INDONESIAN JOURNAL OF ANESTHESIOLOGY AND REANIMATION
Volume 6 (1), January 2024: 32-41

Case Report

PULSED RADIOFREQUENCY ON SPHENOPALATINE GANGLION AS THE INTERVENTIONAL PAIN MANAGEMENT IN CLUSTER HEADACHE SECONDARY TO SPHENOID MENINGIOMA

Naomi Rahmasena[1], **Mirza Koeshardiandi**[2a], **Fajar Tri Mudianto**[2]

[1] Faculty Medicine of Universitas Airlangga, Surabaya, Indonesia
[2] Departement of Anesthesiology and Reanimation, dr. Soedono General Hospital, Madiun, Indonesia
[a] Corresponding author: Mirzakoes@gmail.com

ABSTRACT

Introduction: Cluster headache is one of the neurovascular headaches characterized by severe recurrent unilateral pain distributed around the orbit and accompanied by autonomic symptoms such as lacrimation, conjunctival injection nasal congestion or rhinorrhea, edema of the eyelid, sweating, and miosis. The attack usually lasts for 15 to 180 minutes. The possible mechanism of cluster headache is through the trigeminal-autonomic reflex. Management of the cluster headache is divided into pharmacological therapy including abortive and prophylaxis, as well as interventional pain management like deep brain stimulation, occipital nerve stimulation, and radiofrequency of the sphenopalatine ganglion. **Objective:** This report aims to demonstrate the effectivity of pulsed radiofrequency sphenopalatine ganglion on cluster headaches secondary to meningioma. **Case Report:** A 47-year-old female consulted the pain clinic with a chief complaint of profound facial pain for a year. The patient also reported autonomic symptoms such as rhinorrhea and lacrimation. The patient was diagnosed with meningioma and already treated with conventional therapy such as gabapentine, carbamazepine, omeprazole, and mecobalamin. Due to the location of meningioma which causes the tumor inoperable. The patient complained of constant and worsening pain, therefore pulsed radiofrequency on sphenopalatine ganglion was chosen to treat the patient. The patient reported relief of pain ever since. Among the consequences and benefits, pulsed radiofrequency is the choice of interventional pain management. Possibly the pain from the compression of the greater palatine nerve, intervention on the sphenopalatine will cause relief of the pain. Pulsed radiofrequency on sphenopalatine ganglion was reported successful in alleviating the pain of the patient. **Conclusion:** Pulsed radiofrequency of the sphenopalatine ganglion successfully alleviates the pain of the cluster headache due to meningioma. However, further study with a bigger population is recommended to see the efficacy of interventional pain management objectively.

Keywords: Intervention Pain Management; Pulsed Radiofrequency; Secondary Cluster Headache; Sphenoid Meningioma; Sphenopalatine Ganglion

ABSTRAK

Pendahuluan: Nyeri kepala cluster merupakan nyeri kepala neurovaskuler yang ditandai dengan nyeri unilateral berat rekuren yang berada di daerah orbita dan adanya gejala otonom seperti lakrimasi, injeksi konjungtiva, kongesti nasi atau rhinorrhea, edema pada kelopak mata, berkeringat dan miosis. Serangan umumnya berdurasi 15 menit sampai dengan 2 jam. Mekanisme yang mendasari kemungkinan disebabkan refleks trigeminal otonom. Manajemen nyeri kepala kluster dibagi menjadi terapi farmakologis yaitu abortif dan profilaksis serta terapi intervensi nyeri seperti *deep brain stimulation*, *occipital nerve stimulation* dan radiofrekuensi pada ganglion spenopalatin. **Tujuan:** Studi ini bertujuan untuk demonstrasi efektivitas *pulsed radiofrequency* ganglion spenopalatin pada nyeri kepala kluster akibat meningioma. **Laporan Kasus:** Perempuan 47 tahun dikonsultasikan pada klinik nyeri dengan keluhan utama nyeri kepala hebat selama 1 tahun. Pasien menyebutkan adanya gejala otonom seperti rinorea dan lakrimasi. Pasien terdiagnosis meningioma dan mendapat terapi konvensiopnal seperti gabapentin, carbamazepine, omeprazole, dan mecobalamin akibat lokasi meningioma yang menjadi kasus yang tidak dapat dilakukan pembedahan. Adanya nyeri yang konstan dan memburuk, radiofrekuensi berdenyut pada ganglion spenopalatin menjadi pilihan untuk terapi pasien. Pasien melaporkan nyeri berkurang setelah dilakukan intervensi. Menimbang keuntungan dan kerugian manajemen intervensi nyeri lainnya, PRF merupakan pilihan manajemen intervensional nyeri. Radiofrekuensi berdenyut dilaporkan berhasil mengurangi nyeri pada pasien. **Kesimpulan:** *Pulsed radiofrequency* pada ganglion spenopalatin berhasil

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

mengurangi nyeri kepala kluster akibat meningioma. Namun dibutuhkan dilakukan studi lebih lanjut untuk melihat efektivitar terapi secara objektif.

Kata kunci: Manajemen Nyeri Intervensi; Radiofrekuensi Berdenyut; Nyeri Kepala Kluster Sekunder; Meningioma Sphenoid; Ganglion Spenopalatin

Article info: Received: April 14, 2023; Revised: December 8, 2023; Accepted: December 11, 2023; Published: January 29, 2024

INTRODUCTION

Cluster headache is one of the neurovascular headaches which usually triggered by vasodilators such as alcohol or nitroglycerin (1). The characteristic of cluster headache is severe recurrent unilateral pain usually distributed around the orbit. The symptoms are usually accompanied by autonomic cranial symptoms such as lacrimation, conjunctival injection, nasal congestion or rhinorrhea, edema of the eyelid, sweating, and miosis. The duration of the attack is from 15 minutes to 180 minutes (2). In August 2007, a meta-analysis found during 1-year prevalence, the number of cluster headaches ranged from 3 to 150/100,000 cases. The sex ratio on cluster headaches differs according to the type of cluster headaches and the age of the onset. During the age of onset under 50 years old, both episodic and chronic cluster headaches happened to males more likely than females. Meanwhile, on the age of onset of 50 years old, the distribution differed, episodic cluster headaches were more likely to happen to males, while chronic cluster headaches were more likely to happen to females (3).

Cluster headache possibly caused by activation of trigeminal-autonomic reflex. The trigeminal-autonomic reflex is a connection in the brainstem that connects between the trigeminal nerve and facial cranial nerve parasympathetic outflow. The reflex is usually triggered by the stimulation of the trigeminovascular pathway. Through the sphenopalatine ganglion, the reflex is also activated through the parasympathetic outflow from the superior salivatory nucleus, and the cranial nerve which causes vasodilatation and parasympathetic activation (3). Other than the primary cause, cluster headaches are also caused by other etiologies such as nasopharyngeal carcinoma, sphenoidal meningioma, carotid artery dissection, vertebral artery dissection, pituitary adenoma, or aneurysm (KOU) (4).

Management of cluster headaches varied from conservative to interventional management. Conservative therapy from abortive therapy such as the use of oxygen, ergotamine, or sumatriptan injection. The use of verapamil is still widely applied for prophylactic therapy. When the conservative therapy is ineffective, and the pain recurrent the clinician should start to consider interventional management like radiofrequency of the ganglion pterygopalatine (PPG), Occipital nerve stimulation (ONS), or deep brain stimulation (DBS) (5).

In this study, we reported the case of secondary cluster headache due to sphenoid meningioma. Due to the tumor being inoperable, we need to gather the physicians to alleviate the pain. This report aims to demonstrate the effectivity of pulsed radiofrequency sphenopalatine ganglion on cluster headaches secondary to meningioma.

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

INDONESIAN JOURNAL OF ANESTHESIOLOGY AND REANIMATION
Volume 6 (1), January 2024: 32-41

CASE REPORT

A 47-year-old female was consulted at the pain clinic for interventional pain management. The patient came with a chief complaint of profound facial pain. The pain has already been felt since one year ago but has worsened in the last two months. The pain was located in the right ocular area and radiated through the back of the head. Recently, the pain also radiated through the back of the neck. The quality of the pain was constant, and sharp stabbing. The pain was triggered while the patient prayed, looked up, woke up, and closed her eyes. The pain is constant during the day, but when triggered the pain worsens for 15 to 30 minutes.

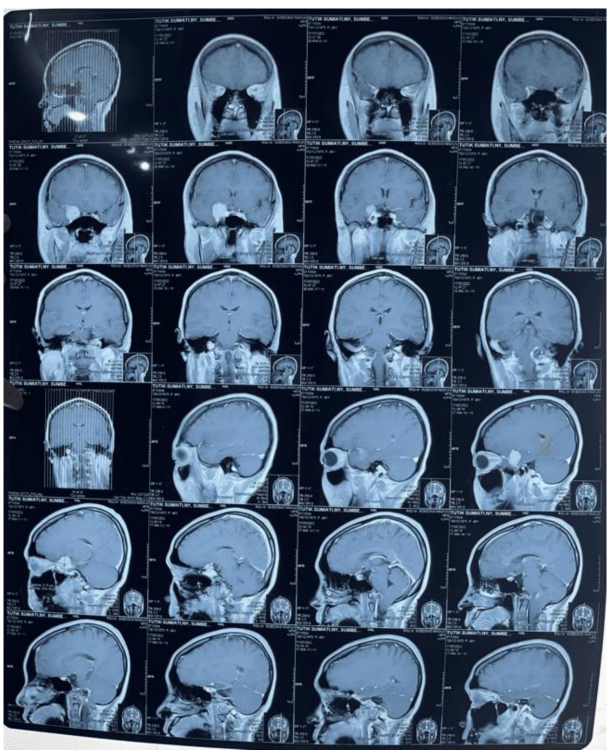

Figure 1. Coronal and Sagittal View MRI of the Patient

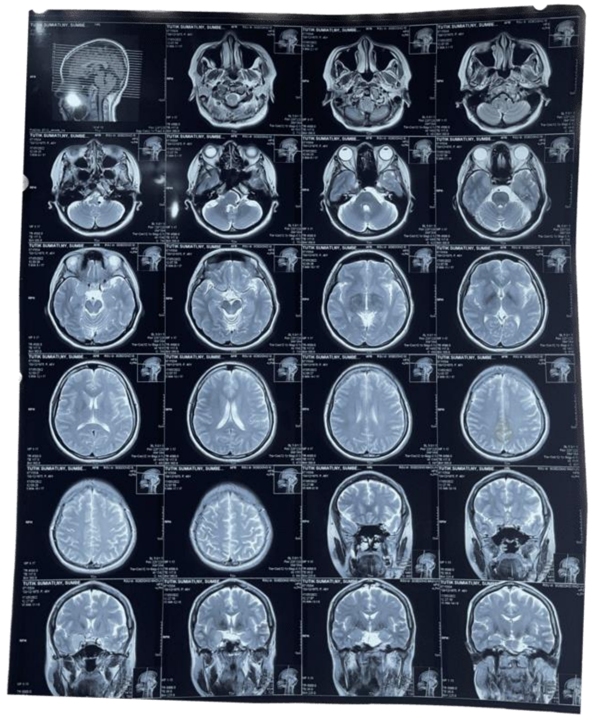

Figure 2. Coronal and Axial View MRI of the Patient

The patient first comes to the ophthalmologist due to the ocular pain, there are no visual disturbances, double vision, tunnel vision or floaters. The patient was cleared because of no apparent disturbances in her vision.

The patient was prescribed hyaluronic acid eyedrops. The pain did not subside, then the patient went to the neurologist and was diagnosed with migraine due to unilateral headache. The patient was given ibuprofen but still the pain has not subsided.

The patient was taken to MRI and found a meningioma on the right super-sellar which pressed the dextrous optic chiasm with the size 1.9 x 2.5 x 2.7cm. The patient has a history of three-month birth control injections for fourteen years. Before the patient was referred to the neurosurgeon, the neurologist was prescribing

Available at https://e-journal.unair.ac.id/IJAR | DOI: https://doi.org/10.20473/ijar.V6I12024.32-41

INDONESIAN JOURNAL OF ANESTHESIOLOGY AND REANIMATION
Volume 6 (1), January 2024: 32-41

gabapentin, phenobarbital, and dexamethasone. The patient was referred to the neurosurgeon and prescribed mecobalamine, gabapentin, carbamazepine, and omeprazole. Due to the location of the meningioma, the management taken was conventional and nothing invasive. The neurosurgeon then referred to the pain clinic for interventional pain management.

When asked the Numeric Rating Scale (NRS) from 0 to 10, with 0 being pain-free and 10 being the worst facial pain in her life, the patient answered the scale was 7-9. The pain disturbed her daily activities such as bathing, eating, and her quality of sleep. During the attack, the patient also experienced autonomic symptoms such as rhinorrhea, and lacrimation (epiphora). The patient had no history of hypertension, diabetes, or allergy.

The vital signs of the patient were compos mentis with a total Glasgow coma score (GCS) of fifteen. Blood pressure was 120/80 mmHg, with 79 beats per minute, regular. The temperature was 36 degrees Celsius, and the respiratory rate was 16 times per minute.

The patient was given sphenopalatine ganglion block for the pain intervention. The empiric therapy given included bedrest, slight head up thirty degrees, ringer acetate (RA) solution 1500cc/24hours, fentanyl drip 100mcg/kolf of RA solution, tramadol administered per oral twice daily, amitriptyline per oral twice administered twice daily, ondansetron 40mg injection administered twice daily intravenous, and topazole 40mg injection administered twice daily intravenous.

The patient also did a diagnostic procedure to confirm the sensitivity of the sphenopalatine ganglion block beforehand. The patient was prepared in a supine position with an extending cervical spine. The transnasal approach will be done with a cotton tip applicator, therefore needed to measure the estimated depth of the cotton tip applicator by measuring the opening of the nares to the mandibular notch below the zygoma. The applicator was soaked with lidocaine 1% and then inserted into the nares parallel to the zygoma, angled laterally until it lays on the nasopharyngeal mucosa posterior to the middle nasal turbinate. Then the second applicator was applied slightly posteriorly and cranially to the initial applicator. The patient well responded to the diagnostic block by confirming the current NRS was 1-2, which has proven sensitive to future intervention.

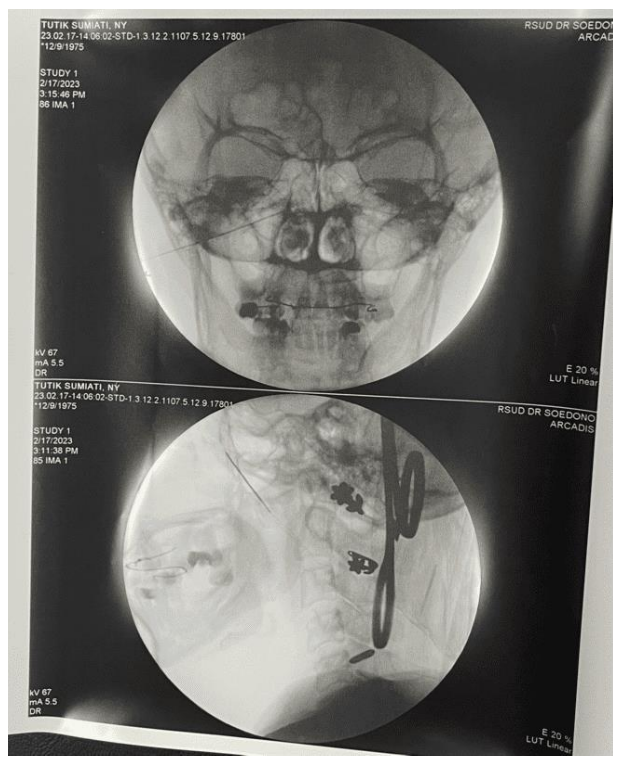

Figure 3. Fluoroscopy Imaging of the Intervention

The intervention began with positioning the patient supine on the operation table. The area of

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

the intervention which is the zygoma area disinfected with betadine and alcohol and later covered with sterile draping. The intervention was guided by fluoroscopy and positioned both AP and lateral projection. The local anesthetized by lidocaine 1% infiltrated around the injection area until wheal was formed. The needle is inserted by inferior to the zygomatic arch and directed medially in coaxial view until the zygomatic arch is passed. Then needle slightly redirected the cephalad into the pterygopalatine fossa. The depth of the needle was later confirmed by the AP projection of the fluoroscopy.

The stimulation began with sensory stimulation at 0.15Hz 2.5mV then followed by motoric stimulation at 5mV. The pulsed radiofrequency was used with 10 Ampere with 2 mV with four cycles of four minutes at 42 degrees Celsius. The bleeding caused by this procedure was minimal.

Following the procedure, the patient only felt pain in the injection area, which is still and locally anesthetized using lidocaine 1%. Patients did not experience epistaxis, transient anesthesia or hypoesthesia, lacrimation of the eye, or local or retroorbital hematoma.

The patient was prescribed paracetamol three times a day for the anti-inflammation, amitriptyline twice a day as the prophylactic therapy, and tramadol twice a day as needed for the painkiller.

The day after the procedure, said the patient the pain was abruptly lessened. The NRS was between 1-2 on the dextrous area. The patient felt comfortable with the daily activities. And the pain is still constant with NRS 1-2 until day 5 after the procedure. Patients were followed after 10 months post interventional pain management, and the NRS still constant in 1-2. The patient is still able to tolerate the pain and the pain does not interfere with her daily activities.

DISCUSSION

Meningioma can cause several alterations in the physiology of the brain such as increased intracranial pressure, compression of pain-sensitive structures (dura, blood vessels, periosteum), secondary to difficulty with vision, extreme hypertension (part of cushing triad), and also psychogenic due to stress from loss of functional capacity (5). A study conducted by Hadidchi, et al (6), states 40% of meningioma showed the symptom of meningioma-associated headache, with tension-type headache as the most likely type shown. The characteristic of the headache is mostly dull, with NRS 4-6, without trigger, and bilateral. These findings are in contrast with the patient due to the characteristic of the pain sharp, with NRS 7-9, trigger-involved and unilateral.

According to the International Classification Headache Society (7), cluster headache is described as severe unilateral pain usually located orbital, supraorbital, and temporal and lasts between 15 and 180 minutes. The autonomic symptoms such as ipsilateral conjunctival injection, lacrimation, nasal congestion, rhinorrhea, forehead, and facial sweating, miosis, ptosis, and/or eyelid edema and or agitation usually accompany the cluster headache. This type of headache matches our finding in this report, in which the patient complained of sharp pain in the right orbital area with lacrimation and rhinorrhea. The patient also felt symptoms for approximately 9 months. This complaint matches the ICHS criteria for chronic cluster headaches (7).

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

Prevalence of the cluster headaches is about 0.1% worldwide, which mostly happens to males. Due to the rare incidence of cluster headaches, the incidence of cluster headache-secondary to meningioma becomes rarer. Secondary cluster headaches are usually caused by nasopharyngeal carcinoma, sphenoidal meningioma, carotid artery dissection, vertebral artery dissection, pituitary adenoma, or aneurysm (4). With the MRI confirmation, the patient has meningioma located on suprasellar dextra. Possibly the patient had a secondary cluster headache due to the meningioma.

The position of the meningioma itself possibly induces the cluster headache. With the MRI, the position of the meningioma on this patient posteriorly to the orbital fissure which presses the greater palatine nerves. The greater palatine nerve is one of the sensory fibers of the sphenopalatine ganglion which supplies the sensation of the palate, and mucus membrane and also the sympathetic vidian nerve passing through the SPG which is distributed later to the nose, palate, and lacrimal gland, this possibly explained the symptoms of rhinorrhea and lacrimation of the patient (8). This theory aligned with a systematic review in 2020, which showed secondary cluster headaches associated with 37.7% vascular pathologies and 32.5% due to tumor pathologies including brain mass-like lesions (9).

The cluster headache pathophysiology includes the trigeminal system, parasympathetic system, and hypothalamus mediated. The trigeminal system plays a role where there is a trigeminal nococervical complex that modulates and transmits potentially painful stimuli from the face and head to the brain (8). Study (10) showed evidence of mast cells in all grade meningioma, mostly in high grade. With the activation of mast cells, it will release multi-potent molecules, one of them is histamines (11). Histamine works as a vasoactive substance, which will cause vasodilatation. The patient already felt the pain for almost 10 months without remission, which according to the IHS diagnosed with chronic cluster headache. Due to the location of the meningioma, the neurosurgeon decides the tumor is inoperable, which according to the studies before shows complete relief of pain after tumor resection (12,13). Treated with conventional therapy like carbamazepine, mecobalamine, and gabapentine for 10 10-month periods the patient admitted there was no significant difference in pain levels. The patient also complained two weeks recently, that the pain had worsened Therefore, this suggests the therapies are ineffective for this patient and need to consider possible interventional pain management.

The patient was done diagnostic block transnasal with lidocaine 1% and proven to relieve the pain with confirming from VAS 7-9 to VAS 1-2. Relief of the pain confirms the patient might be sensitive to the sphenopalatine ganglion block. The intervention was done with pulsed radiofrequency at 42 Celsius and four cycles of 120 seconds. The patient later confirmed the relief of the pain until the tenth month after the intervention follow-up. These findings aligned with studies before (14,15).

Sphenopalatine ganglion is hypothesized to play a role in the pathophysiology of trigeminal autonomic cephalgia (TAC) which includes cluster headache. The sphenopalatine ganglion parasympathetic effect mechanism is through the afferent signals from cranial vessels and dura mater get relayed through the trigeminal ganglion and then end in the trigeminal cervical complex.

Available at https://e-journal.unair.ac.id/IJAR | DOI: https://doi.org/10.20473/ijar.V6I12024.32-41

These signals then activate the superior salivatory nucleus then show sympathetic activity which correlates with the symptoms shown in patients such as rhinorrhea, and lacrimation (16).

Intervention pain management on sphenopalatine ganglion such as neural block, continuous radiofrequency, pulsed radiofrequency, and electrical stimulation was proven significant to relieve the patient pain on cluster headache (2,16–18). The SPG nerve block provides a positive result, and the side effect is typically local, which is a bitter taste and numbness of the throat. However, one study showed the need for repetitive intervention to reach long-term pain relief. The evidence of nerve block pain management is mostly case reports and case series, but there are few randomized controlled studies. Continuous radiofrequency or some called radiofrequency ablation, tends to have a longer-lasting effect than SPG nerve block. The side effects of CRF are more complex than the nerve block. Temporary paresthesia in the upper gums and cheeks which last for 3-6 weeks, and permanent hypoesthesia over the cheek and the palate, which disappeared within 3 months (18). CRF mechanism to alleviate the pain is via ablating the nociceptive nerve fibers, exposing the nerve to high temperatures (70- 90 Celsius degree) continuously. This mechanism is probably the reason why there are such profound uncomfortable side effects due to the damage to the nerve itself (19). The neurostimulation of SPG proved efficient for treating cluster headaches (18), but the utilities and infrastructure are unavailable.

Our rationale for choosing PRF laid on the main mechanism of the pulsed radiofrequency is neuromodulation. The neuromodulation process alters the excitability of c-fibers, which are commonly involved in neuropathic pain syndromes (19,20). PRF is also shown evident in some immune activity-pain pathways. The study showed PRF pain management resulted in decreased microglial activity, which is one of the neuropathic pain pathways. PRF also modulates inflammatory cytokines such as IL-6, IL-17, IFN-gamma, IFR8, and TNF-alpha, which mediate neuropathic pain (20). The other mechanisms include adjustment of the inner structure axons, gene expression, and inhibition of extracellular signal-regulated kinase (19). Studies have shown the increase of *c-fos* immunoreactive neurons in the superficial lamine of the dorsal horn three hours after application, meanwhile on conventional radiofrequency the enhancement starts on day seven after the intervention. This enhancing *c-fos* immunoreactive will form prepodinorphin which acts as endogenous analgesia. *c-fos* neuron also acts as an inhibitory interneuron that reduces nociception (21,22). Enhancement of *c-fos* is also inversely correlated with the excitability of C fibers which attenuates the neuropathic pain (19).

This intervention in pain management is also supported by the other study (15,23), which shows the long-term efficacy of the SPG PRF. Small prospective studies of 6 patients with chronic short-lasting unilateral neuralgiform headache with conjunctival injection and tearing accompanied by cranial autonomy symptoms showed that SPG PRF is considered a safe and effective treatment. Three patient patients experienced worsening head pain for two to four weeks after the procedure. However, the authors explained this is a common and high percentage due to the small population of the study (24).

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

There are currently no reports on interventional pain management for cluster headaches secondary to meningioma with SPG PRF due to the rarity of the cases.

The study conducted by Ho and Elahi, 2014 (25) showed successful interventional pain management of cluster headaches secondary to sphenoid meningioma through SPG-CRF. The patient also reported NRS after the intervention pain management is 2-3, and able to wean off all of the narcotics drugs. Although the result of SPG PRF may vary possibly due to different parameters such as frequency, pulse width, temperature, time, cannula, and active tip size; varies tissue types like sympathetic ganglia, peripheral nerves, and DRG; and varies of species such as humans versus rodents (20). The incomplete pain relief in this case was hypothesized due to the presence of the inoperable meningioma still But, according to the patient, she was satisfied with the result and felt significant comfort than before the interventional pain management. She also did daily activity comfortably even at the 10 monthly follow up.

The limitations of this study is the lack of routine monthly follow-up to the pain clinic, and due to the rarity of the cases, future research needs to be done in a larger population and a longer time to determine the effectiveness of the SPG PRF on cluster headache secondary to meningioma pain management.

CONCLUSION

From this study, pulsed radiofrequency on sphenopalatine ganglion block on cluster headache secondary meningioma can be an option whether the conventional therapy is already ineffective. This result needs further study which requires a bigger sample size, and a longer period of follow-up to conclude a more objective result.

Acknowledgment
None.

Conflict of Interest
The authors declare no conflict of interest

Funding Disclosure
This study did not receive funding from any organization.

Authors' Contributors
All authors have contributed to all processes in this research.

REFERENCES

1. Panconesi A. Alcohol-induced headaches: Evidence for a central mechanism? J Neurosci Rural Pract. 2016 Apr 25;07(02):269–75. [PubMed]
2. Fontaine D, Santucci S, Lanteri-Minet M. Managing cluster headache with sphenopalatine ganglion stimulation: A review. Vol. 11, Journal of Pain Research. Dove Medical Press Ltd.; 2018. p. 375–81. [PubMed]
3. Wei DYT, Yuan Ong JJ, Goadsby PJ. Cluster headache: Epidemiology, pathophysiology, clinical features, and diagnosis. Vol. 21, Annals of Indian Academy of Neurology. Medknow Publications; 2018. p. S3–8. [PubMed]
4. Branco M, Rodrigues R, Lopes M, Ruano L. Cluster-Like Headache Secondary to Sphenoid Sinus Mucocele. Case Rep Neurol Med. 2018 Dec 5;2018:1–3. [PubMed]

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

5. Greenberg MS. Handbook of Neurosurgery. 9th ed. Greenberg MS, editor. Vol. 1. New York: Thieme Medical Publishers, Inc. ; 2020. [WebPage]
6. Hadidchi S, Surento W, Lerner A, Liu CSJ, Gibbs WN, Kim PE, et al. Headache and Brain Tumor. Neuroimaging Clin N Am. 2019 May;29(2):291–300. [PubMed]
7. International Classification of Headache Disorder. ICHD. 2018. Cluster Headache. [WebPage]
8. Tronvik E, Jensen R, Cortelli P, Cevoli S, Garcia J, Lainez MJA. Cluster Headache and other Trigeminal Autonomic Cephalgias. Leone M, May A, editors. Cham: Springer International Publishing; 2020.
9. Long RJ, Zhu YS, Wang AP. Cluster headache due to structural lesions: A systematic review of published cases. World J Clin Cases. 2021 May 16;9(14):3294–307. [PubMed]
10. Polyzoidis S, Koletsa T, Panagiotidou S, Ashkan K, Theoharides TC. Mast cells in meningiomas and brain inflammation. Vol. 12, Journal of Neuroinflammation. BioMed Central Ltd.; 2015. [PubMed]
11. Krystel-Whittemore M, Dileepan KN, Wood JG. Mast cell: A multi-functional master cell. Vol. 6, Frontiers in Immunology. Frontiers Media S.A.; 2016. [WebPage]
12. Long RJ, Zhu YS, Wang AP. Cluster headache due to structural lesions: A systematic review of published cases. World J Clin Cases. 2021 May 16;9(14):3294–307. [PubMed]
13. Kou L, Huang J, Xu Y, Han C, Ma K, Guo X, et al. Cluster-Like Headache Secondary to Anamnesis of Sphenoid Ridge Meningioma: A Case Report and Literature Review. Front Neurol. 2019 Jan 25;10. [PubMed]
14. Li J, Ren H, Wang B, Wu D, Luo F. Multicentre, prospective, randomised, controlled, blinded-endpoint study to evaluate the efficacy and safety of pterygopalatine ganglion pulsed radiofrequency treatment for cluster headache: study protocol. BMJ Open. 2019 Mar 23;9(3):e026608. [PubMed]
15. Fang L, Jingjing L, Ying S, Lan M, Tao W, Nan J. Computerized tomography-guided sphenopalatine ganglion pulsed radiofrequency treatment in 16 patients with refractory cluster headaches: Twelve- to 30-month follow-up evaluations. Cephalalgia. 2016 Feb 20;36(2):106–12. [PubMed]
16. Láinez MJA, Puche M, Garcia A, Gascón F. Sphenopalatine ganglion stimulation for the treatment of cluster headache. Vol. 7, Therapeutic Advances in Neurological Disorders. 2014. p. 162–8. [PubMed]
17. Goadsby PJ, Sahai-Srivastava S, Kezirian EJ, Calhoun AH, Matthews DC, McAllister PJ, et al. Safety and efficacy of sphenopalatine ganglion stimulation for chronic cluster headache: a double-blind, randomised controlled trial. Lancet Neurol. 2019 Dec;18(12):1081–90. [PubMed]
18. Ho KWD, Przkora R, Kumar S. Sphenopalatine ganglion: block, radiofrequency ablation and neurostimulation - a systematic review. J Headache Pain. 2017 Dec 28;18(1):118. [PubMed]
19. Park D, Chang MC. The mechanism of action of pulsed radiofrequency in reducing pain: a narrative review. Journal of Yeungnam Medical Science. 2022 Jul 31;39(3):200–5. [PubMed]
20. Sam J, Catapano M, Sahni S, Ma F, Abd-Elsayed A, Visnjevac O. Pulsed Radiofrequency in Interventional Pain

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41

Management: Cellular and Molecular Mechanisms of Action - An Update and Review. Pain Physician. 2021 Dec;24(8):525–32. [PubMed]

21. Fei Y, Huang B, Deng J, Xu L, Yao M. Efficacy of Dorsal Root Ganglion Pulsed Radiofrequency Combined with Paravertebral Injection of Recombinant Human Interferon-α2b in Herpetic Neuralgia. J Pain Res. 2021 Mar;Volume 14:711–9. [PubMed]
22. Li J, Yin Y, Ye L, Zuo Y. Pulsed radiofrequency of C2 dorsal root ganglion under ultrasound guidance for chronic migraine: a case report. J Pain Res. 2018 Sep;Volume 11:1915–9. [PubMed]
23. Elahi F, Ho KWD. Successful Management of Refractory Headache and Facial Pain due to Cavernous Sinus Meningioma with Sphenopalatine Ganglion Radiofrequency. Case Rep Neurol Med. 2014;2014:1–4. [PubMed]
24. Ornello R, Palmisani S, Murphy M, Sacco S, Al-Kaisy A, Lambru G. Sphenopalatine Ganglion Pulsed Radiofrequency for the Treatment of Refractory Chronic SUNCT and SUNA: A Prospective Case Series. Headache: The Journal of Head and Face Pain. 2020 May 23;60(5):938–45. [PubMed]
25. Elahi F, Ho KWD. Successful Management of Refractory Headache and Facial Pain due to Cavernous Sinus Meningioma with Sphenopalatine Ganglion Radiofrequency. Case Rep Neurol Med. 2014;2014:1–4. [PubMed]

Available at https://e-journal.unair.ac.id/IJAR | **DOI:** https://doi.org/10.20473/ijar.V6I12024.32-41