

Peripheral nerve stimulation to treat chronic painful syndromes*

Estimulação de nervos periféricos no tratamento das síndromes dolorosas crônicas

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ABSTRACT

BACKGROUND AND OBJECTIVES: Peripheral nerve stimulation to treat chronic pain is a neurosurgical armamentarium used for a long time, being indicated to treat neuropathic painful syndromes together with other types of nerve stimulation: dorsal column electric stimulation and deep cerebral stimulation. This study aimed at analyzing the relevance of peripheral nerve stimulation to treat chronic painful syndromes.

CONTENTS: Primary indication is severe chronic neuropathic pain refractory to conservative treatment. However, the affected area needs to have a defined anatomic distribution and related to the peripheral nerve to be stimulated. One should also notice signs of objective involvement of the nerve. A nerve stimulation test shall be performed from 7 to 10 days prior to the final implant and pain must improve at least 50% according to specific evaluation scales. There are two methods to implant electrodes in peripheral nerves: direct surgical approach and percutaneous technique. After the test, the implant with permanent generator is performed.

CONCLUSION: Peripheral nerve stimulation to treat chronic painful syndromes has shown promising results. The development of new materials is extremely necessary for the technical evolution and treatment of chronic painful syndromes. In this sense, new prostheses are being developed and one feature of a more feasible implant to be used in the peripheral nervous system would be a low profile prosthesis with already implanted and rechargeable battery.

Keywords: Chronic neuropathic pain, Chronic painful syndrome, Pain evaluation scales, Peripheral nerve stimulation.

RESUMO

JUSTIFICATIVA E OBJETIVOS: O uso da estimulação elétrica de nervos periféricos para o tratamento da dor crônica constitui um armamentário neurocirúrgico utilizado há bastante tempo, sendo uma modalidade indicada no tratamento das síndromes dolorosas de caráter neuropático, juntamente com outras formas de neuroestimulação: estimulação elétrica da coluna dorsal e a estimulação cerebral profunda. O objetivo deste estudo foi analisar a relevância da estimulação nervosa periférica no tratamento das síndromes dolorosas crônicas.

CONTEÚDO: A principal indicação é a dor neuropática crônica, intensa, refratária ao tratamento conservador. Apresenta, contudo, necessidade de a área acometida ter uma distribuição anatômica definida e relacionada ao nervo periférico no qual se deseja realizar a estimulação. Deve-se perceber também sinais de comprometimento objetivo do nervo. É necessária a realização de teste de neuroestimulação entre 7 e 10 dias previamente ao implante definitivo e deve-se obter melhora de pelo menos 50% da dor em escalas de avaliação específicas. Existem duas formas de implante de eletrodo em nervos periféricos: abordagem cirúrgica direta e técnica percutânea. Após o teste ser completado, é realizado o implante do sistema de gerador permanente.

CONCLUSÃO: O uso da estimulação de nervos periféricos no tratamento das síndromes dolorosas crônicas tem mostrado resultados promissores. O desenvolvimento de novos materiais é extremamente necessário para a evolução da técnica e o tratamento dessas síndromes dolorosas crônicas. Nesse sentido, novas próteses estão sendo desenvolvidas e uma das características de implante mais viável para uso no sistema nervoso periférico seria uma prótese de baixo perfil, com bateria já implantada com os eletrodos e recarregável.

Descritores: Dor neuropática crônica, Escalas de avaliação da dor, Estimulação nervosa periférica, Síndrome dolorosa crônica.

INTRODUCTION

Peripheral nerve stimulation to treat chronic pain is a neurosurgical armamentarium used for a long time, being indicated for neuropathic pain syndromes together with other nerve stimulation methods: dorsal column electric stimulation (CES) and deep brain stimulation (DBS). Historically, peripheral nervous system (PNS) electric stimulation to treat pain dates from an-

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tiquity¹, but it was with the publication of the Gate Theory by Melzack & Wall in 1965 that appeared a new idea about peripheral circuits function and that several experiments with electric stimulation have become feasible to treat chronic pain syndromes.

Although several aspects of the gate theory pathophysiology have succumbed, this theory provided the scientific basis for peripheral nerve stimulation to treat chronic pain: the stimulation of large fibers activated with lower threshold as compared to small fibers, at enough intensity to produce paresthesia, should also relieve pain².

The first experiments with peripheral nerve stimulation were published in 1967^{3,4} when infraorbital foramen was stimulated in eight patients who presented significant pain improvement while the stimulation was working. Authors have also suggested in this study the idea of an implantable stimulator. At the same time, a study was started about dorsal column nerve stimulation with early results leading to the development of implantable systems, being the first battery-powered system developed by Cordis in 1976 (cited for Rossi)⁵.

In following years, several studies were carried out using peripheral nerve stimulation⁶⁻²¹. Unfortunately, early results of such studies were not very promising: in 1976 a global improvement rate of 26% was reported. In 1982, the reported success rate was 53%¹⁴.

Due to described results, to reports of peripheral nerve injury by the placement of the electrode and the broader dissemination of dorsal column stimulation to treat chronic pain syndromes, peripheral nerve stimulation has become less attractive. This was also reflected in the development of specific devices for peripheral nerve stimulation, which were very restricted, with just one device approved by the Food and Drug Administration (FDA).

Peripheral nerve stimulation to treat chronic pain reappeared with a study describing a technique of percutaneous implant of electrodes in the occipital nerve to treat occipital neuralgia. Several studies have followed using stimulation both for occipital nerves and the combined use in supraorbital branches to treat chronic migraine headache and other autonomic headaches²³⁻²⁹. From then on, reports on the use of implants in trigeminal nerves³⁰, their use to control post hernia repair chronic pain (inguinal nerve), and the use of paraspinal electrodes to treat post-herpetic neuralgia, sacroiliitis and coccydynia have returned to PNS stimulation to treat chronic neuropathic pain syndromes³¹⁻³⁴.

INDICATIONS

They follow the same patterns of spinal neuromodulation having as major indication chronic severe neuropathic pain affecting patients' functionality and refractory to conservative treatment (drugs, physiotherapy, local anesthetic and sympathetic blocks, transcutaneous electric stimulation, botulinum toxin, etc.)¹⁹⁻²¹. However, the affected area has to be a well defined anatomical area and related to the peripheral nerve where stimulation is to be performed. One should also notice signs of

objective peripheral nerve involvement (hypoesthesia, hyperpathia, hyperesthesia, allodynia, etc.)¹⁹⁻²¹.

Confirmation of the respective "target" nerve involvement through local anesthetic block is a stage often recommended by the literature²¹; however, there are no evidences that such parameter is a factor for better prognosis.

Nerve stimulation test before the definitive implant through externalization of electrodes is mandatory. It is performed in a specific period (between 7 and 10 days) and there shall be pain improvement of at least 50% according to specific pain evaluation scales¹⁹⁻²¹.

Specific indications

- A- Post-herpetic neuralgia;
- B- Post-traumatic neuropathic pain;
- C- Postoperative neuropathic pain;
- D- Facial neuropathic pain;
- E- Clinically untreatable occipital neuralgia or occipital cervicogenic pain;
- F- Transformed migraines with continuous occipital and hemi-cranial pain;
- G- Complex regional pain syndrome;
- H- Cluster headache.

CONTRAINDICATIONS

They encompass: use of anticoagulants or patients with coagulation disorders, patients with active infection on probable surgical area, patients with major cognitive problems, untreatable depression or with neuropsychological evaluation indicating major personality disorder¹⁹.

Another contraindication is patient needing routine follow up with MRI due to the limitations of these exams with such materials²¹.

SURGICAL TECHNIQUE

General aspects

Electrode implant follows well-defined recommendations. There are basically two types of peripheral nerve implants: direct surgical approach, involving direct nerve exposure and placement of "plaque" electrodes on the nerve to one side or on both sides ("Sandwich" technique). Optionally, the electrode may be placed by the percutaneous technique through a needle inserted perpendicularly to the nerve pathway.

Types of electrodes are:

- For the percutaneous technique, cylindrical electrodes with 4 or 8 poles are used: Pisces-Quad Compact, Pisces-Quad, Octad, Quad plus or Quad Compact from Medtronic or Quatrode, Octrode from ANS/St. Jude.
- For the open surgical technique plaque electrodes with 4, 8 or 16 poles are used: Resume, Resume II, On-Point PNS, Resume TL, Specify, Specify 2x8 from Medtronic or the models Lamitrode S4, Lamitrode 44C, Lamitrode S8, Lamitrode 88C from ANS/St. Jude.

For both techniques, it is critical to adequately anchor the

electrode to prevent migrations and shifts. Depending on the technique, this may be done in the entry area of the electrode (for example, by the percutaneous occipital nerve stimulation technique) or through direct fixation of the electrode in subcutaneous and fascia/periosteum planes in open incisions.

The implant protocol requires pain control efficacy test. So, after the implant, the electrode has to be tunneled and connected to an external test extensor associated to an external generator. It is important to assure, before pain evaluation, that the painful area is covered with the sensation of paresthesias/numbness. Painful area coverage may be tested in the intraoperative or immediate postoperative period. During the test period, patients are usually covered with antimicrobials (although their use does not demonstrably decrease the chance of infection).

After test completion (mean of 7 to 10 days), the permanent generator system is implanted in the operating center, under general anesthesia, because the insertion of subcutaneous tunnelers is painful. Most frequent implant sites are gluteus region, abdominal wall or infraclavicular region. Regardless of the chosen site, final generator implant site shall be deep enough to avoid bedsores and shall be located in reduced mobility regions (Figures 1 and 2).

Specific aspects of percutaneous implants

Occipital, supraorbital and infraorbital nerve implant:

Electrodes are almost routinely inserted under radioscopy. There are parameters for implants placement: infraorbital foramen and orbit base for the infraorbital nerve, limit and supra-orbital foramen for the supraorbital nerve, C1 arch and mid-line for occipital nerve.

Electrodes may be placed from medial to lateral or vice-versa, depending on surgeon's experience. Electrodes with 4, 8 or 16 contacts may be used, crossing below the epifascial plane but above the muscles. Electrode placement pattern should cross the sense of the nerve for it to be stimulated by at least two electrode contacts.

Trigeminal nerve implant

The electrode is inserted by Hartel's technique³⁵, crossing the oval foramen, under radioscopy. It is then tunneled and fixed

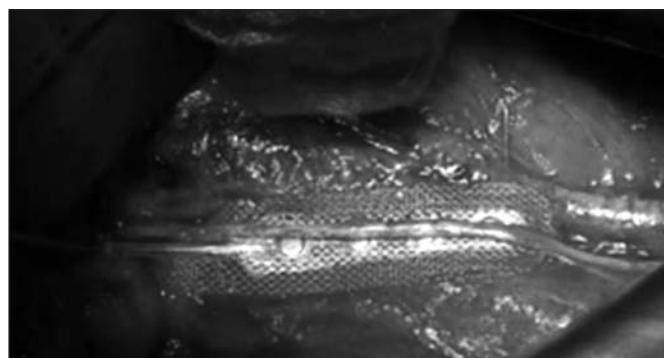


Figure 1. Example of plaque electrode model On-Point PNS (Medtronic) placement

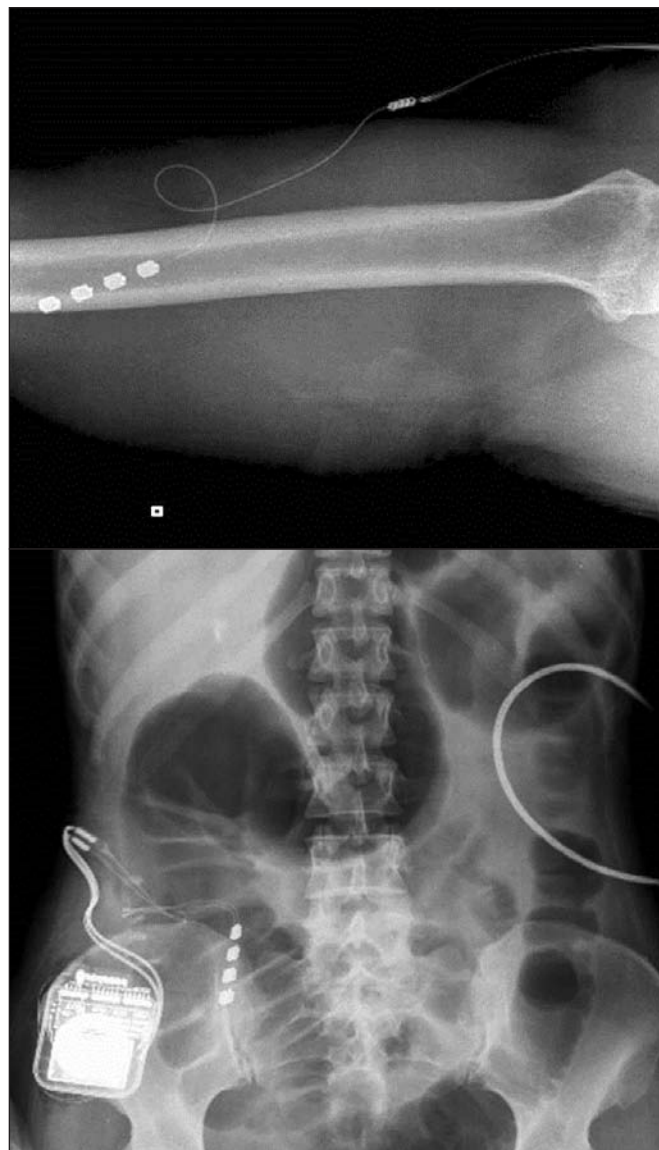


Figure 2. Electrode in radial nerve and femoral nerve

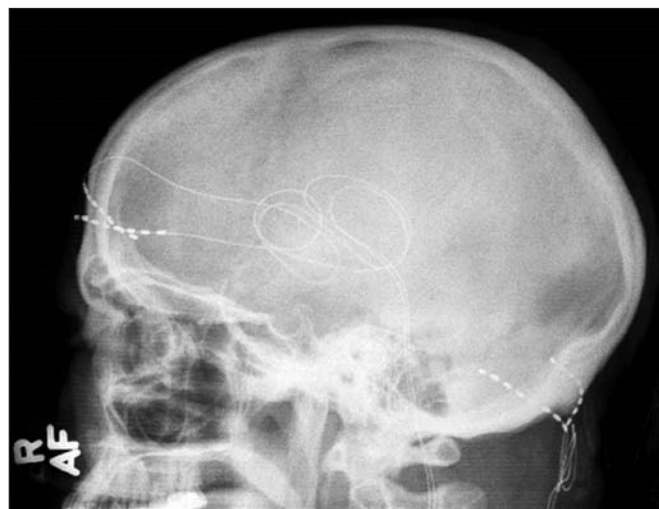


Figure 3. Supraorbital and occipital nerves stimulation

by its entry hole to the skin, being taken subcutaneously to the masseter and subauricular region.

RESULTS

With regard to neuropathic pain syndromes (regional complex pain syndrome, traumatic or postoperative neuropathy), most studies show 50% improvement in pain scales for an average of 60-70% of patients submitted to the procedure with follow-up of more than 3 years^{36,37}.

For percutaneous stimulation for facial pain syndromes, results are similar to those described above, especially for occipital neuralgia, with 50% improvement in pain scales for an average of 65% of patients with follow-up from 1 month to 3 years³⁰.

There are several new indications for peripheral nerves stimulation: cluster headache, migraine, daily chronic headache and fibromyalgia³⁸. Preliminary results were:

Migraine

A case series involving occipital nerve stimulation was reported in 2003²³. Eighty-eight percent of patients had 50% decrease in pain scales and incidence of headache.

A retrospective case series described in 2007²⁴ has shown 8 patients treated with occipital nerve stimulation in 3 years follow-up. There has been more than 50% improvement in pain scales for half the patients.

The first study including a control group in the ONSTIM²⁵. The occipital stimulation group had improvement in 39% of patients in a 3-month follow-up. Other prospective, randomized and controlled occipital nerve stimulation studies have been produced, however still without published results.

Hemicrania continua

A case series with six patients submitted to occipital nerve stimulation has been described. Four out of six patients had more than 50% improvement in pain scales²⁶.

Cluster headache

Two prospective studies with 8 patients each were published. In the first²⁷, stimulation was unilateral and 5 out of 8 patients had more than 50% decrease in the frequency of crises. In the second group, stimulation was bilateral and only three patients had this level of improvement.

A case series with four patients was described using bilateral occipital stimulation to treat cluster headache²⁸. These patients were followed-up for six months and two had more than 50% improvement in severity and number of headache crises.

Combined supraorbital and occipital nerves stimulation

Migraine

A case series with seven patients was described in the literature²⁹. Six out of seven patients have reported 90 to 100% decrease in pain scales and five had no need for drugs in a follow-up of up to 35 months.

CONCLUSION

Peripheral nerves stimulation to treat chronic pain syndromes has shown promising results. The development of new materials, better adapted to peripheral nerve stimulation, with low profile, is extremely needed for the development of the technique and the management of these chronic pain syndromes. In addition, new prostheses are being developed and one feature of a more feasible implant to be used in the PNS would be a low profile prosthesis with rechargeable battery already implanted with the electrodes.

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