CASE REPORT

Peripheral electrical nerve stimulation in chronic post-surgical pain: Let's try!

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ABSTRACT

Chronic post-surgical pain (CPSP) is a common complication after surgery, which has significant effects on quality of life with restriction of activities of daily living, and it is associated with increased analgesic use. The incidence of CPSP has wide variations among different surgical procedures and this can be due to difference in definition of CPSP and small sample size studies. The mechanisms of CPSP are complex, poorly understood, and many patients show neuropathic pain features. CPSP is often refractory to medical and interventional management and it may have profound consequences for the quality of life of the patient. Percutaneous electrical nerve stimulation (PENS) can be an effective treatment for management of neuropathic pain and may be a viable treatment option that should be considered when other treatments fail. The aim of these case reports is to encourage the use of PENS in the management of CPSP and to motivate further studies on the use of PENS in this field. We present a case report of two patients with CPSP and features of neuropathic pain, refractory to other pharmacological treatments and successfully treated with one-day trial of PENS.

The aim of this article is to underline the possible role of Peripheral Electrical Nerve Stimulation (PENS) in the management of Chronic Post-Surgical Pain and to encourage further studies on the use of PENS in this field.

Key words: PENS; Neuropathic Pain; Chronic Post-Surgical Pain

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INTRODUCTION

Chronic post-surgical pain (CPSP) is a common complication after surgery and it can be defined, as proposed by Macrae and Davies, as pain developing after a surgical procedure, of at least 2 months duration, with exclusion of other causes of pain (e.g. malignancy, infection) and excluding a pre-existing pain. CPSP has significant effects on quality of life with restriction of activities of daily living and it is associated with increased analgesic use. The incidence of CPSP has great variability and this can be due to difference in definition of CPSP and small sample size studies. The incidence of chronic pain after thoracotomy, for example, ranged from 5 to 65% of cases and in more than 50% of patients undergoing surgery is associated with nerves and tissue damage.[1]

The mechanisms of CPSP are complex and poorly understood. Most of patients show neuropathic pain features. One of the postulated mechanism is nerves injury during surgery, for example intercostal nerves injuries are an important cause of chronic pain after thoracotomy. Nerve injuries result in release of neurotransmitters going to act both locally and on the spinal cord contributing to central sensitization that occurs when repetitive nociceptive stimuli are applied and that can leads to altered dorsal horn activity and sensory flow's amplification. These changes cause symptoms as allodynia and hyperalgesia which are associated with neuropathic pain.[1] However, nerve injuries are not the only cause of CPSP as demonstrated by the fact that even without nerves' sectioning the CPSP may also be present and that the section of

the nerves do not always hesitate in the occurrence of chronic pain.[2]

Risk factors for CPSP include pre-, intra- and post-operative risk factors. Age is inversely related to the development of CPSP. Other risk factors are long duration of surgery, type of surgery (laparoscopic versus open surgery), radiotherapy and chemotherapy.[2] A high intensity of pain in the postoperative period is able to predicts the development of CPSP and this seems to confirm the hypothesis of central sensitization.[1] There are conflicting evidences on the benefit of the use of regional anesthesia, ketamine, gabapentin and pre-emptive analgesia.[3,4] Furthermore, CPSP is often refractory to medical and interventional management. Percutaneous electrical nerve stimulation (PENS) can be an effective treatment for management of neuropathic pain. Through a needle, placed in the subcutaneous layer, a low voltage electrical current is released close the nervous termination. Usually this therapy is used to treat chronic nerve pain including area of chronic post-surgical pain. Other fields of application are management of headache[5] and of diabetic neuropathic pain.[6] CPSP so represents a challenge for the physician, and a condition capable to alter the patient's quality of life. PENS may be an alternative treatment that must be taken in case of failure of other treatments.

We present case reports of two patients who presented with CPSP with features of neuropathic pain. Both patients experienced persistent pain refractory to other pharmacological treatments.

CASE REPORT 1

A 40-years-old man presented to our hospital complaining of chest wall pain after a thoracotomy performed in April 2015 to correct a diaphragmatic relaxation with the application of a diaphragmatic prosthesis. Postoperative analgesia was performed with acetaminophen, morphine infusions provided by an elastomeric pump and boluses of local anesthetic provided through a paravertebral catheter placed intra-operatively by the surgeon. The patient complained of persistent chest wall pain in T6 - T8 dermatomes characterized by pain in the region of surgical scar with sensation of electric shock, tingling, numbness and hypoesthesia. He was started pharmacological therapy with pregabalin (225 mg/day), duloxetine, oxycodone-naloxone combination and acetaminophen as needed without benefit. We administered Douleur Neuropathique 4 questionnaire (DN4) to establish the neuropathic origin of pain. The DN4 score was 4/10 before and after pharmacological therapy, thus indicating a neuropathic origin of pain that was not modified with conventional drugs. Given the ineffectiveness of pharmacological treatment the patient underwent a 1-day PENS trial. This treatment was performed by subcutaneous insertion in the painful area of a 20 cm long needle (21 Gauge), with position confirmed by ultrasound. We used the following programmed parameters: Frequency of 2-100 Hz, stimulus amplitude 3 V, 25 min duration with pulse amplitude 0,2-2 msec.

Before treatment our patient registered a Numeric Rating Scale (NRS) of 8/10. Immediately after the procedure his NRS was 3/10; so he referred a pain reduction of over 50%. The DN4 questionnaire administered immediately after the procedure was 0/10 indicating the complete resolution of the neuropathic component of his pain. We evaluated the patient four weeks after the PENS trial and he still reported a NRS of 4/10 with a DN4 score of 2/10 indicating a lasting effect of the procedure and the improvement of the neuropathic component of pain.

CASE REPORT 2

In January 2015 a 55-years-old man presented to our hospital reporting pain in right hypochondrium, which appeared after partial epatectomy performed in June 2014 for hepatic cancer secondary to idiopathic cirrhosis. Postoperative analgesia included acetaminophen, ketorolac and morphine infusion with an elastomeric pump. This patient complainted pain in his right hypochondrium along the surgical scar and in T7 - T9 dermatomes. He reported sensation of electric current, tingling, numbness, pins and needles and hypoesthesia to touch and to pin prick. Pain increased by brushing. At the DN4 questionnaire he reported 7/10 score indicating a neuropathic component of pain. He started pharmacological therapy with pregabalin (225 mg/day) and oxycodone-naloxone without benefit. In January 2016 he applied lidocaine 5% medicated plasters with poor results. In May 2016 his NRS was 8/10. Given the ineffectiveness of pharmacological treatment, after evaluation by a pain psychologist, he underwent a 1-day PENS trial. Immediately after the procedure he referred an NRS score of 0/10 indicating a total resolution of the painful sensation. The DN4 questionnaire score, administered immediately after the PENS trial, was 2/10 (he referred only tingling and hypoesthesia to touch) indicating an impressive

improvement of neuropathic pain component. We evaluated the patient four weeks after the procedure and he reported a NRS score of 2/10. The DN4 questionnaire score was 1/10 (he referred only the presence of hypoesthesia to touch) indicating a lasting effect of PENS trial and almost total resolution of the neuropathic component of pain which in this patient was the predominant component before the medical treatment.

DISCUSSION

In literature there are few case reports which describe the use of peripheral nerve stimulation (PENS) as a treatment for chronic pain[12] and well-localized chronic pain syndromes involving the low-back, abdomen, pelvis and thorax.[7,8]

The concept of stimulation analgesia was born in 1965 following the publication of Gate-Control Theory of Melzack and Wall.[9] The exact mechanism of action of PENS is unknown but probably the Gate-Control Theory is involved. A clinical application of the Gate-Control Theory was realized by Wall and Sweet who demonstrated later that pain can be alleviated by the stimulation of peripheral large sensory nerves.[10] The stimulation of A-beta fibers in the subcutaneous layer with consequent inhibition of A-delta and C-fibers can alleviate pain. The extracellular fluid in the subcutaneous layer works as an electrical conduit allowing the depolarization of A-beta fibers. In a totally similar to TENS (Transcutaneous Electrical Nerve Stimulation), the electrical current delivered by PENS may induce local endorphins' release, alter the local blood flow in the subcutaneous region and the neurotransmitters' release, inhibiting membrane depolarization and so preventing the release of nociceptors. In some animal studies it has been shown that PENS may alleviate pain through the changes induced on the central pain processing system.[11] The use of PENS for treatment of post-thoracotomy pain has been described in a previous study.[12] In this study Al Tamimi at al. demonstrated a reduction of pain > 50% with a reduced need for pain medications.[12]

The correct placement of leads (depth and position in the subcutaneous layer) is fundamental, in fact, the subcutaneous region has the highest density of terminal sensory A- beta fibers. The positioning of leads below the subcutaneous layer, e.g. in the muscular or adipose tissue does not allow the stimulation of terminal sensory fibers.

Our patients demonstrated the beneficial effect of PENS on CPSP. This beneficial effect is immediately perceived by our patients with a reduction of > 50% of NRS scores in first patient and a total resolution of pain in the second patient. The beneficial effects of PENS on neuropathic component of pain is demonstrated by the reduction of DN4 questionnaire scores (from 4/10 to 0/10 for the first patient and from 7/10 to 2/10 in the second patient). The use of pharmacologic therapy instead may be ineffective as in our patients and can produce adverse side effects and interfere with activity of daily living and sleep-wake cycles.[14] For this reason the interest in non-pharmacologic therapies (TENS, PENS, and acupuncture etc.) has been gradually increasing. The immediate benefits of this procedure were demonstrated not only by the reduction of pain scores but also by the improvement of the quality of life reported by our patients, and by 50% reduction in the pharmacological therapy for the first patient and the complete cessation by the second patient.

The long-term benefits of PENS is still unclear. The best mode of PENS, both in terms of number of sessions and duration of therapy to obtain a lasting analgesia also needs to be worked up. The degree of improvement of pain seems to depend on the duration of electrical stimulation. There are no significant differences between PENS sessions of 30 and 45 min, in both cases they were found to be more effective than 15 min sessions, suggesting that the recommended duration of a PENS session should not be less than 30 min.[13] Our PENS trials' duration was 25 min in accordance with the major results of scientific literature.

Despite PENS produced acute analgesic effects, its long-lasting effects are controversial. There is evidence that needles placed in nonacupuncture points lead to analgesic effects, perhaps due to endorphin release.[15] The release of endogenous opioids such as β-endorphin would be able to produce an analgesic effect lasting more than two hours. For this reason, although a short-term analgesia induced by PENS is simple to explain, the long-term benefits of PENS are controversial.[16]

Our patients have shown benefits to four weeks demonstrating a long-lasting effect of the procedure. Both patients are still in follow-up at our hospital, taking into account the possibility of repeated treatment needed at some stage.

CONCLUSION

In conclusion we can say that these promising results indicate that PENS is a valid, low-risk, well-tolerated and minimally invasive procedure for treatment of CPSP. At our knowledge there

are only two similar case reports of patients with CPSP treated with PENS trials. While in the cases reported by Al Tamimi et al.[12] and by Goyal et al.[17] where they executed a 10-days trial and a 1-week trial stimulation respectively, implanting later a permanent implantable pulse generator, we executed only a 1-day PENS trial and we did not need to implant any permanent device to achieve excellent long-term results. Despite this, our reports are only two isolated cases, so we need randomized controlled trial to establish the real role of this procedure in the treatment of CPSP.

Ethical submission: The authors report that the study was approved by the ethics committee and the patients signed an informed consent.

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