



Refractory neuropathic pain from a median nerve injury: spinal cord or peripheral nerve stimulation? A case report

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Abstract

Spinal cord stimulation (SCS) is the most frequently used neuromodulation technique even for neurogenic pain from a peripheral nerve injury although peripheral nerve stimulation (PNS) has been designed for this purpose. PNS appears less invasive than SCS or deep brain stimulation. It provides greater and specific target coverage and it could be more cost-effective than SCS because low electrical stimulation is exclusively delivered to the precise painful territory. We report a case of excellent result following median nerve stimulation at arm level after SCS failure and a 10-year history of intense pain. PNS would certainly have been considered much earlier if it was accepted and reimbursed by the Belgium National Insurance. PNS is a safe, simple, and efficient technique available for decades but it is still considered as experimental and underemployed. Belgian National Insurance fears an explosion of indications on neuromodulation if PNS was reimbursed. We consider that PNS aside SCS and other neuromodulation techniques should be made available in Belgium in case of peripheral chronic neuropathic pain.

Keywords Peripheral nerve stimulation · Spinal cord stimulation · Neuromodulation · Neuropathic pain · Neurogenic pain

Introduction

Neuromodulation has been used for more than half a century to relieve neurogenic pain [1]. In many countries, the first indication of neuromodulation is the failed back surgery syndrome (FBSS). In this context, spinal cord stimulation (SCS) is obviously the technique to choose, with success rates from 47 to 62% reported in the literature [2, 3]. In case of neurogenic pain arising from an injured nerve in an extremity, peripheral nerve stimulation (PNS) has been developed and is being used instead of SCS in many countries. PNS cannot be considered in Belgium by the pain clinicians/surgeons due to no reimbursement by INAMI/RIZIV, the national medical insurance. We here report the long pain-history and dramatic issue of a young patient and our efforts to obtain PNS.

Case report

A 22-year-old man developed neuropathic pain in the right median nerve's sensory territory following a forearm compartmental syndrome. It was due to a misplacement of a peripheral venous catheter at the elbow.

The patient was managed in another institution for the neurogenic pain. Many medications were unsuccessfully used. The patient was then considered as a good candidate for spinal cord stimulation (SCS). At the age of 24, the patient underwent implantation of a Quad electrode (Medtronic®) at the level C3–C5 with an excellent result (Fig. 1, left). The patient was able to go back to work and play tennis. Unfortunately, the SCS device had to be removed 1 year later due to infection. Prolonged antibiotic therapy was given; 6 months later, a new electrode was placed; the patient obtained very poor pain relief (Fig. 1, right).

When the patient presented to us, at age 31, he had been in heavy pain for many years despite multiple medications at very high doses (opiates, tricyclic antidepressants, benzodiazepines, neuroleptics, antiepileptics). The patient also drank a large amount of alcoholic beverages. The patient had been in secondary depression for many years. With the generator activated, the patient felt paresthesia in the arm

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Fig. 1 Cervical X-rays showing the SCS electrode at first implantation (left) and second implantation (right). Left: the laterally placed electrode probably stimulates the spinal nerves; relief of pain is excellent. Right: with the medially placed electrode, relief of pain is very poor



and forearm, but not in the hand. On physical examination, a mild atrophy of thenar muscles was observed. Severe allodynia forced the patient to constantly wear a double glove (Fig. 2a).

Upon review of the previous cervical X-rays, we noticed that the first electrode was particularly laterally placed while the second was located at the midline (Fig. 1). The patient was a good candidate for median nerve PNS. We requested PNS use for this extremely invalidated young patient to the medical insurance advisor. A negative answer was given, since “peripheral nerve stimulation is not considered in the nomenclature codes for reimbursed interventions”. The electrode was provided by the company for compassion indication, the generator being already in place. Under sedation and local anesthesia, a Resume electrode (Medtronic®) was implanted beneath the median nerve at mid-arm level. During the intra-operative testing, the patient felt the paresthesia in the digits I–IV. During the same procedure, now under

general anesthesia, an extension cable was connected from the electrode to the Itrel 3 generator (Medtronic®) which had been previously placed in the abdomen.

Postoperatively, the patient was immediately relieved from pain and allodynia in the hand. He was able to hold objects without wearing a glove (Fig. 2b), with much less medication and no more alcohol.

He left the Neurosurgery Department at postoperative day 7 to the Psychiatry Department for a planned hospitalization to progressively reduce medical treatment, avoid weaning and benefit from a psychological support. He left the hospital 1 month after surgery.

When seen in Neurosurgery clinics 3 months postoperatively, the patient was highly improved: he did use the right upper arm normally. He still took multiple medications with progressive weaning. He said he had multiple life projects.

5 days later, the patient committed suicide by throwing himself under a train...

Fig. 2 Patient’s right hand use before (left) and after (right) PNS. Left: double glove covering the sensory territory of the right median nerve. Right: no more allodynia. Normal use of the right hand with much less medication and no more alcohol



Discussion

We here report the history of a young patient who had suffered from severe median nerve neurogenic pain for almost 10 years and secondary depression before PNS was discussed and could be done thanks to a Medtronic company contribution.

One will never know whether the patient's issue would have been different if PNS had been performed earlier, before the stage of a chronic, severely debilitating, drug and alcohol addictive disease. Obviously, the patient had returned to a normal social and professional life with the well-functioning SCS...

The literature well describes patients cured from a chronic disease, especially by surgery, who paradoxically are unable to face a normal, disease-free life and commit suicide. Case reports are published following epilepsy and bariatric surgery [4–9].

The use of opioids is not recommended in chronic neuropathic non-malignant pain. Ideally, the patient should have been detoxified before surgery. However, opioids and alcohol consumption had occurred for many years before he presented to us. He was followed by the general practitioner, a psychiatrist and a pain clinician. All claimed that detoxification was impossible alone, without an efficient solution. Therefore, the patient was progressively detoxified following the successful surgery.

Although PNS was developed in the 1960s by Wall and Sweet [1], it is still considered as experimental partly because its mechanisms of action are not perfectly known. They involve the “gate control” theory of pain described by Melzack and Wall, as well as other complex peripheral and central mechanisms [10]. In the 1960s and 1970s, PNS results were not entirely encouraging because of technical, surgical limitations and failures [11]. Therefore, SCS quickly imposed worldwide as the technique of choice. As a result, there has been a lack of interest for PNS by the medical community and pharmaceutical industry, which has resulted in a lack of data in the literature.

Because of this vicious circle, PNS is usually used after a long history of pain and after other techniques have failed [10].

Indications for PNS include refractory neuropathic pain from a plexus lesion and peripheral or spinal nerve injury [11–16]. According to Reverbi et al., CRPS, post-herpetic neuralgia, trigeminal nerve neuralgia, refractory headaches [17] represent other indications.

Technical improvements have been developed in the implanted material and surgical technique so that nowadays PNS is considered as a safe and efficient procedure [18–21]. In 2016, Bouche et al. [10] reported a 65% positive outcome in a series of 26 patients at 1 year of

stimulation. In Reverbi et al.'s series of nine patients [17], seven obtained a good result and were able to return to work.

PNS is less invasive than SCS or deep brain stimulation (DBS). It provides greater and specific target coverage with a minimal invasive or percutaneous technique [14]. It could be more cost-effective than SCS because stimulation is exclusively delivered proximal to the lesion to the precise painful territory. In recent years, percutaneous implantation of the lead under ultrasound guidance has been developed [14].

We did not consider dorsal root ganglion stimulation (DRG) because it needed a new procedure at the cervical level which had been operated on three times. Furthermore, for our patient, we are not sure that a C6 DRG stimulation would have been as efficient as the median nerve PNS. Figure 2a shows that the painful area covered a larger area than the C6 sensory territory.

In Belgium, until recently, only cerebral or spinal cord stimulation was allowed to treat neurogenic pain of long duration due to a central, spinal cord, root or peripheral nerve lesion, which is resistant to surgical and/or pharmacological treatment. CRPS and neurogenic pain from diabetic neuropathy have been specifically excluded from the indications of neuromodulation in Belgium.

For neurogenic pain following a peripheral nerve injury, the Belgian law only allowed CNS stimulation.

Following the dramatic issue of our patient, we were willing to try to change this. We and the Belgian Society of Neurosurgery requested in 2013 to the implant committee of the INAMI/RIZIV to add PNS in the text cited previously. We thus asked that every time a patient is in the indications of CNS stimulation, the treating team would be allowed to choose between CNS and PNS. We strongly argued that our purpose was not to enlarge the indications of neurostimulation. Therefore, no extra costs would arise from the modification asked. PNS instead of CNS stimulation for an injured nerve could even lead to lower costs due to lesser energy needed with PNS. The relevant literature was detailed. We rapidly received a negative answer, the fear being an explosion in the neurostimulation indications if CRPS was considered.

Since January 2018, the legislation concerning neuromodulation has been hardened so that indications other than FBSS or failed neck surgery syndrome could be very restrained in the future (Annex).

Aside the reported patient, we implanted a PNS in two other patients, respectively for pain post-last phalanges amputation of the two first digits, and for saphenous nerve pain post knee-injury. Injury occurred during a work-related accident in both patients so that PNS instead of SCS could be performed thanks to the good sense of the physician from the private insurance. PNS in Belgium nowadays can be discussed in a minority of patients suffering from severe pain

from a nerve trunk injury, either because the nerve injury is work-related or the patient is both implanted at spinal cord and nerve levels. In rare circumstances, the patient will personally take in charge the costs of PNS... These rare indications can lead to small series, such as the one from Gybels et al. [22–24]; this team from the Northern part of Belgium published in 2011 a series of six patients still using their PNS device, after 20 years or more post-implantation, with good pain relief [23].

The second author (AD) analyzed a few years ago the reimbursement system of neuromodulation in the French-speaking countries (France, Quebec, Belgium, Luxembourg) [25]. SCS is used in all these countries and also in UK, Germany, Spain and in the US where PNS is FDA approved (Food and Drug administration). Belgium is the only country where PNS does not appear in the armamentarium of the pain clinicians/surgeons. Though, PNS is considered to be more logical, less invasive, and as or more cost-effective than SCS [11, 17] in selective indications, mostly neurogenic pain in a well-defined nerve distribution.

Conclusion

To conclude, in memoriam of the young patient here reported, we wanted to report our small but positive experience of PNS for severe refractory neurogenic pain. PNS aside SCS and motor cortex stimulation should be made available in the neuromodulation techniques in well-selected patients.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from the unique participant.

Annex: latest modifications of the Belgian Law concerning neuromodulation in neurosurgery

25 OCTOBRE 2017 Arrêté ministériel modifiant le chapitre «B. Neurochirurgie» de la liste jointe comme annexe 1rea l'arrêté royal du 25 juin 2014 fixant les procédures, délais et conditions en matière d'intervention de l'assurance obligatoire soins de santé et indemnités dans le coût des implants

et des dispositifs médicaux invasifs. http://www.ejustice.just.fgov.be/doc/rech_f.htm.

25 JUIN 2014 Arrêté royal fixant les procédures, délais et conditions en matière d'intervention de l'assurance obligatoire soins de santé et indemnités dans le coût des implants et des dispositifs médicaux invasifs. <http://www.ejustice.just.fgov.be/eli/arrete/2014/06/25/2014022305/moniteur>.

16 MAI 2017 Arrêté ministériel modifiant le chapitre «H. Gynécologie» de la liste et les listes nominatives jointes comme annexes 1 et 2 à l'arrêté royal du 25 juin 2014 fixant les procédures, délais et conditions en matière d'intervention de l'assurance obligatoire soins de santé et indemnités dans le coût des implants et des dispositifs médicaux invasifs. http://www.ejustice.just.fgov.be/doc/rech_f.htm.

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