



Treatment of Cluster Headache by Occipital Nerve Stimulation: Case Report

Tratamento de cefaleia em salvas por estimulação do nervo occipital: Relato de caso

Andressa Lima Oliveira¹ Vitória Harumi Rodrigues Takahashi Monteiro¹ Ledismar José da Silva¹

¹ Faculty of Medicine, Pontifícia Universidade Católica de Goiás (PUC-Goiás), Goiânia, Brazil

Arq Bras Neurocir 2022;41(3):e300–e304.

Address for correspondence Ledismar José da Silva, MSc, Faculdade de Medicina, Pontifícia Universidade Católica de Goiás (PUC-Goiás), Avenida Universitária 1.440, Setor Universitário, 74605-010, Goiânia, GO, Brazil (e-mail: ledismarsilva@gmail.com).

Abstract

Keywords

- ▶ cluster headache
- ▶ treatment
- ▶ neuromodulation
- ▶ quality of life
- ▶ nerve
- ▶ anesthetic block

Resumo

Palavras-chave

- ▶ cefaleia em salvas
- ▶ tratamento
- ▶ neuromodulação
- ▶ qualidade de vida
- ▶ nervo
- ▶ bloqueio anestésico

Cluster headache (CH) is a primary headache characterized by severe pain that is strictly unilateral, with orbital, supraorbital, or temporal location, accompanied by ipsilateral autonomic manifestations. It has a considerable socioeconomic impact and impairs patients' quality of life. The present study aimed to report the case of a patient presenting with CH who underwent occipital nerve stimulation and to verify the improvement in her quality of life after this procedure.

A cefaleia em salvas (CS) é uma cefaleia primária caracterizada por dor intensa estritamente unilateral, com localização orbital, supraorbital ou temporal, acompanhada por manifestações autonômicas ipsilaterais. A CS tem considerável impacto socioeconômico e prejudica a qualidade de vida dos pacientes. Este estudo teve como objetivo relatar o caso de uma paciente com CS submetida a neuroestimulação occipital e verificar a melhora de sua qualidade de vida após este procedimento.

Introduction

Cluster headache (CH) is a primary type of headache that is classified in to the group of trigeminal autonomic cephalalgias.¹ The main characteristics of CH are severe and strictly-unilateral pain, with orbital, supraorbital, or temporal location, associated with ipsilateral autonomic manifes-

tations. Crises can last from 15 to 180 minutes, occurring one or several times a day for a few weeks, generally followed by a period of remission.^{2,3}

Since CH is characterized by intense, excruciating, and highly-incapacitating pain, accompanied by prominent cranial autonomic manifestations or a feeling of restlessness or agitation, it is common for CH patients to experience

received
October 13, 2020
accepted after revision
December 20, 2021
published online
August 1, 2022

DOI <https://doi.org/10.1055/s-0042-1743104>.
ISSN 0103-5355.

© 2022. Sociedade Brasileira de Neurocirurgia. All rights reserved. This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)
Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

problems regarding their family relationships and professional life due to their inability to participate in activities or perform normal work during crises. Consequently, CH has a considerable socioeconomic impact and compromises the quality of life of the patients. Its pharmacological treatment includes a wide range of drugs such as triptan, lithium carbonate, verapamil, and corticosteroids. In addition, oxygen inhalation can be used to treat CH.⁴⁻⁶

In cases refractory to the pharmacological treatment, neuromodulation procedures such as deep brain stimulation, spinal cord stimulation, and occipital nerve stimulation can be employed. Not only has occipital nerve stimulation been shown to be less invasive compared to the other procedures, but it also significantly reduces the frequency and the number of crises of CH, thus improving patients' quality of life.^{7,8} Patients can control the implanted system with a handheld remote control, which enables them to turn the device on or off and to adjust the stimulator parameters, contributing to a reduction in painful events.⁹ Therefore, the present study aimed to report the case of a patient with CH who underwent occipital nerve stimulation and to verify the improvement in her quality of life after this procedure.

Case Report

The present study was approved by the Ethics Committee of Pontifícia Universidade Católica de Goiás (under CAAE: 30101019.6.0000.0037). It was conducted following the principles of the Declaration of Helsinki, and the patient signed the informed consent form.

A 29-year-old female patient sought medical attention due to severe periorbital left frontal headache that came in crises (score of 10–10 in the numeric pain rating scale-10, NRS-10), associated with eyelid ptosis, miosis, ocular hyperemia, and rhinorrhea. She reported having had 3 to 4 daily episodes of severe headache for the past 7 years, lasting around 50 minutes, followed by remission periods of approximately 7 days. The patient was unresponsive to the pharmacological treatment with lithium carbonate, fluoxetine, topiramate, verapamil, prednisone, olanzapine, duloxetine, quetiapine fumarate, codeine, and codeine phosphate associated with paracetamol. She underwent blockages of the stellate ganglion, sphenopalatine ganglion, and occipital nerve without effective pain control. She frequently needed assistance in the emergency department for the use of nasal oxygen (8–10 L/min) for pain relief. Hence, the patient fulfilled the international criteria for the diagnosis of CH.¹

Due to the refractory nature of her case to the clinical approach, test electrode implantation in the left occipital nerve region coupled to an external pacemaker was indicated (► **Fig. 1A and -1B**). The test was carried out for 3 weeks, and the patient reported improvement in CH from a score of 10–10 to 3–10 on the NRS-10, as well as reduction in the frequency of crises from 3 times a week to ~1 crisis every 3 weeks. Subsequently, a permanent octopolar electrode (amplitude: 2 V; frequency: 40 Hz; pulse width: 400 μ s) was implanted using a left-sided retromastoid approach,¹⁰ with an expected battery life of approximately 4–5 years. After the

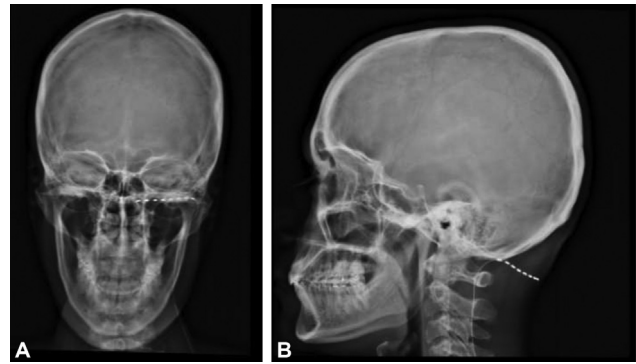


Fig. 1 (A) Radiograph on coronal section. Radiograph on sagittal section.

implant, the patient complained of pain at the generator site for 3 months and of cutaneous electric shock at the implant site. The pain at the battery site disappeared spontaneously, whereas the electric shock in the skin was solved through adjustments in the stimulation parameters (telemetry).

She remains in outpatient clinic follow-up and has reported an improvement in the intensity and frequency of painful events. She has also experienced a reduction in the need for assistance in the emergency department and greater job stability due to a decrease in health-related absenteeism.

Discussion

Compared to migraine, CH is a rare condition, since its prevalence is lower than 1%. It mostly affects the male population in a ratio of 3:1, mainly between 20 and 40 years of age. The crises are serial and can last for weeks or months, associated with periods of remission that generally last for months or years.^{1,2,11}

The clinical manifestations that accompany CH include autonomic symptoms ipsilateral to the pain, such as conjunctival hyperemia, tearing, nasal congestion, rhinorrhea, sweating on the forehead and face, miosis, ptosis, and eyelid edema. During the crises, most patients exhibit uneasy behavior and marked agitation.^{1,3,12}

Many studies on CH have been conducted so far, and this condition has been recognized for many years. Typical CH attacks are characterized by severe strictly-unilateral pain, and the most severe pain is localized deep behind one eye or the temple, in association with ipsilateral facial autonomic symptoms.^{13,14}

Currently, the diagnosis of CH can be made based on the well-characterized clinical history of headache.¹⁵ Given that two major temporal patterns of CH have been identified, episodic and chronic, the differential diagnostic criteria should be considered when deciding on the proper treatment. The patterns are based on the presence as well as on the duration of the periods of remission. On the one hand, episodic CH is the most common subtype (affecting 80% of the patients), and it is characterized by discrete but repetitive daily attacks, which can last from 1 week to 1 year, usually followed by a period of 3 to 12 months without pain

before another attack. On the other hand, chronic CH is characterized by daily attacks, which can last longer than 1 year, with no remission or with pain-free periods lasting less than 3 months each.^{1,2,16,17}

The prevalence of CH has historically been higher among men, and the male-to-female ratio tends to be the highest when its onset is in the age ranges from 20 to 49 years, and the lowest, when its onset is after the age of 50.^{4,18} In Brazil, an observational cross-sectional study¹⁹ demonstrated the highest prevalence of CH among men (86.67%) and in the age group between 35 and 45 years (53.34%).¹⁹

In general, the treatment of CH relies on the pharmacological therapy to control acute attacks, because they reach the peak of maximum intensity in a few minutes after the beginning, and on the prophylactic treatment, consisting in the administration of daily doses of medication, to reduce the attacks during the cluster bout.^{20,21} For the treatment of acute attacks, triptans are the most effective drugs of choice for the majority of patients. A 6-mg single dose of sumatriptan can be administered subcutaneously and is effective approximately 15 minutes after administration. Single 5- and 10-mg doses of zolmitriptan nasal spray and a single 20-mg dose of sumatriptan nasal spray are effective 30 minutes after administration.^{17,22}

For more than 60% of the patients with CH, oxygen therapy is often very useful. Oxygen is administered using a high-flow mask at a flow rate of 12 L/min to 15 L/min, and the effect is usually felt 15 to 20 minutes after the treatment begins. The main advantages of oxygen inhalation are the nonexistence of side effects and the prospect of employing the same therapy as many times as necessary.^{17,23}

In addition, lidocaine is also effective in treating acute attacks in more than 30% of the patients with CH. This medication can be taken into consideration if the patient does not respond to oxygen therapy and triptans. Lidocaine dripped or sprayed into the ipsilateral nostril, at concentrations ranging from 4% to 10%, usually provides relief within 10 minutes after administration.²⁴

The preventive treatment of patients with a history of episodic or chronic CH includes several drugs that have already been proven to be effective in reducing the frequency of these attacks. Verapamil has been considered the first choice and the most prescribed drug at doses ranging from 360 mg/day to 560 mg/day. Severe cases may require, doses of up to 960 mg/day. However, due to the adverse effects of verapamil on cardiac function, it is advisable to perform electrocardiograms before and after the dose needs to be increased.^{17,25}

Lithium has also been broadly used worldwide in the first-line preventive treatment of CH, and it effectively reduces the frequency of attacks. The dose, ranging between 600 mg/day and 1200 mg/day, needs to be adjusted. Patients should start the treatment at a lower dose, which should gradually increase until the disappearance of the pain indicates that the optimal therapeutic response has been achieved.^{23,25,26}

Another option of pharmacological therapy for the prophylactic treatment of CH is anticonvulsant drugs such as topiramate. The most used dose for these patients varies

between 100 mg/day and 200 mg/day, and it can be administered in isolation or added to an ongoing treatment with verapamil.^{17,25-27}

Although corticosteroids have been successfully used to treat CH, their adverse events should be taken into consideration, mainly in long-term treatments. The common dose of oral prednisone or prednisolone is of 60 mg/day (in a single daily dose) for a period of 5 to 10 days or until the attacks stop. After that, the dose should be gradually reduced by 5 mg to 10 mg at intervals of 4 to 10 days. Dexamethasone can be administered as an intramuscular injection or orally at a dose of 8 mg/day for 5 to 10 days.^{25,26}

Surgery is indicated in CH patients who are clinically intractable and refractory to the pharmacological treatment. Neurostimulation techniques such as hypothalamic deep brain stimulation, spinal cord stimulation, stimulation of the sphenopalatine ganglion, vagus nerve stimulation, and occipital nerve stimulation have yielded favorable outcomes.^{26,28}

In deep brain stimulation, electrodes are placed on the posterior hypothalamus. This procedure has been proven to be effective in the control of CH crises in most patients. These outcomes provide evidence of the considerable role the hypothalamus plays in the pathophysiology of this disease. Hypothalamic stimulation is believed to increase the blood flow in the ipsilateral trigeminal system as well as in the brain areas involved in the pain center.^{28,29}

Another important target for the treatment of CH is spinal cord stimulation; however, few reports^{12,28} on this procedure are available. Using this neuromodulation technique, cervical epidural electrodes, with power supplied by a battery, can be implanted in patients with CH, making it possible to reduce the average frequency of attacks and the intensity of crises.^{12,28}

The sphenopalatine ganglion, an extracranial structure located in the pterygopalatine fossa, has sympathetic and parasympathetic components. Due to the direct and indirect connections of this structure with somatic and visceral nervous components of the face, trigeminovascular system, upper salivatory nucleus, and hypothalamus, it plays a distinctive role in the pathophysiology of CH. Therefore, it has been used as a therapeutic target to treat CH, showing some successful outcomes. The physiological stimulation of the sphenopalatine ganglion blocks the parasympathetic flow, resulting in improvement in pain and autonomic symptoms.^{21,28}

Another procedure introduced in the treatment of CH is vagus nerve stimulation. The existence of several connections between the solitary tract nucleus and the spinal nucleus of the trigeminal nerve suggests that the inhibition of pain by stimulating the vagus nerve occurs due to the inhibition of the vagal afferents of the caudal nucleus of the trigeminal nerve.^{21,28}

Stimulation of the occipital nerve, the neuromodulation therapy chosen for the treatment of the patient in the present case report, exerts its effectiveness through several mechanisms. Spinal cord modulation at C2-C3, the point of convergence of the trigeminal nerve and upper cervical

afferents, may account for the beneficial effects of occipital nerve stimulation. To perform the technique, the major occipital nerve is stimulated by means of a subcutaneous electrode that crosses the nerve path in order to provoke paresthesia in this region. Patients presenting with clinically-intractable CH who underwent stimulation of the occipital nerve showed favorable results with reduced attacks.^{3,28}

In cases of chronic refractory CH, neuromodulation of the occipital nerve should be considered, because this pain management technique can be safer than other more invasive procedures. In general, neurostimulation of the distal branches of C2–C3 (the greater and the lesser occipital nerves) is used. The patient undergoes minimal sedation and should be in the prone or lateral positions. Either a lateral or a retromastoid approach can be used, and the incision at the level of C1 can be performed posteriorly or inferiorly to the mastoid process. A Tuohy needle is then inserted subcutaneously and transversely, carefully bent and adjusted to the specific curvature of that patient's occipital nerve. After that, an electrode should be inserted through the Tuohy needle, which, in turn, is removed, leaving the electrode at the correct site.¹⁰

The electrodes should be inserted subcutaneously and superficially to the cervical muscle fascia, usually under fluoroscopic guidance.⁹ Painful stimulation requires electrode repositioning. This system is maintained by an external power source, the pulse generator, which can be implanted in the infraclavicular region. After the surgical procedure, radiographs of the skull can be taken to document the final position of the electrode, preventing cases of electrode migration or fracture. If the patient finds neurostimulation uncomfortable, the stimulation parameters (amplitude, frequency, and pulse width), can be adjusted by telemetry.¹⁰

The system for the neuromodulation of peripheral nerves requires that batteries work at higher intensities than those needed in other kinds of stimulation.¹⁰ In the case herein reported, the battery lasted only 2 years, although this device has a useful life of around 4 to 5 years according to the manufacturer. Battery depletion is a disadvantage in this type of implant, but replacements can be avoided by using rechargeable systems.¹⁰

Conclusion

The professional, social, functional, economic, and psychological well-being of those affected by refractory CH can be significantly hampered, consequently reducing their quality of life. In the case herein reported, it became evident that, after the implantation of the neuromodulator in the left occipital nerve, the patient experienced an improvement in the intensity and frequency of the painful episodes. Therefore, stimulation of the occipital nerve should be considered as a therapeutic approach for CH patients refractory to the pharmacological therapy.

Conflict of Interests

The authors have no conflict of interests to declare.

References

- Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders. 3rd ed.. Cephalalgia; 2018;38(01):1–211
- Robin AM, Pabaney AH, Mitsias PD, Schwalb JM. Further evidence for a pain pathway involving the cingulate gyrus: a case of chronic cluster headache cured by glioblastoma. *Stereotact Funct Neurosurg* 2015;93(03):194–198
- Leone M, Proietti Cecchini A, Messina G, Franzini A. Long-term occipital nerve stimulation for drug-resistant chronic cluster headache. *Cephalalgia* 2017;37(08):756–763
- Mueller O, Diener HC, Dammann P, et al. Occipital nerve stimulation for intractable chronic cluster headache or migraine: a critical analysis of direct treatment costs and complications. *Cephalalgia* 2013;33(16):1283–1291
- Wilbrink LA, Teernstra OPM, Haan J, et al. Occipital nerve stimulation in medically intractable, chronic cluster headache. The ICON study: rationale and protocol of a randomised trial. *Cephalalgia* 2013;33(15):1238–1247
- Abu Bakar N, Torkamani M, Tanprawate S, Lamburu G, Matharu M, Jahanshahi M. The development and validation of the Cluster Headache Quality of life scale (CHQ). *J Headache Pain* 2016;17(01):79
- Gaul C, Roguski J, Dresler T, et al. Efficacy and safety of a single occipital nerve blockade in episodic and chronic cluster headache: A prospective observational study. *Cephalalgia* 2017;37(09):873–880
- Fontaine D, Blond S, Lucas C, et al. Occipital nerve stimulation improves the quality of life in medically-intractable chronic cluster headache: Results of an observational prospective study. *Cephalalgia* 2017;37(12):1173–1179
- Lamburu G, Matharu MS. Occipital nerve stimulation in primary headache syndromes. *Ther Adv Neurol Disord* 2012;5(01):57–67
- Trentman TL, Zimmerman RS, Dodick DW. Occipital nerve stimulation: technical and surgical aspects of implantation. In: Slavov KV, ed. *Peripheral nerve stimulation. Progress in Neurological Surgery*. Vol. 24. Basel: Karger; 2011:96–108
- Wei DYT, Yuan Ong JJ, Goadsby PJ. Cluster headache: epidemiology, pathophysiology, clinical features, and diagnosis. *Ann Indian Acad Neurol* 2018;21(Suppl 1):S3–S8
- Müller OM, Gaul C, Katsarava Z, Sure U, Diener HC, Gasser T. Beidseitige Nervus-occipitalis-Stimulation zur Behandlung des therapierefraktären chronischen Cluster-Kopfschmerzes: eigene Fallserie und Initiierung einer prospektiven Studie. *Fortschr Neurol Psychiatr* 2010;78(12):709–714
- Turkewitz LJ, Wirth O, Dawson GA, Casaly JS. Cluster headache following head injury: a case report and review of the literature. *Headache* 1992;32(10):504–506
- Waldenlind E, Sjöstrand C. Pathophysiology of cluster headache and other trigeminal autonomic cephalalgias. In: Aminoff MJ, Boller F, Swaab Det al., eds. *Handbook of clinical neurology*. Vol. 97: Headache. Amsterdam: Elsevier; 2011:389–411
- Russell MB. Epidemiology and genetics of cluster headache. *Lancet Neurol* 2004;3(05):279–283
- Fischera M, Marziniak M, Galow I, Evers S. The incidence and prevalence of cluster headache: a meta-analysis of population-based studies. *Cephalalgia* 2008;28(06):614–618
- Hoffmann J, May A. Diagnosis, pathophysiology, and management of cluster headache. *Lancet Neurol* 2018;17(01):75–83
- Ekblom K, Svensson DA, Träff H, Waldenlind E. Age at onset and sex ratio in cluster headache: observations over three decades. *Cephalalgia* 2002;22(02):94–100
- Jurno ME, Pereira BSR, Fonseca FAS, et al. Epidemiologic study of cluster headache prevalence in a medium-size city in Brazil. *Arq Neuropsiquiatr* 2018;76(07):467–472
- Goadsby PJ, Cohen AS, Matharu MS. Trigeminal autonomic cephalalgias: diagnosis and treatment. *Curr Neurol Neurosci Rep* 2007;7(02):117–125

- 21 Leone M, Proietti Cecchini A. Advances in the understanding of cluster headache. *Expert Rev Neurother* 2017;17(02):165–172
- 22 van Vliet JA, Bahra A, Martin V, et al. Intranasal sumatriptan in cluster headache: randomized placebo-controlled double-blind study. *Neurology* 2003;60(04):630–633
- 23 Robbins MS, Starling AJ, Pringsheim TM, Becker WJ, Schwedt TJ. Treatment of Cluster Headache: The American Headache Society Evidence-Based Guidelines. *Headache* 2016;56(07):1093–1106
- 24 Dagenais R, Zed PJ. Intranasal lidocaine for acute management of primary headaches: a systematic review. *Pharmacotherapy* 2018;38(10):1038–1050
- 25 Brandt RB, Doesborg PGG, Haan J, Ferrari MD, Fronczek R. Pharmacotherapy for cluster headache. *CNS Drugs* 2020;34(02):171–184
- 26 Leone M, Giustiniani A, Cecchini AP. Cluster headache: present and future therapy. *Neurol Sci* 2017;38(Suppl (Suppl 1):45–50
- 27 McGeeney BE. Topiramate in the treatment of cluster headache. *Curr Pain Headache Rep* 2003;7(02):135–138
- 28 Láinez MJ, Guillamón E. Cluster headache and other TACs: Pathophysiology and neurostimulation options. *Headache* 2017;57(02):327–335
- 29 Leone M, Franzini A, Cecchini AP, Broggi G, Bussone G. Hypothalamic deep brain stimulation in the treatment of chronic cluster headache. *Ther Adv Neurol Disord* 2010;3(03):187–195