through this wheal a 19 S.W.G. needle 14 - 20 cm long is introduced and advanced forward and medially, aiming at the vertebral body. At this distance from the midline, the transverse process will be

circumvented and the first solid tissue reached will be the body of the vertebra. When correctly placed, the tip of the needle will have advanced about 1 cm from the point of the first contact with the vertebral body, a slight forward and backward movement of the needle will elicit a characteristic feeling as it rubs against the surface of the vertebra and there will be no sense of resistance if air or fluid is injected. The position of the needle may be checked by x-ray in the anteroposterior and transverse views.

After aspiration to ensure that the tip of the needle is not in a blood vessel, 2-4 ml of 10% phenol (Swerdlow, 1978) or 3 ml of 6.5-7% phenol (Lofstrom, 1979) dissolved in water, or glycerine-water, is injected. Lofstrom has also used 3 ml of absolute alcohol instead of phenol. Sympathetic block with phenol gives good results for up to 6 months, after which the effect usually diminishes.

Complications of chemical sympathectomy include:

- a decrease in blood pressure, frequently in elderly patients with severe vascular diseases. An intravenous infusion must be available for use.
- a haemorrhage in the psoas sheath, especially in the case of heparinated patients.
- paraesthesia. The easiest way to avoid this complication is to insert the needle at a reasonable distance from the midline.
- a neuritis of the genitofemoral nerve which runs in the psoas sheath, especially when using absolute alcohol as a neurolytic agent. This discomfort may last 2-5 weeks.
- paraplegia, if the needle is directed too far medially and passes into the intervertebral foramen. This can be recognised by the flow of cerebrospinal fluid.

Other complications can include:

puncture of the renal pelvis; subarachnoid injection; somatic nerve damage; perforation of disc; stricture of the ureter following phenol or alcohol injection; back pain (Rose and Swerdlow, 1980).

Indications for chemical lumbar sympathectomy include those patients with arterial disease in whom diagnostic sympathetic blocks improve skin blood flow. Lumbar sympathetic blocks may benefit patients with the following conditions: circulatory insufficiency in the leg; arteriosclerotic disease with severe rest pain; intermittent claudication (selected cases); gangrene; diabetic gangrene; arterial embolus; and those patients with pain resulting from: a post-traumatic syndrome; causalgia; phantom limb; stump pain; intractable urogenital pain (selected cases).

III COMPARISON BETWEEN SURGICAL AND CHEMICAL SYMPATHECTOMY

Surgical lumbar sympathectomy has become one of the most widely used forms of treatment in many pain syndromes, especially in the case of vascular diseases. Unfortunately a high incidence of postoperative retroperitoneal bleeding, postsympathectomy neuralgia (50% incidence), sexual disturbance, genitofemoral neuralgia and uretal injuries have been reported (Rutherford, 1977). Together with the necessary hospitalisation (6 - 10 days) and the risk of complication during anesthesia in elderly patients, preference has developed to perform chemical sympathectomy using neurolytic agents such as phenol or alcohol. But even this popular technique incurs risks and serious complications including:

- genitofemoral neuralgia (50% incidence)
- ilio-inguinal neuralgia (somatic nerve) (Swerdlow, 1977)
- decrease in blood pressure (frequently in elderly patients with severe vascular disease)
- intravascular injection
- bleeding in the psoas sheath (by heparinised patients)
- ureteral injuries (stricture of the urethra)

After both surgical and chemical sympathectomy, pain or discomfort in the groin is often experienced. Neurolytic sympathectomy using phenol or alcohol offers the advantage of short hospitalisation and avoids the risk of surgery. Surgical sympathectomy should be used as a last resort when other forms of therapy have failed, but often such a prolonged approach is not possible.

IV SUMMARY AND CONCLUSIONS

There is a great variety of possibilities and reports concerning treatment of painful conditions involving sympathetic hyperactivity, but there is insufficient datafrom controlled studies concerning treatment of low-back pain in patients with sympathetic reflex dystrophy following lumbar disc surgery. The most commonly usec treatments have already been documented. Satisfactory pain relief ranging from 50% - 70% has been described in many reports, but statistics vary widely between different studies. Taking into consideration that low-back pain in reflex sympathetic dystrophy following lumbar disc surgery manifests with obvious clinical sympathetic hyperactivity, and taking into account the disadvantages and complications involved in both surgical and chemical sympathectomy, the use of percutaneous radiofrequency thermal sympathectomy has been stimulated.

PART TWO :
OWN INVESTIGATIONS AND FINDINGS

CHAPTER 3

PERCUTANEOUS RADIOFREQUENCY THERMAL LUMBAR SYMPATHECTOMY (PRTLS)

I INTRODUCTION

A percutaneous radiofrequency thermolesion in the central or peripheral nerves is widely used in the treatment of pain. This technique demands sophisticated equipment due to the need to produce accurate and controlled lesions.

A thermal lesion is created by applying a radiofrequency current to the electrode and from the tip of the electrode in all directions of the surrounding area. Pioneer work on the use of electrocautery in pain treatment was performed by Kirschner (1931) for the trigeminal nerve, and later by Mullan (1965) for the treatment of cancer pain with percutanous cordotomy in the cervical cord. With these early techniques, complications and severe side effects were reported, probably due to the unsophisticated electrical apparatus and inability to control the thermal lesion. Currently, due to the development of advanced medical facilities and lesion-making equipment, direct monitoring by accurate recording of temperature is possible. Brodkey *et al.* (1964) have described thermal lesions of the nervous tissue. A permanent lesion with a temperature above 44°C caused irreversible denervation of the tissue, whereas below 44°C the damage is reversible.

In 1968 Letcher and Goldring presented a study concerning thermal destruction with a temperature above 45°C, particularly affecting the smaller A delta and C fibres (unmyelinated fibres). In the brain the purpose is to destroy all tissue around the electrode tip which justifies the use of maximal temperatures of 75-80°C. In the spinal cord the electrodes are placed in the spinothalamic lateral tract which conducts C and A delta fibres. In the peripheral nerves and nerve roots the purpose is to maintain mechanical continuity in the nerve with intact large afferents and destroyed A delta and C fibres. Temperature control is necessary because 65°C is the limit for damage of the large afferents. Accurate temperature is also essential and can be achieved by incorporating a thermistor in the tip of the electrode or by using a thermocouple. Before radiofrequency thermolesion is performed, neuroelectrostimulation through sensory stimulation at 50-100 Hz, is applied to increase efficacy in selecting the desired target. Motoric stimulation at 2-5 Hz is applied to ensure a proper distance from the motoric part of the nerve surrounding the target. The lesion is created by passing the output of the lesion generator.

As already mentioned, it is crucial to precisely control the volume of the lesion (Augustinsson, 1986). The size of the lesion is dependent on temperature, time, configuration of the tip electrodes, and on electrical parameters. It is also essential to take into account the type of nervous tissue. Sluyter (1981), however, has described the possibility of using percutaneous radiofrequency thermolesion for percutaneous facet denervation with uncontrolled temperature but with monitoring of the voltage and time of lesion. A percutaneous radiofrequency thermolesion is widely used for the treatment of many different pain syndromes, including: trigeminal neuralgia (Sweet and Wespic, 1974; Siegfried, 1977); percutaneous myelotomy (Gildenberg, 1985); percutaenous radiofrequency rhisotomy (Loeser, 1972; Uematsu *et al.*, 1974); percutaenous cordotomy (Mullan *et al.* 1965; Rosomoff *et al.* 1965; Mullan and Hosobuchi, 1965; Lin *et al.* 1966); percutaneous facet denervation (Mehta and Sluyter, 1979; Bogduk, 1980) and stereotactic intracranial operations (White, 1969). Apart from the report by Pernak and van de Berg (1985) no other clinical studies concerning the use of radiofrequency thermolesion technique for denervation of sympathetic nerves have been reported in the literature. Taking into consideration that denervation of sympathetic nerves has to be total, application of uncontrolled temperature is the technique of choice.

II DESCRIPTION OF OWN TECHNIQUE

This has been described elsewhere (Pernak and van de Berg, 1985) but minor modifications to this technique have been made over the last few years. No medication is given. The patient is placed in the prone position. The skin temperature of the affected foot is checked by an independent observer using thermographic plates indicating colour changes, and an electronic thermometer. The landmarks include, the midline and the transverse line at the L_4 level (Fig. 3). In the aseptic area a disposable sterile Top-Pole needle (23 gauge, 200 mm long) (Fig. 4) is inserted at the point of intersection of a line drawn 10 cm parallel to the midline and a traverse line at the middle of the body of L_4 vertebra (Fig. 3).

The needle is inserted through the wheal using a C-arm with image intensifier. The needle is directed at an angle of 45° cranially or caudally so that it strikes the transverse process of the vertebra lying above or below, the needle tip is then quickly placed anterolaterally on the vertebra in close proximity to the lumbar sympathetic chain. The position of the needletip is checked by x-ray in the anteroposterior (AP) and lateral views (Figs. 5 and 6).

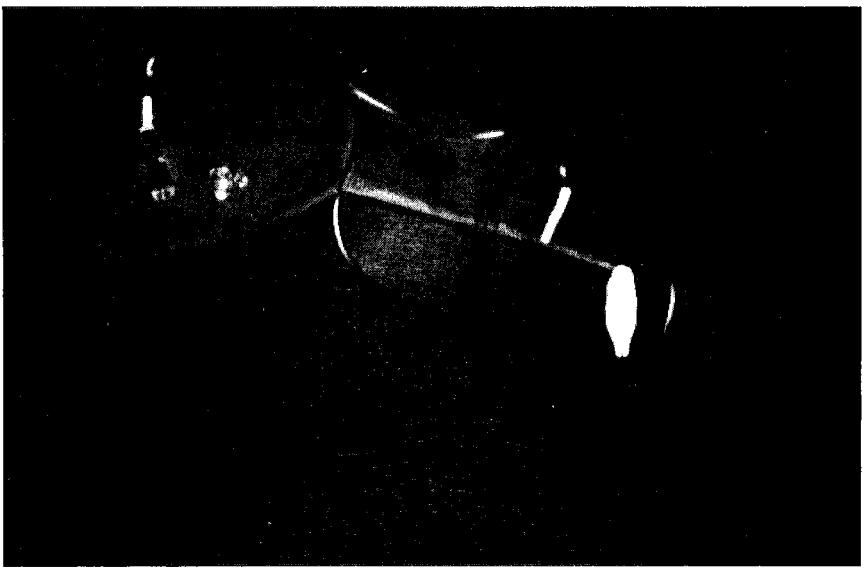


Figure 3 Landmarks

Figure 4 Photograph of needle

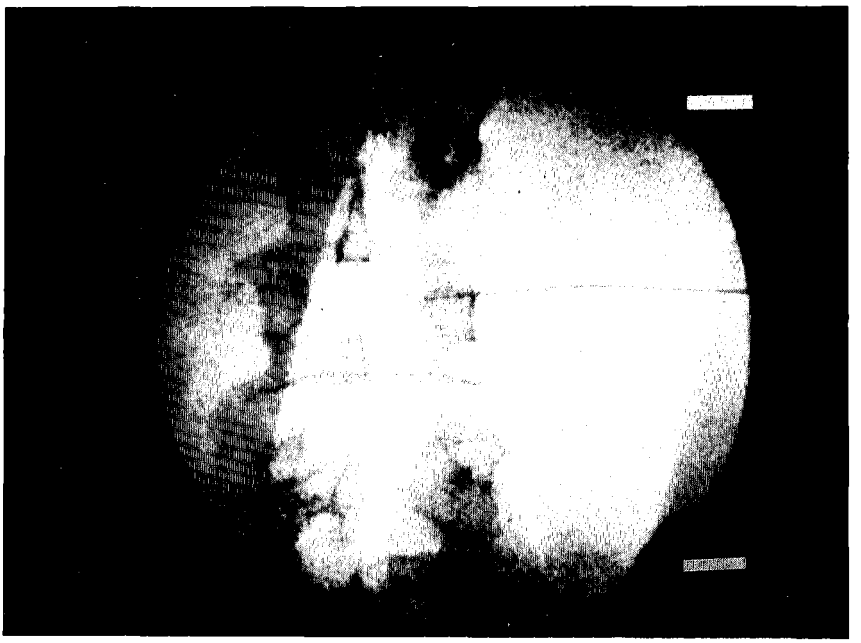


Figure 5 X-ray; AP view

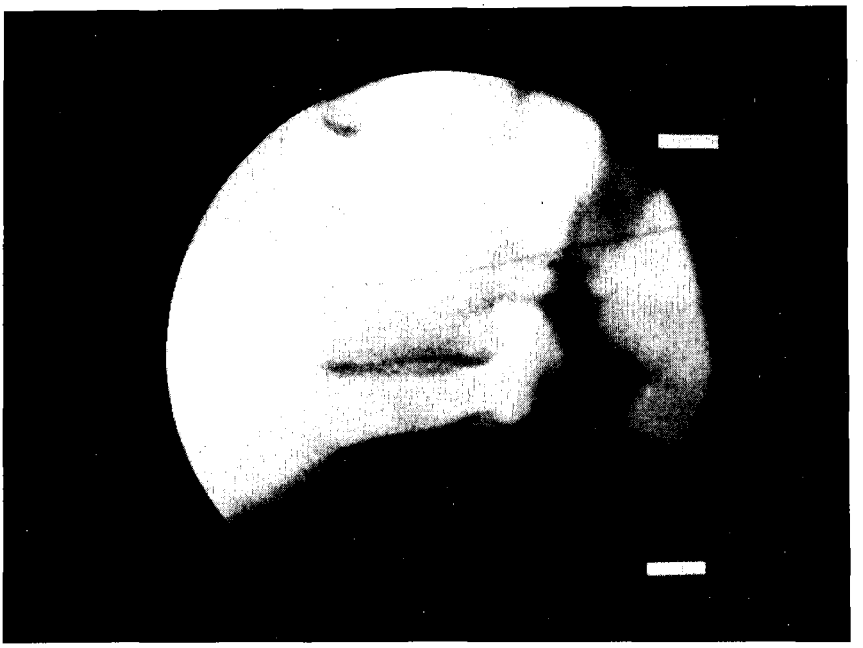


Figure 6 X-ray; lateral view

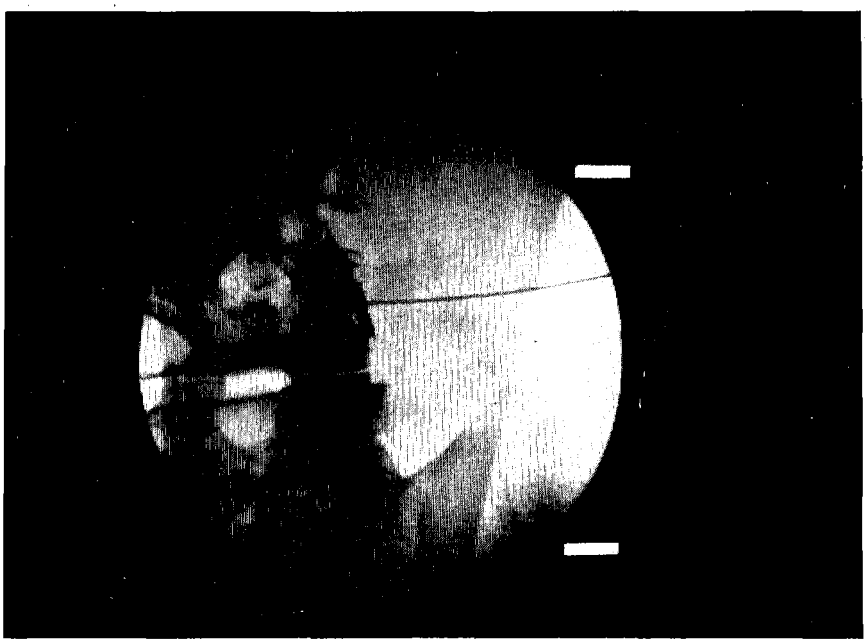


Figure 7 X-ray; AP view + contrast

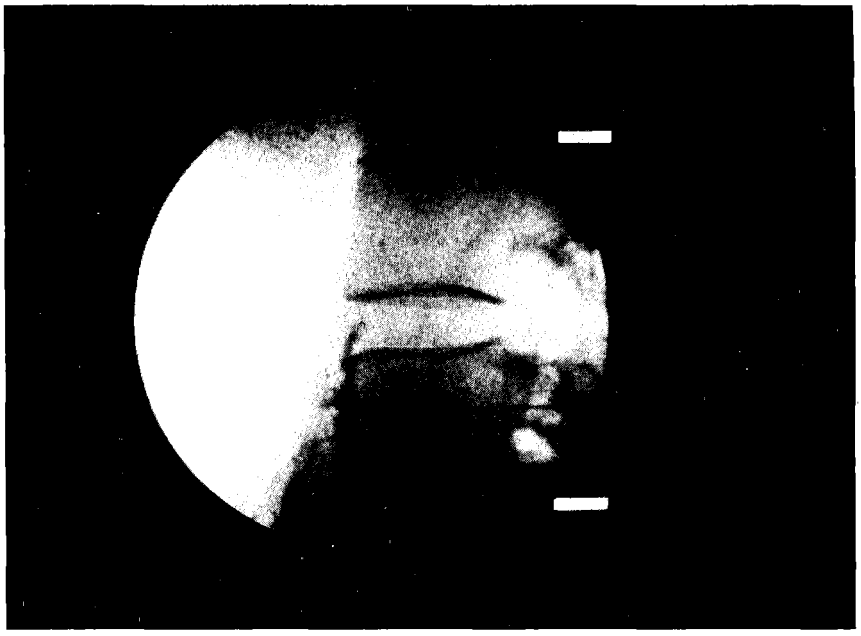


Figure 8 X-ray; lateral view + contrast

In the lateral view (Fig. 6) the needle tip should barely reach the anterior border of the vertebral body. The position of the sympathetic chain is then identified by injection of 0.5-1 ml of radiological contrast (Conroy 60) which is checked in the lateral and AP views (Figs. 7 and 8). When the needle is in the correct position and following aspiration, 2-5 ml of 2% lidocaine is injected through the needle. Two minutes later the skin temperature in the heel and foot is checked. If a clear colour change of at least 1°C is obtained, confirming a positive sympathetic block, then the Radionic Lesion Generator (Type RFG-3B) is employed and maintained for a total of 360 seconds (20-22 volts). After every lesion of 60 seconds the skin temperature of the foot is checked by use of the thermographic plate and electronic thermometer (Figs. 9 and 10).

When a satisfactory effect has been achieved, the pole-needle is removed. The patient is returned to the recovery room for one hour's intensive observation before being returned to the ward for 24 hours. If the achieved temperature increase remains for 24 hours following the procedure and no complications are observed, the patient is discharged.

This procedure is considered to be technically successful if the patient reports a warm feeling in the affected lower limb, and objective observations of:

1. colour changes in the skin
2. significant increase in skin temperature of 2.5-5°C immediately following the procedure and lasting 24 hours after

The treatment is considered successful if:

1. the warm feeling in the affected limb lasts longer than 6 months
2. the skin temperature in the affected limb increases by more than 2.5-5°C for longer than 6 months

Another positive indication is a significant diminishing of the atrophic changes in the affected limb.

Complications can include:

1. a genitofemoral neuralgia
2. a ilio - inguinal neuralgia
3. a neuritis of spinal nerves
4. a puncture of aorta or vena cava
5. a bleeding in the psoas sheath

Other less common complications can include: intravasal injection (aorta or vena cava); puncture of renal pelvis or ureter; and perforation of disc.

Figure 9 The skin temperature changes in the treated and in the untreated feet.

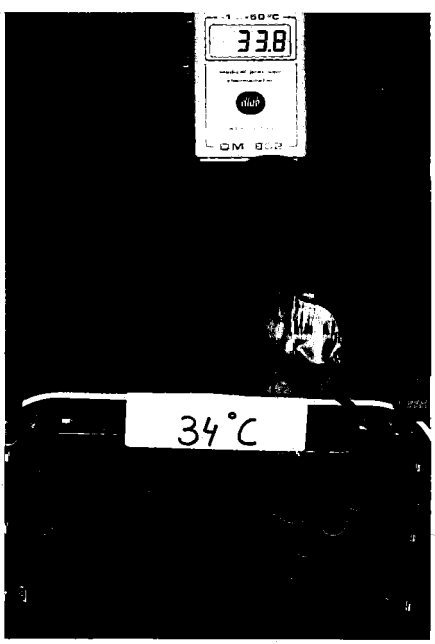


Figure 10 The skin temperature of the treated foot is measured with aid of the thermographic plate and electronic thermometer.

Figure 11 Ulcer before sympathectomy.

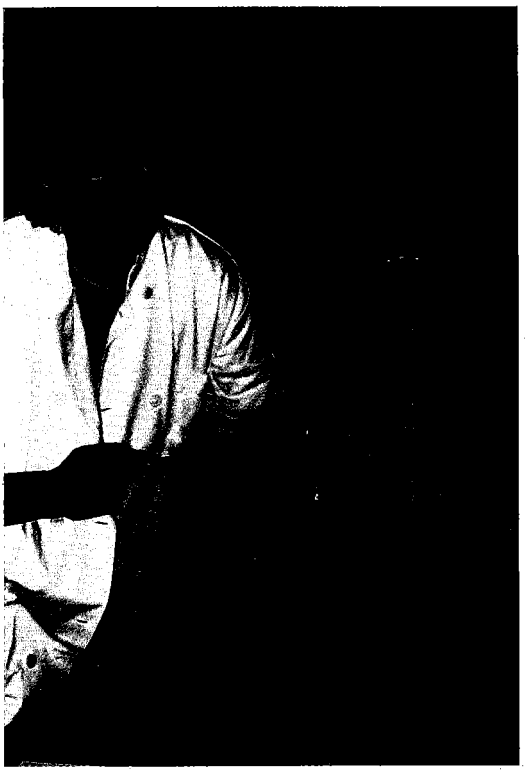


Figure 12 Ulcer 6 months after treatment.

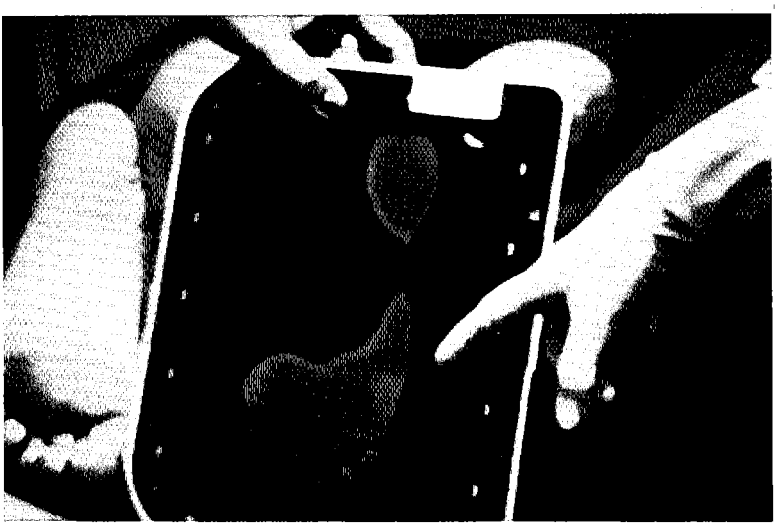


Figure 13 Ulcer during procedure, directly after sympathectomy the thermographic plate-control.

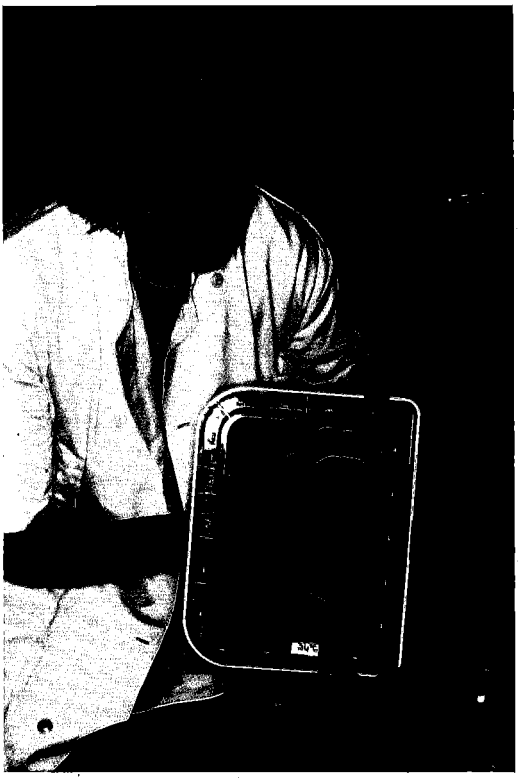


Figure 14 Ulcer 6 month after procedure the thermographic plate-control.

Figure 15 The patient from group 2 before treatment.

Figure 16 The patient during neurologic examination performed by dr. H. Pabst neurologist, 6 months after treatment.

Fig 17 Ulcer before sympathectomy

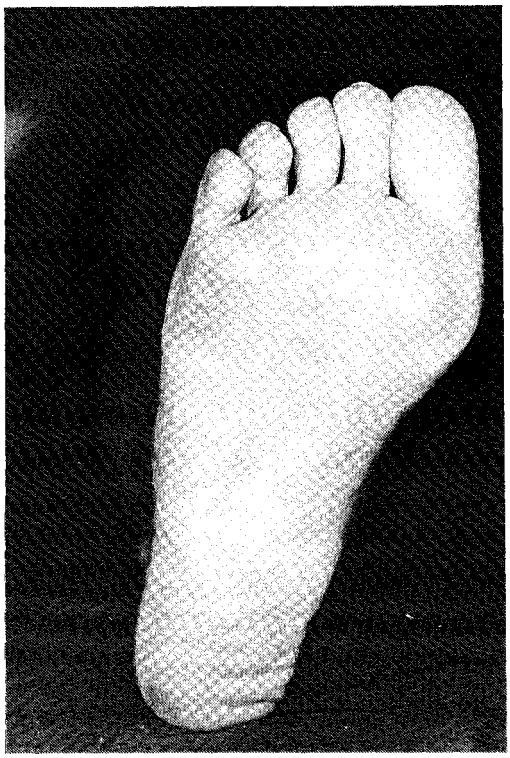


Fig 18 Ulcer 6 months after sympathectomy

III SUMMARY AND CONCLUSIONS. OWN TECHNIQUE COMPARED TO SURGICAL/CHEMICAL SYMPATHECTOMY

Disadvantages and complications arising from surgical and chemical sympathectomy are described in the Summary and Conclusions of Chapter 2. It is important to remember that for sympathetic denervation, neurolytic agents such as phenol or alcohol are still commonly used. Neurolytic agents can provide a considerable degree of pain relief when properly employed, but the possibility of complications is always present. All neurolytic agents can cause chemical neuritis of varying intensity and one report mentions an incidence of 2-10% of all administrations (Swerdlow, 1978). One must bear in mind that the most commonly used surgical and chemical techniques are performed, at the same time, at three lumbar levels (L_2 - L_3 - L_4) where the possibility of complications, such as chemical neuritis, is much higher.

Taking into consideration the character of low-back pain, its radiation to the leg, the typical sympathetic changes in the lower leg and foot, together with knowledge concerning sympathetic innervation from an anatomical point of view, the idea to perform radiofrequency thermal sympathectomy at the fourth (4th) lumbar level only was developed. However, in different pain syndromes, radiofrequency sympathectomy can be performed at every level of the spine.

In comparison to the disadvantages described with the surgical and chemical technique, such as long hospitalisation (average 7 days) and the use of anesthesia, our technique significantly minimises these complications. With sophisticated technical equipment our procedure can be completed in 10-20 minutes. The results can be directly and easily measured either subjectively (i.e. warm feeling in the affected, treated limb) or objectively (i.e. thermographic plate, electronic thermometer, colour changes of skin). If the achieved increase in skin temperature is not maintained, the procedure can easily be repeated. No contraindications to this procedure have been reported. Extra care and control may be needed with heparinated patients. The use of a 23 gauge needle, however, diminishes the risk of haemorrhage.

The procedure has to be performed in an operating theatre employing anesthetic equipment, a C-arm with image intensifier, x-ray apparatus, thermographic plates or with electronic thermometer and, of course, a lesion generator.

Percutaneous radiofrequency thermal sympathectomy can be used in many pain syndromes where there is obvious hyperactivity of the sympathetic nerves.

CHAPTER 4

PATIENTS AND METHODS

I SELECTION OF PATIENTS

In this study, 139 patients were selected from those patients with chronic low-back pain referred to the Pain Clinic Delft between 1983 and 1986. These 139 patients had all undergone lumbar back surgery due to disc disease, on one or more occasions. The major complain was of burning chronic low-back pain with radiation to one or both lower limbs. The duration of low-back pain was longer than 6 months since the last back operation and the character of the pain was different in kind to that before the last neurosurgical intervention. In these patients no recent neurological disturbances, such as produced by herniation, were found. The age range of the group was 24-85 years with an average age of 47.5 years. Patients with significant arteriosclerotic disease and with significant psychopathology were excluded (Tables 1, 2).

Table 1 General classification of studied patients Groups 1, 2 and 3)

Group	Classification	No. of patients
1	after lumbar spine operation without motor dysfunction	128
2	after lumbar spine operation with motor dysfunction	11
3	different pain syndromes without lumbar spine operation but with sympathetic hyperactivity	71
	Total	210

Table 2 Demographic details (Groups 1, 2 and 3)

Female	Male	Total
123	87	210

Age range 24 - 85 years (mean 47.5 years)

Following the initial thorough medical examination, the patients were selected according to the same criteria as for reflex sympathetic dystrophy (RSD) following lumbar disc surgery. These criteria will be outlined in the following section. The 139 patients were divided into two major groups:

Group 1: 128 patients with RSD without significant motor dysfunction

Group 2: 11 patients with RSD and severe motor dysfunction, dependent on wheelchair assistance, with extreme mental depression and, in some cases, suicidal tendencies.

Group 3: In addition, a third group of 71 patients with varying pain syndromes other than those escribed above were selected for this study.

In all of these patients radiofrequency sympathectomy was performed.

II CRITERIA

One criterium for selection was that all 210 patients (groups 1-3) had obvious sympathetic hyperactivity and all patients had undergone radiofrequency thermal sympathectomy. In the first and second group of patients, all had undergone lumbar back surgery, on one or more occasion, due to disc disease.

In Group 1:

76 patients had 1 operation on the lumbar spine
39 patients had 2 operations on the lumbar spine
6 patients had 3 operations on the lumbar spine
7 patients had more than 3 operations on the lumbar spine

The major complaints included burning chronic low-back pain with radiation to one or both legs. The character of the pain was different to that before the last neurosurgical intervention. In the 139 patients (Groups 1 and 2) no recent neurological disturbances, such as produced by herniation, were found. In 102 patients the pain was also present during rest. Progressive stiffness was reported in 119 patients and all patients experienced cold limbs, mostly in the feet, with a significant decrease in skin temperature. All 139 patients were resistent to all other pain therapies and used analgesics, hypnotics, tranquilisers and, often, narcotics. Other typical findings included:

1. atrophic changes in the skin of the affected limb (92 patients)
2. cutaneous dysthesia in the affected lower limb (48 patients)

3. excessive sweating in the affected lower limb (17 patients)
4. muscle oedema in the affected lower limb (6 patients)
5. mental depression (46 patients)
6. sexual disturbance (49 patients)

In all 139 patients, skin temperature in the affected limb dropped to below 26°C (mean 25°C). Group 2 comprised 11 selected patients who were confined to a wheelchair or had been immobile for longer than six months.

Symptoms included:

1. pseudoparalysis of the legs
2. motor disability
3. conversion-like behaviour
4. drug addiction
5. secondary local neurological disturbances (3 patients)
6. extreme mental depression and suicidal tendencies.

Group 3 comprised 71 patients in whom no operation on the lumbar spine had been performed. The group consisted of:

37 patients with chronic low-back pain with clinical signs of sympathetic hyperactivity

10 patients with post-traumatic reflex dystrophy

7 patients with lumbar radicular pain or LDH

5 patients with peripheral neuralgia

4 patients with vascular diseases

4 patients with phantom and stump pain

3 patients with polyneuropathy

1 patient with a cervical spinal cord injury

In all 71 patients the skin temperature in the affected limb dropped to below 26°C. The common treatment in all these patients with varying pain syndromes was radiofrequency thermal sympathectomy.

III DATA ANALYSIS

Group 1. After LDH operation without motor dysfunction (128 patients)

Table Ia Referral to Pain Clinic

	No. of patients
General Practitioners	81
Neurologists/Neurosurgeons	31
Orthopaedic Surgeons	12
Physical Doctors	3
Others	1
	Total 128

Table Ib Demographic details

Female	Male	
75	53	Total 128
Youngest	Oldest	Mean (years)
24	72	48.5

Table Ic Duration of low-back pain

Time (years)	0 - 1	1 - 3	3 - 5	5 - 10	10 - 15	over 15
No. of patients	-	17	18	19	15	59

Table Id Duration of reflex sympathetic dystrophy

Time (years)	0 - 1	1 - 3	3 - 5	5 - 10	10 - 15	over 15
No. of patients	35	28	23	32	-	15

Table Ie Previous back surgery

No. of lumbar spine operations	1	2	3	4+
No. of patients	76	39	6	7

Table If Reflex sympathetic dystropy criteria

Symptoms	No. of patients
Decrease in skin temperature of affected limb	128
Burning pain	127
Stiffness of the spine	119
Rest pain in the back (especially at night)	102
Cramp in affected limb	40
Atrophic changes in affected limb	92
Cutaneous dysthesia or parasthesia	48
Excessive sweating	17
Muscle oedema	6
Mental depression	46
Sexual disturbances	49
Positive trigger points over the facet joints	120
Painful extension of lumbar spine	126

Table Ig Physical examination

Findings	No. of patients
Skin temperature of affected limb below 26°C (mean 25°C)	128
Skin colour changes of affected limb	128
Positive trigger points over the facet joints	120
Painful/limited extension of lumbar spine	126
Atrophic changes in affected leg	92
Excessive sweating in affected foot	17

Table Ih Treatment prior to Pain Clinic Delft treatment

	No. of patients
Reoperation or chemonucleolysis	39
Physical therapy	128
Pharmocological (including: analgesics, narcotics, hypnotics, tranquillisers, antidepressants	128
Psychological or psychiatric	35
Acupuncture	13
TENS	5
Epidural blocks	16
Other nerve blocks	4
Different specialist consultations	39
Combined treatment in rehabilitation or Pain Centre	38
Other (including: alternative medicine, orthopaedic corset, spinal cord stimulation)	34

Group 2. After LDH operation with motor dysfunction (11 patients)

Table IIa Referral to Pain Clinic

	No. of patients
General Practitioners	9
Neurologists or neurosurgeons	2
Orthopedic surgeons	-
Physical doctors	-
Others	-

Table IIb Demographic details

Female	Male	
8	3	Total 11
Youngest	Oldest	Mean (years)
31	62	46

Table IIc Previous back surgery

No. of lumbar spine operations	1	2	3	4+
No. of patients	6	2	1	2

Table IId Clinical findings

	No. of patients
Motor disability - wheelchair	8
Motor disability - partial	3
Skin temperature of affected limb below 26°C (mean 25°C)	11
Skin colour changes of affected limb	11
Positive trigger points over the facet joints	11
Painful and limited extension of lumbar spine	11
Atrophic changes in affected leg	11
Excessive sweating in affected leg	11
Neurological disturbances	11
Depression	11
Suicidal tendencies	4
Drug addiction	11

Table IIe : General Details

Age	Sex	Duration of pain (years)	Duration of RSD (years)	Previous surgery	Our findings
31	F	8	7	2 x lumbar laminectomies - LDH	RSD. Pseudoparalysis, left leg motor dysfunction. Disability - wheelchair. Depression with suicidal tendency. Drug addiction.
35	F	10	2	1 x lumbar laminectomy - tethered cord syndrome	RSD. Suicidal tendency. Motor dysfunction. Paralysis. Disability - wheelchair. Mental depression. Drug addiction.
41	F	5	1	1 x lumbar laminectomy - LDH	RSD. Motor dysfunction. Disability - wheelchair. Depresion. Drug addiction.
42	F	4	4	2 x lumbar laminectomies - LDH 1 chemonucleolysis	RSD. Pseudoparalysis - right leg. Disability - wheelchair. Mental depression. Drug addiction. Suicidal tendency.
35	F	21	14	1 x lumbar laminectomy - LDH	RSD. Pseudoparalysis. Disability - wheelchair. Mental depression. Drug addiction.
52	F	27	3	1 x lumbar laminectomy - LDH	RSD. Pseudoparalysis. Disability - wheelchair. Mental depression. Drug addiction.

Table IIe : General Details (continuing)

Age	Sex	Duration of pain (years)	Duration of RSD (years)	Previous surgery	Our findings
52	M	10	7	3 x laminectomies - LDH	RSD. Pseudoparalysis. Disability. Peroneus lesion left. Mental depression. Drug addiction.
61	M	30	12	6 x laminectomies	RSD. Pseudoparalysis. Disability. Coxartrosis bilaterally. Gonarthrosis bilaterally. Drug addiction. Mental depression. Alcohol abuse, liver dysfunction.
40	M	5	4	1 x lumbar laminectomy - LDH	RSD. Pseudoparalysis. Disability. LDH - cervical susp. lesions. Postpunctionel syndrome with cerebral disturbance. Mental depression. Drug addiction.
58	F	4	3	4 x laminectomies 3 x LDH + canal stenosis 2 x rhisotomy L_5	RSD. Motor dysfunction - paralysis of right leg. Neurogenic ulcera. Disability - wheelchair. Serious mental depression, suicidal tendency. Drug addiction.
62	M	8	8	1 x lumbar laminectomy - LDH. Complete spinal cord injury Th_9	RSD. Complete paralysis of both legs. Disability - wheelchair. Bladder catheter. Bladder dysfunction. Drug addiction. Depression.

Table IIf Treatment prior to Pain Clinic Delft treatment

	No. of patients
Reoperation or chemonucleolysis	5
Physical therapy	11
Pharmocological (analgesics, narcotics,tranquillisers,	11
Acupuncture	2
TENS	8
Epidural blocks	7
Other blocks	2
Combined treatment in Rehabilitation Centre	11
Other	11

Table IIg Drug addiction prior to Pain Clinic Delft treatment

Drug	No. of patients
Narcotics	11
Analgesics	11
Hypnotics	11
Tranquillisers	11
Antidepressants	5
Alcohol abuse	3

Table IIh Duration of low back pain

Time (years)	0 - 1	1 - 3	3 - 5	5 - 10	10 - 15	over 15
No. of patients	-	-	2	4	2	3

Table IIi Duration of reflex sympathetic dystrophy

Time (years)	0 - 1	1 - 3	3 - 5	5 - 10	10 - 15	over 15
No. of patients	1	1	4	3	2	-

Group 3. With different pain syndromes without LDH operation but with clinical sympathetic hyperactivity (71 patients)

Table IIIa Demographic details

Female	Male	
40	31	Total 71
Youngest	Oldest	Mean (years)
24	85	48

Table IIIb Classification

Pain Syndrome	No. of patients
Low-back pain with sympathetic hyperactivity	37
Posttraumatic reflex dystrophy	10
Lumbar radicula pain or LDH	7
Peripheral neuralgia in the lower limbs	5
Vascular disease in the legs	4
Phantom pain + stump pain of lower limbs	4
Polyneurapathy in the lower limbs	3
Others	1

CHAPTER 5

TREATMENT

I MULTISTEP TREATMENT CONCEPT

It is most important to remember that chronic low-back pain is a symptom and not a disease in itself, thus it is essential to exclude the possibility of malignancies. Chronic low-back pain is defined as pain which has persisted for at least 6 months. The degree of disability varies among individuals but in extreme cases patients may be totally confined to a wheelchair as a result of the pain. The effect of the pain on the patient leads to an inability to perform their normal functions and usually, sooner or later, to psychological difficulties. Such patients have been treated in the Pain Clinic Delft and have been included in Group 2 of this study.

The selected 139 patients (Groups 1 and 2) in this study had been suffering from:

1. chronic burning pain in the back with radiation to one or both lower limbs
2. pain that was different in character from that before surgical intervention
3. progressive stiffness of lumbar spine
4. cold leg(s)
5. decrease in skin temperature in the lower limbs to below 26°C often accompanied by:
6. excessive sweating
7. atrophic changes in affected leg(s)
8. cutaneous dysthesia

11 patients had serious motor dysfunctions and had been confined to a wheelchair for varying periods. All had suffered from mental depression and some had suicidal tendencies. Before being referred to the Pain Clinic Delft all these patients had been previously treated by other practitioners and in Rehabilitation Centres, with a variety of different treatment regimens. Chronic pain in these patients is a complexity of different symptoms which involves several disease processes occurring simultaneously, including:

1. sympathetic hyperactivity
2. peripheral denervation, sometimes with local neurological dysfunction
3. secondary motor dysfunction
4. mental depression, including conversion-like behaviour

One should attempt to treat all these disease processes simultaneously.

All patients underwent ambulatory evaluation and some single therapeutic procedures, such as TENS, epidural blocks (corticosteroid combined with local anaesthetic) or Laser penetration were performed. If the monoconventional technique failed and no pain relief was achieved, clinical treatment was proposed involving few days days hospitalisation.

Group 1

The treatment for group 1 exists of:

1. percutaneous thermal sympathectomy at the level L_4 only
2. percutaneous facet joints denervation at the levels L_3-L_4-L_5-S_1, unilaterally or bilaterally, if so indicated

Group 2

Patients with motor dysfunction:

These patients underwent ambulatory evaluation and were finally treated clinically. Due to the complexity of the symptoms, combined pain treatment was performed. As mentioned above, due to the presence of different symptoms of different disease processes, the treatment was performed simultaneously.
In these 11 patients:

1. percutaneous thermal sympathectomy at level L_4 only, unilaterally or bilaterally if so indicated
2. percutaneous facet joint denervation at the level L_3-S_1 was performed other unilaterally or bilaterally is so indicated
3. TENS
4. thiopenthone treatment (Pernak *et al.* 1986)

Finally, immediately after thiopentone treatment an intensive physical therapy regimen was started at the "Back School" of the Pain Clinic Delft and continued for the following 6 weeks (ambulatory). For all patients confined to wheelchairs, intensive psychological support during their stay at the Pain Clinic was also necessary. In the extremely serious cases of depression with suicidal tendencies, psychiatric consultation and support was necessary (2 patients).

Group 3

In the third group, only percutaneous thermal sympathectomy was performed.

In the first group of patients (Group 1) the stay at the Clinic for clinical procedures took 2-3 days, after ambulatory evaluation.

In the second group of patients confined to a wheelchair (Group 2), all treatment procedures were complete within 1-3 weeks. In a few patients from Group 2, an

additional stay at the Pain Clinic was necessary for psychological support only. In the 11 patients of Group 2, all analgesics were stopped on the first day of admittance to the Pain Clinic.
In the third group the stay at the Clinic took 1 day.

Follow-up procedures were undertaken at:

1. 1 day (day of discharge)
2. 6 weeks
3. 3 months
4. 6 months
5. 1 year
6. 1.5 years
7. 2 years

and evaluation was based on the following criteria:

1. skin temperature
2. warm feeling in legs
3. skin changes

Treatment was considered successful if there was:

1. an increase in skin temperature of the feet by more than 2.5-5°C after 6 months
2. a stable warm feeling for longer than 6 months
3. a decrease in skin changes

Other criteria such as: reduction in pain; increase in activity level; diminished or discontinued use of analgesics and/or hypnotics; and increase in work capacity were all taken into consideration when evaluating whether treatment should be continued, changed or ceased.

CHAPTER 6

RESULTS

In this study, results concerning percutaneous radiofrequency thermal lumbar sympathectomy only are discussed.

Increase in skin temperature
The increase in skin temperature following radiofrequency thermal sympathectomy was assessed by objective measurement of the skin temperature of the affected limb (e.g. foot, heel, calf) by means of:

1. thermographic plates with colour change indicator (Bayer, Nederland B.V.) and
2. electronic thermometer Ellab, Copenhagen DM 852 (Lameris, Netherlands)

These parameters were assessed during physical examination 6 weeks, 3 months, 6 months, 1 year, 1.5 years and 2 years following treatment.

Decrease in pain and use of medication; increase in activity level
These were assessed subjectively by means of two different questionnaires:

Form 1. during pain treatment in Delft (see model, page 6)
Form 2. 6 weeks and 1 years following Pain Clinic treatment (see model, page 6)

Other parameters including:

1. atrophic skin changes
2. sweating
3. mental, psychological and other factors were also observed but are not discussed in this study.

In all 210 patients an increase in skin temperature (2.5-5°C) was observed immediately following the procedure.

I Group 1

Long-lasting increase in skin temperature was observed in 123 patients from Group 1. The follow-up was longer than one year. In 7 patients thermal sympathectomy was repeated after 24 hours, in 1 patient after 6 weeks, in 1 patient after 3 months and in 5 patients after 6 months.

II Group 2

In the 11 wheelchair bound patients spectacular results were achieved, probably due to our new approach to pain treatment. In all these patients, a significant increase in

skin temperature was maintained for longer than 1 year. The patients were reviewed at 6 monthly intervals with the longest follow-up at 4.5 years. Of the 11 patients, ten are now completely mobile and independent of the wheelchair and free from narcotic use. All are leading normal lives and, where applicable, have returned to work. Apart from 3 patients who required extra psychological support for 6 months, no complications have been noted.

III Group 3

Two patients from Group 3 had a short-lasting effect (less than 24 hours). In one of these patients radiofrequency thermal sympathectomy was repeated 3 times, but withoutsatisfactory results. Surgical sympathectomy was indicated and subsequently performed. A significant increase in skin temperature in all subgroups of patients with different pain syndromes occurred following radiofrequency thermal sympathectomy. Decrease in pain was observed in those patients with posttraumatic reflex dystrophy, radicular pain or LDH.

Group 1

Table Ia Follow-up after radiofrequency sympathectomy

Positive results	No. of patients
Immediate results	128
After 6 weeks	127
After 3 months	126
After 6 months	123

Table Ib Results

	3 months	6 months	1 year	over 1 year
Increase in skin temperature	*126	123	123	123
Decrease in pain	102	106	108	107
Decrease in medication	102	106	108	107
Increase in activity level	102	111	111	109

*2 of the 128 patients - no data available at 6 weeks control

Table Ic Repeated radiofrequency sympathectomy

Repeated Radiofrequency sympathectomy	No. of patients
After 24 hours	7
6 weeks	1
3 months	1
6 months	5
Total	14

Group 2

Table IIa Results

	3 months	6 months	1 year	over 1 year
Increase in skin temperature	11	11	11	11
Decrease in pain	11	11	11	10
Decrease in medication	11	11	11	10
Increase in activity level	9	9	10	10

Table IIb Repeated radiofrequency sympathectomy

Repeated Radiofrequency sympathectomy	No. of patients
After 24 hours	0
6 weeks	0
3 months	0
6 months	0
Total	0

Group 3

Table IIIa Repeated radiofrequency sympathectomy

Repeated Radiofrequency sympathectomy	No. of patients
After 24 hours	2
6 weeks	1
3 months	-
6 months	-
Longer	-

Table IIIb Results after 6 months

Activity	No. of patients per group	Increase in skin temp.	Decrease in pain	Decrease in medication	Increase activity level
Low-back pain with sym. hyperactivity	37	34	20	20	20
Posttraumatic reflex dystrophy	10	9	8	8	8
Radicular pain or LDH	7	6	5	5	5
Vascular diseases	4	4	1	1	1
Phanton + stump pain	4	4	1	1	1
Peripheral neuralgia	5	5	1	1	1
Polyneuropathy	3	3	-	-	-
Others (cervical spinal cord injury)	1	1	1	1	-

IV COMPLICATIONS FOLLOWING PRTLS (Groups 1, 2, 3)

Following percutaneous radiofrequency lumbar sympathectomy the following complications were reported (all groups of this study):

1.	Punctured aorta	9 patients
2.	Genito-femoral neuralgia	7 patients
3.	Neuritis of the spinal nerves	2 patients

Ad. 1 Puncture of the aorta is most frequently reported due to the fact that the aorta lies close to the sympathetic chain. It is then necessary to change the position of the needle - no other treatment is required. In those patients using anticoagulants the prothrombin time was checked.

Ad. 2 In 7 patients genito-femoral neuralgia occurred. This complication is often reported in all types of sympathectomy. Neuritis of the genito-femoral nerve is caused by injury of this nerve, which runs close to the sympathetic chain in the psoas sheath. The resulting pain can persist for 5-20 days (average 14 days) and is located low in the back and in the inguinal region. The pain was controllable with analgesics: Dorsiflex (Mefenoxalon) or Paracetamol.

Ad. 3 Two patients suffered neuritis of the spinal nerves. This was treated with a single paravertebral spinal nerve block at the level L_4 with 80 mg methyl-prednisolone acetate (Depomedrol) with 2 ml of 2% lidocaine which produced effective pain relief.

CHAPTER 7

SELECTED CASE REPORTS

CASE REPORT

Male, 45 years old, a car mechanic. Unable to work for the last 8 years due to history of low-back pain. Two LDH (1980 and 1982).

Previous therapy:
1. physical therapy.
2. analgesics

Pain Clinic findings:
Postlaminectomy lumbar scar. Painful extension and flexion of lumbar spine. Paravertebral tenderness over the facet joints L_3-S_1 left. Atrophy of the upper left leg. Negative SLR (straight leg raising) sign. Decrease in skin temperature of both feet to below 24°C.

Pain Clinic treatment:
Ambulatory: epidural caudal block with 240 mg Depomedrol and 24 cc of 0.5% lidocaine.
Clinical:
1. percutaneous facet joint denervation L_3-S_1 left;
2. PRTLS L_4, left.

Results:
6 months later, significant improvement in left leg and than radiofrequency sympathectomy at L_4 level, right had been performed. Follow up for ± 2 years. Patient is pain-free, no recurrence of pain. Patient has returned to work after 8 years of being at home.

CASE REPORT

Married woman aged 52 years. 27 years history of low-back pain. In 1982 the patient underwent laminectomy at the level L_3-L_5 due to a discus protrusion. Other operations include a hysterectomy in 1981. Confined to a wheelchair for more than one year.

Complaints:
Persistent burning and cutting low-back pain with radiation to the left leg to the distribution L_3-L_4 and L_5-S_1, left. Also radiation to the right knee. Immobility, sensory changes, paraesthesia of right foot. Anaesthesia and hypo-aesthesia in L_5-S_1, left. Loss of power in legs, rest pain, depression.

Previous treatment and medication:
1. analgesics, tranquilisers, hypnotics
2. physical therapy
3. Rehabilitation Centre - clinical treatment with physical therapy, ergotherapy, psychological support, wheelchair.

Our clinical findings:
Immobility. Sensory and motor dysfunctions at the distribution L_5-S_1 left. Anaesthesia and hypoaesthesia at L_5-S_1 left. Paresis M. extensor hall, longus left. Painful and limited extension/flexion of lumbar spine. Also limited and painful rotation. Paravertebral tenderness over the facet joints L_3-S_1 left and on sacro-iliac joint left. Negative SLR sign. Atrophic changes in the left underleg. Skin temperature of left foot below 24°C.

Pain Clinic treatment:
1 week stay following our regimen:
1. PRTLS L_4 left
2. percutaneous facet joint denervation L_3-S_1, left
3. intensive physical therapy
4. psychological support

Discharged after 1 week able to walk with assistance, followed by six weeks of physical therapy.

Results:
Follow up at 1.5 years. Significant pain relief, significant increase in skin temperature of left foot to above 34°C. Significant increase in activity level. The patient is now able to walk without any assistance for several hours. Significant positive improvement in psychological condition. All medication ceased.

CASE REPORT

Married woman, 46 years old, nurse (unable to work because of pain). Four year history of low-back pain. LDH operation 3 years previously.

Complaints:
Low-back pain with radiation to right mid-buttock, posterior thigh and lateral calf. Rest pain and cold feeling in right leg - especially at night. Sweating feet. Unable to work. Depression.

Previous treatment:
1. Physical therapy,
2. analgesics, narcotics, hypnotics.

Pain Clinic findings:
Lumbar scar following laminectomy. Points of tenderness over L_3-S_1 paravertebrally and bilaterally in the facet joints. Painful and limited extension. Negative SLR sign. Skin temperature of the right foot below 24°C.

Pain Clinic treatment:
Ambulatory: 2 epidural blocks with corticosteroids and lidocaine.
Clinically:
1. Percutaneous facet joints denervation L_3-S_1 bilaterally.
2. PRTLS at level L_4 right.

Results:
Excellent pain relief. No recurrence of the complaints. Significant increase in activity. Follow up at 3 years.

CASE REPORT

Married businessman, aged 44 years. History of low-back pain for 9 years. In 1983 two lumbar spine operations performed, due to LDH, which failed to provide pain relief.

Complaints:
Low-back pain with radiation to the left lumbar region, the posterior thighs and posterior calves and to the feet. Atrophy of the left calf, cold left leg. Rest pain. After surgery the pain diminished for a short period and then returned with increased intensity.

Previous treatment:
1. physical therapy
2. analgesics.

Pain Clinic findings:
Large lumbar postlaminectomy scar. Limited and painful extension of lumbar spine. Paravertebral tenderness over the facet joints L_3-S_1 left. Skin temperature below 24°C, left side. Negative SLR sign.

Pain Clinic treatment:
Ambulatory: 2 x epidural blocks with corticosteroids.
Clinical:
1. percutaneous facet joint denervation L_3-S_1, left
2. PRTLS L_4 left.

Results and follow up:
1. Objective results - 1 year later. Skin temperature of left foot above 34°C. Activity level - improved movement of lumbar spinal column, patient able to cycle 3-4 kilometres without problem.
2. Subjective results - patient complained of no relief from pain and no change in the character of pain. Patient is currently being treated with TENS.

CASE REPORT

Married man, aged 57 years. (His wife is confined to a wheelchair due to low-back pain following various lumbar spine procedures due to herniation, she also became one of our patients). Low-back pain history of 5 years. In 1981 LDH operation, was pain free until 1984. Later in 1984 acute low-back pain occurred with radiation to the left leg. Rest pain. After neurological evaluation at our hospital the patient was referred to the Pain Clinic.

Neurological findings:
Scoliosis of lumbar spine. SLR test left, positive by 90°. EMG: motor deficiency L_5 left, possibility of axonal neuropathy. CT-scan: small global discus prolapse L_5-S_1 and postoperative changes.

Previous treatment:
1. Physical therapy
2. analgesics.

Pain Clinic findings:
Lumbar scar after spine operation. Paravertebral tenderness over the facet joints L_3-S_1. Skin temperature of left foot below 26.3°C. Atrophy of left calf.

Pain Clinic treatment:
Ambulatory: L_5 anterior blocks with 2 cc of 2% lidocaine and 80 mg Depomedrol.
Clinical:
1. Percutaneous facet joint denervation L_3-S_1 left.
2. PRTLS L_4 left.

Results and follow up:
Direct results were excellent. During hospitalisation the patient followed clinical physical therapy and continued therapy for 6 weeks attending the Pain Clinic "Back School". Six months later there was significant painrelief. In addition, skin temperature of the left foot increased to above 34°C. Significant decrease in atrophy of the left calf. Activity levels significantly increased. Follow up at 2.5 years.

CASE REPORT

Male, 68 years old. History of chronic low-back pain for 14 years.

Complaints:
Low-back pain with radiation to the right leg, especially to the right calf and knee. In the last few years, cramps in both legs and cold feet. Also neck pain with radiation to the right side and right arm.

Previous medication and therapy:
1. physical therapy
2. analgesics
3. orthopaedic corset

Pain Clinic findings:
Painful and limited extension of lumbar spine. Paravertebral tenderness over the facet joints L_3-L_5, right. Skin temperature of right foot below 24°C.

Pain Clinic treatment:
Ambulatory: 2 x epidural caudal block
Clinical:
1. percutaneous facet denervation L_3-S_1, right.
2. percutaneus radiofrequency sympathectomy L_4, right.

Results:
Increase in skin temperature in right foot to 34°C. Excellent pain relief reported at 6 months follow-up.

CASE REPORT

Female aged 31 years, social worker. Unable to work for the last two years. 14 years low-back pain history. Two LDH procedures at levels L_4-L_5 and L_5-S_1. Confined to a wheelchair for 1 year.

Complaints:
Burning low-back pain with radiation to left lumbar region, posterior left thigh and lateral calf left. Rest pain, cold legs, immobile. Depression with suicidal tendencies.

Previous treatment and medication:
1. intensive physical therapy in Revalidation Centre for over 5 years
2. Diazepam, Paracetamol, narcotics
3. physical therapy
4. rehabilitation centre

Pain Clinic findings:
Postlaminectomy scar. Hypertonia of lumbar muscles. Points of tenderness over the facet joints L_3-S_1 also sacro-iliacal left, painful and tender to pressure. Negative SLR sign. Atrophy of the lower thigh and calf. Skin temperature of both legs below 26°C. X-ray revealed spondylosis and status after two laminectomies L_4-L_5 and L_5-S_1. Spondyloarthrosis L_4-L_5 bilaterally.

Pain Clinic treatment:
Two week hospitalisation following our regimen:
1. percutaneous facet denervation L_3-S_1 bilaterally and also:
2. percutaneous radiofrequency sympathectomy L_4 bilaterally
3. pentothal treatment
4. psychological support
5. psychiatric consultation
6. intensive physical therapy

Discharged after 2 weeks, walking with assistance and attended our "Back School" for 6 weeks. Follow up at 4 years. Completely recovered, has returned to full working activity and sport. All medication ceased.

CASE REPORT

Married man, aged 45 years, harbour worker. Low-back pain history + 16 years. Stomach operation in 1959. LDH procedure and spondylodesis operation L_3-L_5 in 1968 was followed by a few months pain-free activity.

Complaints:
Burning low-back pain with radiation to right leg. Cold right foot. Decrease in sexual potency and psychological problems within family due to patient's pain.

Previous treatment:
1. Physical therapy
2. analgesics.

Pain Clinic findings:
Postlaminectomy and postspondylodesis scars. Paravertebral tenderness over the facet joints L_3-S_1, right and sacro-iliacal right. Cold right foot with temperature below 26°C. Atrophy of right upper leg. Negative SLR sign.

Pain Clinic treatment:
Three epidural caudal blocks with good but short-lasting response.
Clinical:
1. percutaneous facet denervation L_3-S_1 right
2. PRTLS L_4 right

Results:
Skin temperature of right foot increased to above 34°C. Significant pain relief. Significant increase in activity level, is able to drive a car for several hours. Has returned to full-time work, family problems have been solved. Is a happy man! Follow up at 2 years.

CASE REPORT

Married woman aged 58 years. Admitted to the Pain Clinic Delft for pain treatment because of progressive invalidism and intractable chronic low-back pain of 4 years duration, following 3 LDH operations (twice at the levels L_4-L_5 and L_5-S_1). Also operatively confirmed spinal canal stenosis at the level L_3-L_4. Surgical rhisotomy L_5 bilaterally was also performed. Confined to wheelchair for 1.5 years.

Complaints:
Persistent burning low-back pain with radiation to both sides of thighs and to both legs, more intensively to right leg, paresthaesia in left leg. Anaesthesia in right leg. Loss of power in legs, cramps, rest pain, immobility. Depression, suicidal tendencies.

Medication and previous treatment:
1. Pharmacological with various analgesics, including Depronal, Morphine, Brufen, Fortral.
2. Intensive physical therapy for 1.5 years in a Rehabilitation Centre.

Pain Clinic findings:
Immobility, sensory and motor dysfunction at distribution L_3-S_1 both sides. Neurogenic ulcer on right foot, see Figure 15. Fixed spinal column. Painful and limited extension and flexion. Paravertebral tenderness over the facet joints L_3-S_1, bilaterally. Atrophic changes in right foot and right calf. Knee reflex positive. Anaesthesia in S_1 right, negative SLR sign. Skin temperature in both legs below 24°C.

Pain Clinic treatment:
1. percutaneous facet joint denervation L_3-S_1 right and also:
2. PRTLS L_4 right
3. psychological support
4. TENS
5. Pentothal treatment
6. intensive physical therapy

Results:
Discharged after 2 weeks, able to walk with assistance. Followed our "Back School" course for 2 months. After 3 months patient returned for a short stay (1 week) for psychological support. During this stay significant pain relief was achieved. The patient's motor function and sensory reactions significantly improved. The neurogenic ulcer on the right foot recovered and closed 3 months after sympathectomy (Figs. 11 - 16).

CHAPTER 8

SUMMARY AND DISCUSSION

210 patients with different pain syndromes and obvious sympathetic hyperactivity were selected and treated with percutaneous radiofrequency thermal lumbar sympathectomy (PRTLS). There were two major diagnostic groups with low-back pain and sciatica following lumbar disc surgery:

1. patients with RSD without motor dysfunction (128 patients)

2. patients with RSD and severe motor dysfunction and confined to a wheelchair (11 patients)

In addition there was a third group (Group 3) of 71 patients which consisted of those with a variety of pain syndromes without previous disc surgery but with sympathetic hyperactivity.
In all three groups percutaneous radiofrequency thermal lumbar sympathectomy was performed.

Group 1

Of the 128 patients in Group 1 in a follow-up after one year, 123 patients continued to have a significant increase in skin temperature and 107 patients had continued pain relief. 107 patients had a significant decrease in consumption of medication and 109 had a significant increase in activity level.

Group 2

The most outstanding results were observed in the 11 patients of Group 2, all of whom reported a significant increase in skin temperature of the affected limb after one year. In addition, 10 of these 11 patients had a significant decrease in pain, decreased consumption of medication and a significant increase in their activitylevel. In this group of patients, all of whom were previously immobile, 10 of the 11 patients are now completely mobile and, where applicable, have returned to work.

Group 3

In this group of patients with a variety of pain syndromes, at 6 months follow-up a continued significant increase in skin temperature was reported, whereas significant pain relief and decreased consumption of medication and increase in activity level was only observed in those patients with post-traumatic reflex dystrophy and with radicular pain.

CONCLUSION

Analysis shows that the best results were achieved in Group 2 patients. This suggests that low-back pain is not a simple single disease but a complexity of different symptoms involving several disease processes occurring simultaneously. Over a protracted period of time together with inadequate treatment, this condition can progress to both mental and physical disability. Thus, it is concluded that simultaneous multistep treatment, including radiofrequency sympathectomy, is essential for success with these patients.

DISCUSSION

Patients with chronic low-back pain and sciatica present a significant health problem in all countries of the world. Various conventional forms of treatment and surgical intervention are available, but these are often ineffective. When successful treatment is not achieved, persistent pain, diminished or loss of productivity and, occasionally, disability can result.

In Holland, lumbar disc herniation operations number approximately 9000 per year. Low-back and leg pain is one of the most common locations of chronic pain in patients attending Pain Clinics. Many patients in this group are young or middle aged and may eventually be excluded from the work activity for extended periods if various treatment regimens are unsuccessful.

Before these patients are finally referred to a specialised Pain Clinic they have generally undergone a prolonged series of ineffective therapies. In consequence, they are often suffering from a variety of associated psychological disorders. In the course of being referred from one specialist to another they will also have been subjected to a variety of drug schedules which can ultimately result in drug abuse problems.

There are many publications describing the persistence of low-back and sciatic pain following lumbar disc surgery and its subsequent treatment, but there are very few reports describing the influence of sympathetic innervation in this particular pain syndrome, although it is well known that the sympathetic innervation represents an important factor in the pathogenesis of different pain syndromes.

There are various forms of treatment for these sympathetic pain conditions, which are described in Chapter I. In many case complete sympathetic denervation is necessary and can be performed surgically, with neurolytic agents or by percutaneous radiofrequency thermal lumbar sympathectomy (PRTLS).

Compared with surgical and chemical sympathectomy PRTLS has several advantages, including:

1. the short hospitalisation (1 day)
2. the ease of use
3. the fact that anesthesia is not required
4. the lack of clinical contraindications
5. its safety
6. low incidence of complications
7. no operation scar

The disadvantages of PRTLS include the necessity for sophisticated equipment, including a fluoroscopic C-arch x-ray image intensifier with memory and a radio-frequency generator. Genitofemoral neuralgia is one of the most commonly reported complications and other complications.
In addition, technological advances in thermal electrode design with endoscopic control, together with a better understanding of the role of the sympathetic innervation in many pain syndromes, can further diminish complications.

Finally, more scientific research has to take place in order to increase precision concerning the selection of targets and lesion parameters.

SAMENVATTING EN DISCUSSIE

210 patienten met verschillende pijnsyndromen en met duidelijke sympathische hyperactiviteit werden geselecteerd en behandeld met behulp van percutane thermische lumbale sympathectomie (PRTLS).

Er waren twee grote diagnostisch verschillende groepen met lage rugpijn en sciatica, na lumbale discus operatie:

- patienten met RSD (reflex sympathische dystrofie) zonder motorische dysfunktie.

- patienten met RSD en ernstige motorische dysfunktie (11 patienten).

Verder was er een derde groep (Groep 3), bestaande uit 71 patienten met verschillende pijnsyndromen die geen voorafgaande discus operatie hadden ondergaan, toch sympathische hyperactiviteit vertoonden.

In al deze drie groepen werd PRTLS op niveau L_4 verricht.

Groep 1

Na een jaar follow-up van de 128 patienten in Groep 1 vertoonden 123 patienten nog steeds een belangrijke huid temperatuur stijging van het betreffende been. 107 patienten hadden blijvende pijn vermindering. Ook was het gebruik van medicijnen bij deze groep patienten duidelijk verminderd. Bij 109 patienten werd een duidelijke stijging van de A.D.B. (algemene dagelijkse behoeften) waargenomen.

Groep 2

De meest spectaculaire resultaten werden bij 11 patienten van deze groep geregisteerd. Bij alle patienten van deze groep was de stijging van temperatuur van het betreffende been langer dan een jaar. 10 patienten hadden ook aantoonbaar pijnvermindering; vermindering van medicijngebruik en verhoging van A.D.B. Van de 11 patienten die voor behandeling immobiel waren zijn allen inmiddels geheel mobiel en (voor zover van toepassing) weer in staat aan het arbeidsproces deel te nemen.

Groep 3

In een follow-up na 6 maanden werd bij deze groep patienten met verschillende pijnsyndromen, wel een belangrijke temperatuurstijging van het betreffende been geregistreerd, maar pijnvermindering, vermindering van medicijngebruik en verbetering van de A.D.B. werd alleen waargenomen bij patienten met een posttraumatische reflex dystrofie en bij patienten met radiculaire pijn.

CONCLUSIE

De analyse laat ons zien dat de beste resultaten zijn bereikt bij patienten van groep II. Dit suggereert dat lage rugpijn niet een eenvoudige aandoening is, maar een complex van verschillende symptomen waarbij verschillende ziekteprocessen tegelijkertijd zijn betrokken. Bij een goede aanpak met intensieve behandeling over een zekere periode kan de lichamelijke en psychische toestand van de patient duidelijk verbeteren.

Derhalve wordt geconcludeerd dat een gecombineerde behandeling inclusief radiofrequentie sympathectomie essentieel is voor het bereiken van blijvend succes bij deze patienten.

DISCUSSIE

Patienten met lage rugpijn en sciatica manifesteren zich als een duidelijke probleemgroep over de gehele wereld.

Verschillende conventionele behandelingsvormen en chirurgische ingrepen zijn mogelijk, maar helaas niet altijd effectief. Wanneer er geen succes met behandeling is bereikt kan chronische pijn ontstaan, en het totale leven van de patient beinvloeden.

In Nederland worden ongeveer 9000 LDH operaties verricht per jaar. Lage rugpijn is de meest voorkomende klacht bij patienten die de Pijnkliniek bezoeken. De patienten uit deze groep zijn meestal jong, of van middelbare leeftijd en vaak van dageljkse activiteiten uitgesloten. Vaak worden bij deze patienten verschillende behandelingen toegepast, echter regelmatig zonder resultaat. Tenslotte kunnen zich na een langdurig ziekteproces, niet geslaagde behandelingen en langdurig medicijngebruik, psychologische problemen ontwikkelen. Er zijn vele publikaties betreffende lage rugpijn na lumbale rugoperaties, maar er zijn slechts weinige die aandacht aan dit pijn syndroom besteden, ondanks de bekendheid dat sympatische innervatie een belangrijke rol speelt in de pathogenese van verschillende pijnsyndromen.

Er zijn verschillende vormen van behandelingsmethoden van deze sympathische pijnsyndromen, welke in hoofdstuk I zijn beschreven. In vele gevallen is complete sympathische denervatie noodzakeljk hetgeen chirurgisch, neurolytisch of via PRTLS verricht kan worden. In vergelijking tot chirurgische en chemische sympathectomie heeft PRTLS verschillende voordelen, zoals:

1. kort verblijf in ziekenhuis (1 dag)
2. gemakkelijk toe te passen
3. anaesthesie niet vereist
4. geen klinische contraindicaties
5. veilig
6. minder complicaties
7. geen blijvend litteken

Een nadeel van PRTLS is het gebruik van geavanceerde apparatuur (inclusief C-armbeeldversterker met geheugen, radiofrequentiegenerator).
De meest voorkomende complicatie is genitofemorale neuralgie. Het is in de nabije toekomst te verwachten dat een technische ontwikkeling van endoscopische thermo-electroden, alsmede een beter begrip van de rol van de sympathische innervatie bij vele pijn syndromen, zal bijdragen tot het afnemen van de complicaties. Ten slotte dient er meer wetenschappelijke werk verricht te worden ten einde de meer preciese factoren te determineren ten behoeve van de selectie van doelgroepen en laesie parameters.

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I would like to express my warm sympathy and great thanks to my dearest colleague dr. J.D. Bryant, anaesthesiologist from Ikazia Hospital in Rotterdam. We have performed many, many radiofrequency sympathectomies together, we have spent hours and hours discussing our findings, and we worked together on the various research studies, presenting papers at different symposia. He has corrected not only my manuscript but also my English. David thank you for everything.

My greatest appreciation is extended to all the general practitioners, neurologists, neurosurgeons, physical therapeutists, internists, anaesthesiologists and other specialists for generously sharing their considerable knowledge of pain treatment, for their recognition of our approach to treatment in Delft especially concerning low back pain. Their enthusiasm and faith in our approach in the Reflex Sympathetic Dystrophy has been for me one of the most important stimuluses in the development of this thesis. Because of this support our study includes patients from all of Holland.

I would not have been able to continue and to finish this study without the generous support and enthusiasm of many my colleagues from different countries in the world.
I give special thanks to such great doctors as: prof. dr. Lars-Erik Augustinsson, neurosurgeon from Göteborg, prof. dr. Josef Ganglberger neurosurgeon from Vienna, prof. dr. Jean Siegfried neurosurgeon from Zürich, prof. dr. Guenter Corssen anaesthesiologist from Arizona, prof. dr. T. Oyama, anaesthesiologist and prof. dr. H. Suzuki, anaesthesiologist both from Japan, prof. dr. Massimo Zoppi rheumatologist from Florence Italy, dr. Heidi Pabst, neurologist from Mauer in Austria, dr. D. Zaric, anaesthesiologist from Genolier in Switzerland, dr. U. Rossi, neurosurgeon from Melbourne in Australia, dr. H. Malakuti from Trier, West Germany, prof. dr. M.T. Bhatia from India, and many, many others for their interest in our Radiofrequency sympathectomy - their visits to Delft to our clinic have been a nice opportunity for me to demonstrate my technique to them and also for us together for the useful discussion which always followed.

It has been a great privilege and honour for me to be invited by many colleaques to different Clinics in the world and to present and to demonstrate percutaneous thermal radiofrequency sympathectomy. May I thank some of them in particular: prof. dr. M. Albin, neurosurgeon from San Antonio - USA, prof. dr. Maciej Babiński, anaesthesiologist also from San Antonio, dr. Bert Kepplinger, neurologist from Mauer in Austria and prof. dr. Keith Bradly, neurosurgeon from Melbourne, Australia. Prof. dr. Keith Bradly's constructive criticism and his immense knowledge of anatomy with special emphasis of the sympathetic nervous system contributed to my better understanding on the clinical problems and stimulated me to restudy the basic anatomy.

The help of mrs. Laraine Visser with the compiling of the literature, the typing many many, many times of the manuscript and correcting the English and giving warm, friendly support is gratefully acknowledged and it will never be forgotten.
My special thanks for the magnificant organisation with the preparation of this manuscript in all aspects and at every stage and especially in the last "nervous" weeks go to mrs. Trudy Drenth, secretary of the Anaesthesiology Department A.Z.R. Rotterdam.
Special thanks are also due to my wonderful coworkers: nurses, physical therapeutists, secretaries, technical advisors, X-ray techinicians and personel from the management of our Hospital in particular to: Mieke Hageman-Kooke, Agnes Khow Hajombada, Chris Boonman-Nijskens, Janny Peek-Groen, Marijke Visser, Astrid Klamer-Fenijn, Ivonne van de Velde, Hans van de Berg, Walter ten Hoeve, Ivonne de Klerk, Annemarie Scholtes, Simone van Loon, Deirdre O'Dogherty, Leo Rodenrijs, Peter de Haan, Fred Hulscher, Mrs. A.J.M.L. Jaques, drs. G. Kersten and mr. A.J.M.N. Brull. Their enthusiasm and support in the every day clinical work was a huge contribution.
I would like to thank mr. Hans Klip and mr. Jerry Slager for their technical support. They helped me not only with the photographs and the slides but all the time in the last 6 years they have encouraged me to continue writing this thesis and not to give up. Also my special thanks to Mr. Johan Barends from Audio-Visual Centre of Erasmus University Rotterdam for his outstanding help with the video-films.
My greatest appreciation is extended to all the pain-patients who have been treated in our Pain Clinic and in particular those in whom percutaneous thermal sympathectomy has been performed. Their cooperation, their satisfaction and their recognition for our pain management has been a continuous stimulant for further study.
Finally I would like to thank you all my friends in particular: Willem M. van Roij, Margot van Vliet-Kuczyńska, dr. Paul Kho and Wigbold Verwey.

My warmest feelings, thoughts and thanks go to my family and friends in Poland.

Above all I would like to thank Gerard, without whose love, support and patience this manuscript would not be finished.

APPENDIX

Afd. Pijn-Kliniek

Mw J.M. Pernak, anaesthesiologe
hoofd pijn-kliniek

Reinier de Graaf Gasthuis

Westlandseweg 2, Delft
telefoon 015 - 603060

Correspondentie:
Postbus 5013
2600 GA Delft

Gebouw Oude- en Nieuwe Gasthuis Delft, Merk:

Beste Mijnheer en Mevrouw,

In verband met mijn proefschrift, betreffende lage rugpijn na HNP (rugoperatie) en zijn behandeling, willen wij u nog enkele extra vragen voorleggen, om zo al uw klachten en problemen van voor en na de operatie goed te kunnen analyseren.
Het derde gedeelte van deze vragenlijst gaat over uw reacties na onze behandeling in de pijnkliniek.
Door uw goede en objectieve gegevens, zullen wij in staat zijn om aan nieuwe patienten voor onze behandeling nog bepaalde vragen te stellen, die nog op tijd verwerkt kunnen worden in mijn onderzoek.

Hartelijk dank voor uw medewerking.

ALGEMENE VRAGEN

-1- NAAM:

-2- MAN 0 GETROUWD X

VROUW 0 GESCHEIDEN 0

ALLEENSTAAND 0

-3- LEEFTIJD: 60 JAAR

-4- BEROEP: HOOGLERAAR

-5- HOEVEEL RUGOPERATIES HEEFT U GEHAD:

- EEN 0
- TWEE 0
- MEER X

-6- HOELANG HAD U IN TOTAAL RUGKLACHTEN: RUIM 40 JAAR.

-7- WANNEER BENT U BIJ ONS OPERATIEF GEHOLPEN:

EIND JANUARI EN HALF MAART 1985

-8- HOEVEEL MAANDEN GELEDEN WAS DAT: ± 3 en 1 MAAND GELEDEN

EERSTE GEDEELTE

-1- HOE EN WANNEER ZIJN DE PIJNKLACHTEN BEGONNEN:

IN DE OORLOG IN CONCENTRATIEKAMP DOOR STOKSLAGEN OP DE RUG.

-2- KUNT U UW PIJNKLACHTEN VAN TOEN OMSCHRIJVEN:

- AANVALLEN X
- STEKEND X
- KLOPPEND 0
- SNIJDEND 0
- OF ANDERS: KORTE BESCHRIJVING UITPUTTEND

-3- WAS DE PIJN ALLEEN IN DE RUG GELOCALISEERD EN/OF WAS ER UITSTRALING NAAR:

- LINKER BEEN
- RECHTER BEEN
- BEIDEN: eerst linker been, later ook rechter been

-4- WANNEER HEEFT DE OPERATIE PLAATSGEVONDEN:

Eerste operatie november 1972, daarna nog vijf operaties, waarvan de laatste in mei 1987.

TWEEDE GEDEELTE - NA DE RUGOPERATIE

-1- WAS U NA DE OPERATIE PIJNVRIJ:

na eerste operatie niet, na 2e ± half jaar pijnvrij, na de volgende operaties niet zonder pijn.

ZO JA, VOOR HOE LANG: zie boven.

-2- WANNEER ZIJN DE PIJNKLACHTEN NA DE OPERATIE WEER BEGONNEN: zie vraag -1-

-3- KUNT U DIE PIJN OMSCHRIJVEN:

WAS DE PIJN:

BRANDEND	X
STEKEND	0
SNIJDEND	0
KRAMPACHTIG	X
UITSTRALEND	0

OF ANDERS (BESCHRIJVEN): uitputtend

-4- WAS DE PIJN ALLEEN IN DE RUG GELOCALISEERD EN/OF WAS ER UITSTRALING NAAR:

- LINKER BEEN
- RECHTER BEEN
- ALLEBEI: eerst links, later ook rechter been.

-5- HEEFT U KOUDE BENEN EN/OF VOETEN GEKREGEN NA DE OPERATIE:

	ja
- LINKS	X
- RECHTS	0
- OF BEIDEN	0

TWEEDE GEDEELTE - NA DE RUGOPERATIE.

-6- HEEFT U LAST GEKREGEN VAN ZWEETVOETEN: JA X

NEEN 0

-7- WAS EEN VAN DE BENEN DUNNER OF DIKKER GEWORDEN:

NEEN 0

JA X, DUNNER X LINKS/RECHTS

DIKKER 0 LINKS/RECHTS

ZO JA, AANGEVEN WELKE VAN BEIDEN

-8- WELKE PIJNSTILLERS GEBRUIKTE U NA DE OPERATIES:

naprosyne 500 mg zetpillen

-9- GEBRUIKTE U SLAAPTABLETTEN:

JA REGELMATIG X

NEEN 0

AF EN TOE 0

-10- HAD U PIJN TIJDENS DE NACHT:

JA, REGELMATIG X

NEEN 0

AF EN TOE 0

-11- HEEFT U VERSCHIL GEMERKT IN UW SEXUELE LEVEN:

- MINDER BEHOEFTE AAN X
- LUKTE NIET (IMPOTENT) 0
- OF ANDERS 0

-12- HOE WAS UW WERKSITUATIE: GOED 0

SLECHT X

ONVERANDERD 0

-13- HOE WAS UW ALGEMENE LEVENSSITUATIE (FAMILIE/SOCIAAL):

GOED 0 MOEILIJK X

SLECHT 0 ONVERANDERD 0

DERDE GEDEELTE - NA DE BEHANDELING IN DE PIJNKLINIEK.

-1- WANNEER BENT U BIJ ONS IN DE PIJNKLINIEK OPERATIEF GEHOLPEN: eind januari en half maart 1985.

-2- WAS DE PIJN NA DE BEHANDELING:

- DIRECT WEG 0
- NA EEN PAAR WEKEN X

-3- KUNT U BETER SLAPEN: JA X
NEEN 0
ONVERANDERD 0

-4- MOEST U NA DE BEHANDELING NOG PIJNSTILLERS INNEMEN:

NEEN X
JA 0
AF EN TOE 0

-5- HAD U DIRECT NA DE OPERATIE EEN WARM OF KOUD BEEN EN/OF VOET:
WARM X
KOUD 0
GEEN VERANDERING 0

-6- IS DAT KOUDE OF WARME GEVOEL TOT NU TOE GEBLEVEN:

JA X
NEEN 0

-7- HEEFT U HET IDEE, DAT DOOR HET KOUDE OF WARME BEEN DE PIJN DUIDELIJK MINDER IS: JA X
NEEN 0
KAN IK NIET AANGEVEN 0

-8- BLIJFT HET BEEN EEN NORMALE ROSE KLEUR HOUDEN:

JA X
NEEN 0

-9- NA HOEVEEL TIJD BEGON U ZICH ZELF BETER TE VOELEN:
(AANGEVEN): na een paar dagen

DERDE GEDEELTE - NA DE BEHANDELING IN DE PIJNKLINIEK

-10- VOELT U ZICH NA DE BEHANDELING PSYCHISCH VERANDERD

ACHTERUIT GEGAAN 0

OPGEKNAPT X

ONVERANDERD 0

-11- HEEFT U FYSIOTHERAPIE GEHAD NA ONZE BEHANDELING:

JA X

NEEN 0

-12- BENT U ACTIEVER OF INACTIEVER GEWORDEN IN UW FAMILIE EN/OF SOCIALE LEVEN: ACTIEVER X

INACTIEVER 0

ONVERANDERD 0

-13- IS UW SEXUELE LEVEN VERANDERD: NEEN X

JA 0

-14- BENT U IN STAAT OM TE WERKEN, OF OM ANDER WERK TE AANVAARDEN: JA 0

NOG NIET, MISSCHIEN LATER X

NEEN 0

-15- DENKT U DAT UW KLACHTEN TERUG ZULLEN KOMEN:

WEET IK NIET X

JA 0

NEEN 0

-16- BENT U OPTIMISTISCH WAT BETREFT DE TOEKOMST:

JA X

NEEN 0

WEET IK NIET 0

-17- WELKE INGREEP (IN DE PIJNKLINIEK), HEEFT DE BESTE RESULTATEN OPGELEVERD:

die behandeling, waarbij opname noodzakelijk was X

poliklinisch 0

DERDE GEDEELTE - NA DE BEHANDELING IN DE PIJNKLINIEK.

-18- WAT ZOU U PATIENTEN MET LAGE RUGPIJN (NA HERNIA OPERATIE) ADVISEREN:

- NOG EEN KEER OPEREREN 0
- VEEL FYSIOTHERAPIE (REVALIDATIE CENTRUM) 0
- MEER PIJNSTILLERS EN SLAAPTABLETTEN 0
- PSYCHOLOGISCHE HULP 0
- T.E.N.S. 0
- PRIKJES IN DE RUG 0
- ALTERNATIEVE GENEESKUNDE 0
- ACUPUNCTUUR 0
- ZENUW DOORBRANDEN 0
- GECOMBINEERDE PIJNBESTRIJDING IN PIJNKLINIEK X

-19- HEEFT U NOG AAN OF OPMERKINGEN OVER DE BEHANDELING IN ONZE PIJNKLINIEK: (OMSCHRIJVEN)

De openhartigheid en de opvang, alsmede de physiotherapie, hebben zeer stimulerend gewerkt met betrekking tot mijn verwachtingen voor de toekomst.

-20- WILT U MISSCHIEN NOG IETS EXTRA'S SCHRIJVEN OVER UW LAGE RUGPIJN:

Na de behandeling is mij duidelijk geworden, dat de jarenlange rugpijn gedurende die periode een negatieve invloed heeft gehad op mijn leven.

Reinier de Graaf Gasthuis
Pijnkliniek Delft

ALGEMENE VRAGENLIJST

Leest U deze vragenlijst eerst eens rustig door en vult U dan die antwoorden in die voor U van toepassing zijn. Zet een kruisje in het juiste hokje. Mocht de ruimte voor het toelichten onvoldoende zijn, schrijft U op een bijgevoegd vel verder.

Naam en voornamen: .....

Geboortedatum: ..... Geboorteplaats: .....

Adres en postcode: ..... Woonplaats: .....

Telefoonnummer: ..... Verzekering en nummer: .....

Nationaliteit: ..... Religie: .....

Beroep: .....

Huisarts: ..... Adres en tel.nr.: .....

Leeft Uw:

Vader ☐ Ja ☐ Neen

Moeder ☐ Ja ☐ Neen

Zo ja, zijn ze gezond: Indien neen, toelichten

Vader ☐ Ja ☐ Neen .....

Moeder ☐ Ja ☐ Neen .....

Indien overleden, waaraan en op welke leeftijd:

Vader .....

Moeder .....

Heeft U: in leven overleden

Broers Aantal: ....

Zusters Aantal ....

Zijn ze gezond: Indien neen, toelichten

Broers ☐ Ja ☐ Neen .....

Zusters ☐ Ja ☐ Neen .....

Indien overleden, waaraan en op welke leeftijd:

Broers .....

Zusters .....

Bent U:

Gehuwd ☐ Ja ☐ Neen Zo ja: sinds wanneer?

Ongehuwd alleenstaand ☐ Neen ☐ Ja .....

Ongehuwd samenwonend ☐ Neen ☐ Ja .....

Gescheiden ☐ Neen ☐ Ja .....

Weduwe/weduwnaar ☐ Neen ☐ Ja .....

Hebt U:

Kinderen ☐ Ja ☐ Neen Aantal: .....

Kleinkinderen ☐ Ja ☐ Neen Aantal: .....

Relatie met familie: ☐ Goed ☐ Slecht

Gezinsrelatie normaal: ☐ Ja ☐ Neen Indien neen, toelichten: .....

.....

Opleiding:

☐ Geen	☐ Universitair	☐ Evt. andere opleiding
☐ L.O.	☐ Vak	.....
☐ M.O.	☐ Studerend	.....

Hobby's: .....

.....

Werkt U?	☐ Ja	☐ Neen	Indien neen, hoe brengt U Uw dag door? (Gebruik zonodig voor Uw antwoord een los bijgevoegd vel!).
			.....
			.....
Werkeloos	☐ Neen	☐ Ja	Indien ja, hoelang: .....
Z.W.	☐ Neen	☐ Ja	
W.A.O.	☐ Neen	☐ Ja	..... % afgekeurd
Gepensioneerd	☐ Neen	☐ Ja	
Voelt U zich in Uw werk:			Indien neen, toelichten
Tevreden	☐ Ja	☐ Neen	.....
Geslaagd	☐ Ja	☐ Neen	.....
Gewaardeerd	☐ Ja	☐ Neen	.....
Tevreden met algemene levenssituatie:			Indien neen, toelichten
Gezin	☐ Ja	☐ Neen	.....
Sexueel	☐ Ja	☐ Neen	.....
Werk	☐ Ja	☐ Neen	.....
Financieël	☐ Ja	☐ Neen	.....

Komen of kwamen er bij Uw grootouders, broers of zusters, een of meer van de volgende ziektes voor; Zo ja, bij wie?

☐ Rheuma	☐ Kanker
☐ Gewrichtspijnen	☐ Tuberculose
☐ Rugklachten	☐ Opname zenuwinrichting
☐ Ruggemergziekte	☐ Zenuwziekten
☐ Hersenaandoening	☐ Drankzucht
☐ Beroerte	☐ Zelfmoord
☐ Hart-en vaatziekten	☐ Ziekte die met pijn gepaard gaat

Bijzonderheden:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Voelt U zich afgezien van Uw pijnklachten gezond: ☐ Ja ☐ Neen

In staat tot lichamelijke inspanning ☐ Ja ☐ Neen

Doet U aan sport: ☐ Ja ☐ Neen

Hebt U lichaamsgebreken: ☐ Neen ☐ Ja

Gewicht:.....kg. ☐ Toegenomen ☐ afgenomen ☐ gelijk gebleven

Rookt U: ☐ Neen ☐ Ja Zo ja, hoeveel: .....

Gebruikt U alcohol: ☐ Neen ☐ Ja Zo ja, Hoeveel: .....

Gebruikt U medicijnen: ☐ Neen ☐ Ja Zo ja, Welke: .....

Overgevoelig voor medicijnen: ☐ Neen ☐ Ja Zo ja, Welke: .....

Bent U weleens verslaafd geweest aan medicijnen?: ☐ Neen ☐ Ja

Bent U in het verleden wel eens door een van de volgende specialisten onderzocht; Zo ja, in welk ziekenhuis, wanneer, waarom en door welke specialist:

	Welk ziekenhuis	Wanneer	Waarom	Naam specialist
Neuroloog				
Psychiater				
Neurochirurg				
Kaakchirurg				
Algemeen chirurg				
Orthopaed				
Rheumatoloog				
Internist				
Cardioloog				
Vrouwenarts				
Uroloog				
Keel-, neus- en oorarts				
Oogarts				
Huidarts				
Allergoloog				
Radioloog				
Röntgenoloog				

Bent U wel eens behandeld door een:

	Wanneer	Waarom
Fsiotherapeut		
Manueeltherapeut		
Acupuncturist		
Magnetiseur		
Kruidendokter		
Andere		

.....

.....

Heeft U wel eens een operatie ondergaan: ☐ Neen ☐ Ja Indien ja,

waar	wanneer.	waarom

Bent U wel eens in het ziekenhuis opgenomen geweest: ☐ Neen ☐ Ja Indien ja,

waar	wanneer	waarom

Heeft U wel eens een ernstig ongeval gehad: ☐ Neen ☐ Ja

Indien ja, wanneer en wat zijn de gevolgen geweest: .....

.....

.....

Heeft U wel eens last van:

duizeligheid	☐ Neen	☐ Ja	oedeem	☐ Neen	☐ Ja	maagpijn-branden	☐ Neen	☐ Ja
flauwtes	☐ Neen	☐ Ja	langdurig hoesten	☐ Neen	☐ Ja	geelzucht	☐ Neen	☐ Ja
bloedarmoede	☐ Neen	☐ Ja	benauwdheid	☐ Neen	☐ Ja	verstopping	☐ Neen	☐ Ja
toevallen	☐ Neen	☐ Ja	kortademigheid	☐ Neen	☐ Ja	urineren (pijnlijk)	☐ Neen	☐ Ja
eetlustgebrek	☐ Neen	☐ Ja	bloed opgeven	☐ Neen	☐ Ja			

Heeft U wel eens geleden aan:

rheuma	☐ Neen	☐ Ja	bronchitis	☐ Neen	☐ Ja	galstenen	☐ Neen	☐ Ja
hernia v.d. rug	☐ Neen	☐ Ja	asthma	☐ Neen	☐ Ja	blaasklachten	☐ Neen	☐ Ja
ischias	☐ Neen	☐ Ja	longontsteking	☐ Neen	☐ Ja	eczeem	☐ Neen	☐ Ja
zenuwziekte	☐ Neen	☐ Ja	tuberculose	☐ Neen	☐ Ja	huidziekten	☐ Neen	☐ Ja
overspannen	☐ Neen	☐ Ja	hartziekten	☐ Neen	☐ Ja	geslachtsziekten	☐ Neen	☐ Ja
tropische ziekten	☐ Neen	☐ Ja	maagklachten	☐ Neen	☐ Ja	suikerziekte	☐ Neen	☐ Ja
oorontsteking	☐ Neen	☐ Ja	darmklachten	☐ Neen	☐ Ja	vaatziekte	☐ Neen	☐ Ja
oogontsteking	☐ Neen	☐ Ja	nierziekten	☐ Neen	☐ Ja			
hooikoorts	☐ Neen	☐ Ja	nierstenen	☐ Neen	☐ Ja			

Indien ja, zonodig toelichten: .....

.....

.....

.....

Voor vrouwen:

Menstruatie normaal ☐ Ja ☐ Neen

Hoe lang duurt deze: .....

Datum laatste menstruatie: .....

Hebt U een verzakking ☐ Neen ☐ Ja

Ontsteking eierstok gehad ☐ Neen ☐ Ja

Vleesboom of gezwel gehad ☐ Neen ☐ Ja

Reinier de Graaf Gasthuis

Pijnkliniek Delft

VRAGENLIJST PIJNKLACHTEN

Naam en voornamen: .....

Geboortedatum: .....

Leest U deze vragenlijst eerst eens rustig door en vult U dan die antwoorden in die voor U van toepassing zijn. Zet een kruis in het hokje bij het juiste antwoord. Probeer de gevraagde antwoorden zo kort mogelijk te houden.

1. **Hoe en wanneer is de pijn begonnen en hoe is het verloop geweest? (Gebruik zonodig voor uw antwoord een los bijgevoegd vel!).**

.....

.....

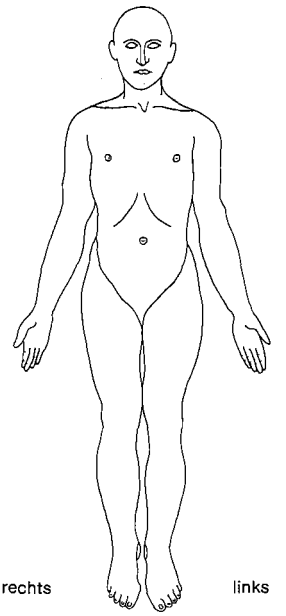
.....

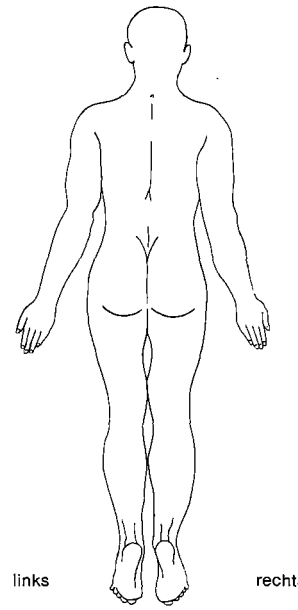
.....

2.

	Waar heeft U pijn		Waar begint de pijn		De pijn straalt uit naar	
	rechts	links	rechts	links	rechts	links
Hoofd						
Gezicht						
Nek						
Hals						
Schouder						
Bovenarm						
Elleboog						
Onderarm						
Hals						
Vingers.						
Borst						
Bovenbuik						
Onderbuik						
De zij						
Rug						
Kruis						
Stuitje						
Geslachtsorgaan						
Heup						
Bovenbeen						
Knie						
Onderbeen						
Voet						
Tenen						
.....						
.....						

3. **Geef op deze tekening de plaats van de pijn aan.**





4. **Welke omschrijvingen passen het best bij Uw pijn.** (Kruisje in het betreffende vak plaatsen).

	Toen Uw pijnklachten begonnen	Thans		Toen Uw pijnklachten begonnen	Thans
Trekkend			Overweldigend		
Brandend			Samenpersend		
Ontmoedigend			Vernietigend		
Zwellend			Koud		
Stekend			Prikkelend		
Kloppend			Gelijkmatig		
Drukkend			Verdoofd		
Gloeiend			In aanvallen		
Kriebelend			Mild		
Verschrikkelijk			Knagend		
Koliekachtig			Afschuwelijk		
Uitputtend			Scherp		
Met scheuten			Snoerend		
Borend			Op één plaats		
Dof			Uitstralend		
Snijdend			Vermoeiend		
Verscheurend			.....		
Krampachtig			.....		

5. **Hebben de pijnen zich in de loop van de tijd uitgebreid naar:**

	rechts	links		rechts	links
Hoofd			Onderbuik		
Gezicht			De zij		
Nek			Rug		
Hals			Kruis		
Schouder			Stuitje		
Bovenarm			Geslachtsorgaan		
Elleboog			Heup		
Onderarm			Bovenbeen		
Hand			Knie		
Vingers			Onderbeen		
Borst			Voet		
Bovenbuik			Tenen		

6. **Waar voelt U de pijnklachten?**

☐ Diep ☐ Oppervlakkig ☐ Buiten het lichaam

7. **Hoe ervaart U de pijn?**

☐ Licht ☐ Zeer onaangenaam ☐ Ondraaglijk
☐ Irritant ☐ Bijna onhoudbaar

8. **Sinds wanneer heeft U pijn?**

☐ 1 week tot 1 maand ☐ 6 maanden tot 1 jaar ☐ 5 jaar tot 10 jaar
☐ 1 maand tot 3 maanden ☐ 1 jaar tot 2 jaar ☐ meer dan 10 jaar
☐ 3 maanden tot 6 maanden ☐ 2 jaar tot 5 jaar

9. **Zijn de pijnklachten in de loop der tijd toegenomen?**

☐ Neen ☐ Laatste maand ☐ Laatste jaar
☐ Ja, geleidelijk ☐ Laatste half jaar

10. **Hoe vaak heeft U last van de pijn?**

☐ Voortdurend ☐ 1 maal in de week ☐ meer dan 1 maal in de maand
☐ 1 maal per dag ☐ meer dan 1 maal in de week
☐ meer dan 1 maal per dag ☐ 1 maal in de maand

11. **Hoelang duren de pijnen?**

☐ Voortdurend ☐ Minuten ☐ Dagen
☐ Seconden ☐ Uren ☐ Weken

12. **Op welk moment van de dag is de pijn het sterkst?**

☐ Steeds gelijk ☐ 's Middags ☐ 's Nachts
☐ 's Morgens ☐ 's Avonds

13. **Verergeren de pijnen door:**

- ☐ Het weer
- ☐ Opwinding
- ☐ Inspanning
- ☐ Boosheid
- ☐ Blijdschap
- ☐ Alcohol
- ☐ Roken
- ☐ Medicijnen
- ☐ Honger
- ☐ Eten
- ☐ Kauwen
- ☐ Menstruatie
- ☐ Overgangsjaren
- ☐ Andere

14. **Hebben familieleden of bekenden dezelfde of bijna dezelfde pijnklachten?**

Zo ja, bij wie? .....

.....

15. **Kunt U de pijn op de een of andere manier minder maken?**

- ☐ Neen
- ☐ Door warmte
- ☐ Door koude
- ☐ Door druk
- ☐ Door beweging
- ☐ Door stilhouden
- ☐ Door bepaalde houding aan te nemen Welke houding: .....
- ☐ Andere

16. **Welke medicijnen neemt U voor de pijn; hoe vaak per dag; welke sterkte?**

(Zo nauwkeurig mogelijk omschrijven). .....

.....

.....

.....

Welke medicijn helpt het best? .....

17. **Slaapt U goed?**

- ☐ Ja
- ☐ Nee, ik kan niet inslapen
- ☐ Nee, ik kan niet doorslapen
- ☐ Nee, ik word steeds door de pijn wakker
- ☐ Nee, ik kan door de pijn niet inslapen

Hoeveel uur slaapt U per nacht: .....

18. **Wat is naar Uw mening de oorzaak van Uw pijnklachten?**

.....

.....

.....

19. **Denkt U dat Uw pijnklachten lichamelijk of geestelijk van oorsprong zijn of zowel lichamelijk als geestelijk?**

	niet	een beetje	gedeeltelijk	voornamelijk	helemaal
lichamelijk					
geestelijk					

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1963 - 1969
University of Warsaw, Medical Academy
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1969-1972
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Previous appointments:

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1973 - 1977
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Jan 1978 - Aug 1979
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PUBLICATIONS

1. Pernak J, v.d. Berg H.
   Treatment of chronic low-back pain following lumbar disc operation by using thermolesion of sympathetic ganglion. In: Erdmann W, Pernak J, Oyama T, eds. Proceedings: The Pain Clinic I. VNU Science Press 1985; 177-186.

2. Pernak J, Biemans JCH.
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   The use of thiopentone in the treatment of chronic pain. In: Sehhati-Chafai G.H. ed. Dr. Dieter Winkler (Verlag) 1986.

5. Bryant JD, Pernak J.
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   Laser therapy in chronic pain syndrome. In: Postuma HS, Lankhorst G, v.d. Heuvel HGA, eds. Proceedings: Symposium Mid Laser in de Sportsgeneeskunde en Revalidatie, Arnhem, The Netherlands: 1986.

Editorial Experience:

1. Editor: The Pain Clinic I, VNU Science Press, Zeist, The Netherlands, 1985.
2. Guest Editor: Applied Neurophysiology, S. Karger, Basel, Switzerland 1985.
3. Member of the Editorial Board of the Pain Clinic journal, VNU Science Press, Zeist, The Netherlands.

Published abstracts:

1. Circulatory reactions on the different induction agents for aortic surgery. 3rd World Congress of Anaesthesiology, Paris, September 1978.
2. Zniany Krozeniowe wywolane uzyciem roznych srodkow indukcyjnych w czasie Aneurysma aorta operacji. 3rd International Congress of Anaesthesiology, Wroclaw, Poland 1979.

3. An acute herpes zoster of nervus trigeminus and its treatment. The First International Symposium on Advances in Pain Research and Therapy, Lackenhof-Mauer, Austria 1984.

4. Treatment of acute herpes zoster.
Mini-Symposium, Dordrecht, The Netherlands, September 1985.

5. The use of penthothal sodium in chronic pain treatment. Academic Meeting of Anesthesiologists, Rotterdam, The Netherlands 1985.

6. Low-back pain after HNP operation and its treatment. 2nd International Symposium on Advances in Pain Research and Therapy, Lackenhof-Mauer, Austria, 1986.

7. Thermal sympathectomy for treatment of low-back pain. 2nd International Symposium "The Pain Clinic". Lille France, June 1986.

8. Thiopenthone in the treatment of conversion-like pain. 2nd International Symposium "The Pain Clinic". Lille, France, June 1986.

9. Percutane Lumbale Sympathektomie.
Radiofrequenzlasion Schmerz Therapie Gesprach Neurologie NO LKH Mauer-Austria, April 1987.

10. Laser therapy in chronic pain syndromes.
Internationale Interdisciplinares Schmerzsymposion, Schmerz und Sport, Ludenscheid, BRD, May 1987.

Guest Lectures:

1. "The treatment of trigeminal neuralgia".
Zweite Deutsche Schmerz Klinik, Stuttgart, September 1984.

2. "The Pain Clinic in Delft: Structure and Organisation". Zweite Deutsche Schmerz Klinik, Stuttgart, September 1984.

3. "The practical points of the Pain Clinic, role of the anesthesiologist in the Pain Clinic". Clinique de Genolier, Switzerland 1985.

4. "Treatment of acute herpes zoster".
Anaesthesiologie Symposium, Dordrecht, The Netherlands, October 1985.

5. "Percutaneous radio-frequency sympathectomy for lower back pain". Special Lecture. Dept. of Anesthesiology, University of Texas, San Antonio, USA May, 1986.

6. "Direct intraneural spinal nerve stimulation in patients with motor dysfunctions". Clinical Lecture; San Antonio, USA May, 1986.

7. "The organisation of the Pain-Clinic". Clinique Genolier, Switzerland, December 1986.

8. "Thermal Sympathectomy". Workshop: 2nd International Symposium "The Pain Clinic", Lille France, June 1986.

9 . "Pijnbestrijding bij gordelroos". Symposium : Acute Herpes Zoster, Rotterdam, The Netherlands, March 1987.

10. "Sympathektomie and Facetdenervation". Praktische Demonstration von RF. Schmerz Therapie Gesprach NO LKH Mauer-Austria, April 1987.

11. Delftse pijnbestrijding bij Brachialgie Symposium. "Neurologische oorzaken van therapie-resistente Brachialgie", Ede, The Netherlands, June 1987.

12. "Moderne Pijnbestrijding". 4e Congres LVO, Eindhoven, The Netherlands, October 1987.

13. "Organisation of Pain Clinic in Delft" Melbourne, May 1988.

14. "Percutaneous radiofrequency thermal sympathectomy in the treatment of different pain syndromes." Melbourne, May 1988.

Other activities:

1. Organisor of three International Pain Symposia in Delft, The Netherlands (1982, 1983, 1984).

2. Chairman of the 1st International Pain Symposium Delft, The Netherlands, March 1982.

3. Chairman of 2nd session of International Pain Symposium 1983.

4. Congress Chairman of 1st International Symposium "The Pain Clinic" Delft, 1984.

5. Chairman of 4th session "Practical points of a Pain Clinic". 1st International Symposium "The Pain Clinic" Delft, 1984.

6. Member of the Scientific Committee of the 2nd International Symposium "The Pain Clinic" Lille, France, June 1986.

7. Chairman of the Work-shop: Peripheral Thermoneurolysis" 2nd International Symposium "The Pain Clinic" Lille, France, June 1986.

8. Chairman of the Session: Algodystrophies, plexular blocks and Sympathectomies". 2nd International Symposium "The Pain Clinic" Lille, France, June 1986.

9. Member of the Scientific Committee of the 2nd International Symposium on Advances in Pain Research and Therapy, Mauer-Lackenhof, Austria, March 1986.

10. Chairman of the 2nd session "Spinal Medication", 2nd International Symposium on Advances in Pain Research and Therapy, Mauer-Lackenhof, Austria, March 1986.

11. Organisation and Chairman of International Symposium "New approach in Clinical Electrostimulation" Rotterdam, The Netherlands, 1986.

12. Chairman 1st session "Sympathectomie and Facetdernervation". Schmerz Therapie Gesprach, Neurologie NO LKH Mauer, Austria, April 1987.

13. Member of the Scientific Committee of the 3rd International Symposium "The Pain Clinic" Florence, Italy, September 10-14, 1988.

14. Presentation "Percutaneous radiofrequency thermal sympathectomy in the treatment of different pain syndromes." Canberra, May 1988.

15. Presentation - Percutaneous facet denervation in the cervical, thoracic and lumbar regions. (Review of ca 2000 cases). J.D. Bryant, J. Pernak, W. Erdmmann.

16. Presentation - Treatment of acute herpes zoster using corticosteriods through epidural and gasserian ganglion blockade. W. Erdmmann, J. Pernak, J.D. Bryant.

The last three papers had been presented on 10th Annual Scientific meeting of the Australian Pain Society, Canberra, May 1988.

Memberships

1. Member of Dutch Chapter of International Association for the study of pain (Nederlandse Vereniging ter bestudering van pijn).

2. Member of International Association for the Study of pain (IASP).

3. Member of Dutch Association of Anaesthesiologie (Nederlandse Vereniging voor Anaesthesiologie).

4. Member of Europaischen Gesellschaft zur Erforschung und Behandlung von Chronischen Schmerzen.