INFORMATION BRIEF (RAPID REVIEW)

RADIOFREQUENCY ABLATION FOR GREATER AND LESSER OCCIPITAL NERVE NEURALGIA

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TITLE: RADIOFREQUENCY ABLATION FOR GREATER AND LESSER OCCIPITAL NERVE NEURALGIA

PURPOSE

To provide brief information on the effectiveness, safety and cost-effectiveness of radiofrequency ablation for greater and lesser occipital nerve neuralgia based on request from the Medical Practice Division, Ministry of Health Malaysia.

BACKGROUND

The occipital nerves are a collection of nerves that emerge from the spinal nerves C2 and C3. They innervate the posterior scalp all the way up to the vertex, as well as other tissues including the ear. The greater occipital nerve (GON), the lesser (or tiny) occipital nerve (LON), and the third (or least) occipital nerve are the three major occipital nerves in the human body. The GON is the largest solely afferent neuron that emerges from the dorsal ramus of the C2 spinal nerve's medial division. From behind the suboccipital triangle, it goes backward between the C1 and C2 vertebrae and traverses between the inferior capitis oblique and semispinalis capitis muscles. Because of its complicated interaction with the surrounding muscles, the GON may be a source of nerve compression, entrapment or irritation. The LON emerges from the ventral rami of the C2 and C3 spinal nerves and travels to the occipital area along the sternocleidomastoid muscle's posterior edge. It pierces the deep cervical fascia near the cranium and ascends. The LON is divided into three branches: auricular, mastoid and occipital **(see Figure 1)**.[1]

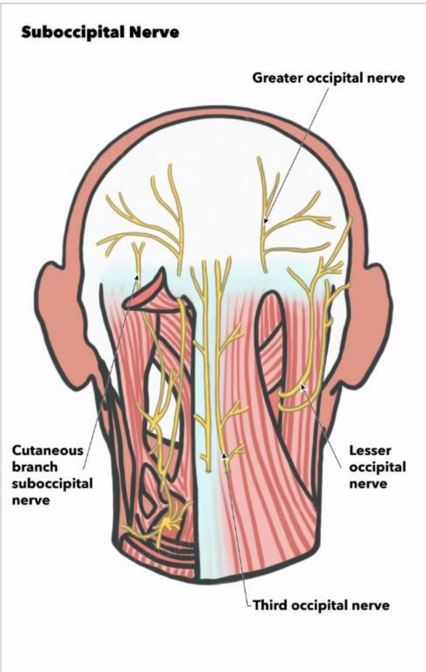

Figure 1: Suboccipital nerve, greater occipital nerve, cutaneous branch suboccipital nerve, lesser occipital nerve and third occipital nerve.[1]

The International Headache Society defines occipital neuralgia as paroxysmal, non-throbbing, shooting, or stabbing neuropathic pain in the distribution of the GON and/or LON that responds to occipital nerve blocks.[2] Occipital neuralgia is distinguished by tenderness covering the nerve trunk or course of the nerve(s), which frequently results in paraesthesias reaching to the apex of the scalp. Patients with migraine and tension-type headaches, on the other hand, may also present with occipital soreness. Other headache disorders such as post-traumatic, cervicogenic and migraine, may also present with occipital pain that responds to nerve blocks, complicating the diagnosis of occipital nerve.[3,4] Although occipital neuralgia is most usually idiopathic, posterior head trauma, entrapment of the GON and/or LON by chronically tensed muscles and upper cervical spine spondylosis are all prevalent causes.[5,6] Compression from intracranial or extracranial arteries, giant cell arteritis, callus formation after spinal fractures, schwannoma and other mass-occupying lesions and tendinomuscular compression are all less common aetiologies.[7-15] In 85.0% of cases, occipital neuralgia is unilateral, with the GON being more usually implicated (90.0%) than the LON (10.0%). In approximately 9.0% of cases, both branches are involved.[16]

According to the World Health Organization (WHO), the global prevalence of present headache disorder (symptomatic at least once in the recent year) among adults is believed to be over 50.0%. Half to three-quarters of adults aged 18 to 65 years in the world have had a headache in the recent year, with 30.0% or more reporting migraine. Headache affects 1.7-4.0% of the world's adult population on 15 or more days each month. Despite regional differences, headache disorders are a global issue that affects people of various ages, races, income levels and geographical places.[17] A headache is not only uncomfortable, but it is also incapacitating. According to the Global Burden of Disease Study, which was updated in 2013, migraine was the sixth leading cause of years lost due to disability worldwide. Headache disorders collectively were third highest. Headache diseases place a palpable burden on sufferers, including significant personal anguish, reduced quality of life and financial costs. Recurrent headache attacks, as well as the continual anxiety of the next one, have a negative impact on family life, social life and career. Long-term coping with a persistent headache issue may predispose the individual to additional ailments. Anxiety and depression, for example, are substantially more common in migraine patients than in healthy individual.[18]

The Malaysian Society of Neurosciences has outlined the management of GON neuralgia in emergency setting and as a secondary headache identification in the Consensus Guidelines on the Management of Headache (2021). The GON neuralgia is treated by using an anaesthetic block (dexamethasone) to end severe migraine.[19] Other treatment of occipital neuralgia aims to alleviate the pain, however it is not a cure. Interventions can be surgical (occipital nerve stimulation, spinal cord stimulation and C2, C3 ganglionectomy) and non-surgical (heat pads, physical/massage therapy, oral medication, percutaneous nerve blocks and botulinum toxin [botox] injections).[20]

Radiofrequency ablation

Previous research suggested that pulsed radiofrequency lesioning could relieve chronic pain by delivering an electrical field and heat bursts (42°C, as opposed to conventional radiofrequency applications that deliver a constant temperature of 60°C to 80°C) to neural tissue without causing neural injury.[21] The procedure is similar to a needle biopsy in that a needle-like probe is inserted into the body **(see Figure 2 and 3)**. The probe emits radiofrequency waves into the surrounding tissue, causing nearby cells to die. As these cells die, the immune system removes them, causing an internal reaction and in general, causing the nodule to shrink. The health care provider uses ultrasound or another imaging technique to place the probe's tip in the correct location. Radiofrequency ablation can be performed in an office or as an outpatient procedure and does not require general anaesthesia. The patient may be given relaxation medication as well as a numbing agent for the area of the skin where the probe is inserted. Most people who have radiofrequency ablation can go home the same day and resume their normal activities within 24 hours.[22] In Malaysia, radiofrequency ablation is not listed in the Private Healthcare Facilities and Services (Private Hospitals and Other Private Healthcare Facilities) (Amendement) Order 2013.[23]

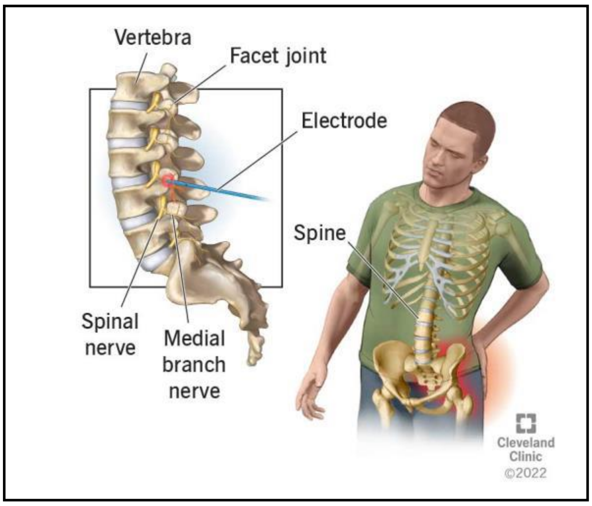

Figure 2: Radiofrequency ablation targets specific parts of a nerve so that it stops sending pain signals to the brain.[24]

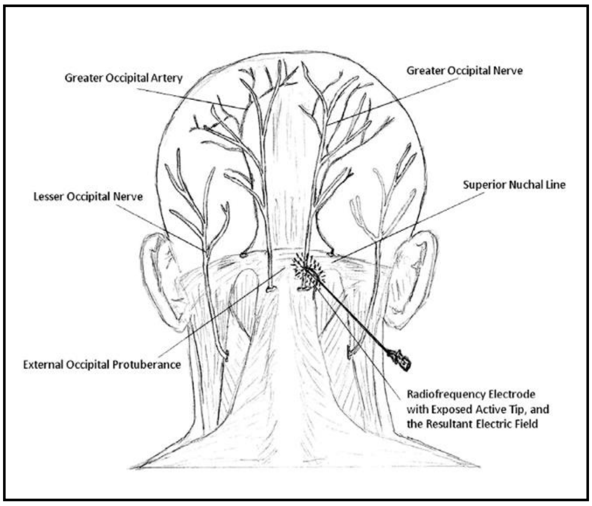

Figure 3: Radiofrequency ablation for occipital neuralgia.[25, level III]

The same procedure can be referred to by either term; radiofrequency neurotomy or radiofrequency ablation. The top five radiofrequency ablation techniques are shown below:[26]

1. **Medial branch neurotomy** is a type of radiofrequency ablation therapy that targets the nerves responsible for transmitting pain from the facet joints and the spinal joints that allow for bending and flexibility.
2. **Lateral branch neurotomy** is used to burn the nerves carrying pain from the sacroiliac joint.
3. **Thermal or conventional** happens when thermal energy is produced by passing a radiofrequency current through an electrode positioned near a nerve. The lesion caused by this heat kills the nerve and prevents it from sending pain signals.
4. **Pulsed ablation** and thermal ablation are comparable. But because it employs a greater voltage, the radiofrequency energy dissipates more easily and produces less heat.
5. **Water-cooled** or cooled radiofrequency, uses active cooling via a continuous flow of water, in a multi-channel electrode, to prevent temperature reaching as high as conventional ablation. This procedure produces a more extensive lesion that stops the nerve from generating painful signals.
6. **Cooled radiofrequency ablation** is a procedure that provides patients with long-term relief. It functions by using imaging guidance to provide radio frequency currents to the damaged nerves via a cooled electrode implanted beneath the skin.
7. **Transdiscal biacuplasty** uses radiofrequency waves to interfere with the brain's pain signals

EVIDENCE SUMMARY

A total of 4,054 titles were retrieved from the scientific databases such the Ovid interface; Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions 1946 to August 22, 2023, Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily 1946 to August 22, 2023, Ovid MEDLINE(R) and In-Process, In-Data-Review & Other Non-Indexed Citations 1946 to August 22, 2023, Ovid MEDLINE(R) ALL 1946 to August 22, 2023, Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily 2019 to August 22, 2023, Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations and Daily 2019 to August 22, 2023, Ovid MEDLINE(R) 1946 to August Week 2 2023, Ovid MEDLINE(R) 1996 to August Week 2 2023, Ovid MEDLINE(R) Epub Ahead of Print August 22, 2023, Ovid MEDLINE(R) Daily Update August 22, 2023 and Ovid MEDLINE(R) 2019 to August Week 2 2023. Searches were also run in PubMed, INAHTA, Cochrane Library and US Food and Drug Administration. Google was used to search for additional web-based materials and information. Additional articles were identified from reviewing the references of retrieved articles. Last search was conducted on 24 August 2023. One systematic review, four randomised controlled trial (RCTs) and one case series were found to be relevant and included in this review.

EFFECTIVENESS

There were five studies reported on the effectiveness of radiofrequency ablation for treating GON and/or LON neuralgia.

An RCT was conducted by Cohen SP et al. (2015) to evaluate the effectiveness of pulsed radiofrequency and steroid injections for occipital neuralgia. The study included 81 participants ≥18 years with a diagnosis of occipital neuralgia based on International Classification of Headache Disorders (ICHD) (second edition), having paroxysmal stabbing pain in the distribution of the GON or LON, tenderness over the affected nerve and relief of pain for at least three hours after bupivacaine local anaesthetic block of the affected nerve, or an ICHD-2 diagnosis of migraine with a predominance of occipital pain and occipital nerve tenderness that responded to local anaesthetic blockade; ≥4/10 pain, failure to respond to previous therapy to include non-opioid analgesics, headache frequency ≥10 days/month. Forty-two participants were randomised to receive local anaesthetic and saline, and three 120 second cycles of pulsed radiofrequency per targeted nerve, and 39 were randomised to receive local anaesthetic mixed with deposteroid and three rounds of sham pulsed radiofrequency. The pulsed radiofrequency group experienced a greater reduction in pain; average occipital pain at six weeks (mean change from baseline -2.743 ± 2.487 versus -1.377 ± 1.970; p<0.001) than the steroid group, which persisted through the six months follow up. Comparable benefits favouring pulsed radiofrequency were obtained for worst occipital pain through three months (mean change from baseline -1.925 ± 3.204 versus -0.541 ± 2.644; p=0.043), and average overall headache pain through six weeks (mean change from baseline -2.738 ± 2.753 versus -1.120 ± 2.100; p=0.037). However, the reduction in severe headache frequency did not reach statistical significant at any time points between the groups. The use of medications for occipital neuralgia and migraine plus occipital neuralgia tenderness did not differ at any follow up. In addition, the pulsed radiofrequency group experienced a lower Athens Insomnia score at six months than the steroid group (mean change from baseline -2.097 [5.696] versus 0.485 [4.285]; p=0.033).[27, level I]

In another **RCT conducted by Yang Y et al. (2015)** examined the efficacy and safety of pulsed radiofrequency in the treatment of chronic migraine on cervical 2-3 posterior medial branches. Forty participants were randomly divided into pulsed radiofrequency and sham groups adhered to the criteria; older than 18 years old of age, suffered for more than six months from chronic migraine, the chronic migraine was diagnosed strictly according to the Third Edition of ICHD and the participants experienced a greater than 30.0% reduction in pain after occipital nerve block of the cervical 2-3 posterior medial branches for the trial. There was a significant difference in the decrease of headache duration between the treatment and the sham groups after following up at one month (t=8.14, p<0.001), two months (t=7.93, p<0.001) and six months (t=7.11, p<0.001). Moreover, the Visual Analogue Scale (VAS) score differed significantly between the groups at one month (t=4.08. p<0.001), two months (t=4.86, p<0.001) and six months (t=3.27, p<0.01) during follow up periods. The participants in the treatment group took a significantly lower aspirin dose compared to the sham group throughout the follow up period; at one months (t=7.00, p<0.001), at two months (t=6.14, p<0.001) and at six months (6.57, p<0.001).[28, level I]

Haspeslagh SRS et al. (2006) in another RCT evaluated on the sequence of various cervical radiofrequency neurotomies. Thirty patients who met the Sjaastad diagnostic criteria for cervicogenic headache were randomly assigned. Fifteen participants had a series of radiofrequency treatments, including cervical facet joint denervation and cervical dorsal root ganglion damages when necessary, and the other 15 participants underwent local injections with steroid and anaesthetic at the greater occipital nerve, followed by transcutaneous electrical nerve stimulation (TENS) when necessary. Visual analogue scores for pain, global perceived effects scores, quality of life scores were assessed at eight, 16, 24 and 48 weeks. All participants also kept a headache diary for assessing the quality of life, global perceived effects, and pain scores. The results showed, there were several improvements in VAS, number of headache days and headache intensity from baseline to 48-weeks period, however there were no significant differences between both groups.[29, level I]

The next **RCT was conducted by Stovner LJ et al. (2004)** to investigate the effects of radiofrequency denervation of facet joints C2-C6 on the side with pain in a group of participants with cervicogenic headache. There were 12 participants with a strictly unilateral cervicogenic headache that was incapacitating, persistent and treatment-resistant. The diagnosis was made solely on the basis of clinical evidence. Six were randomly assigned to sham therapy, and other six were assigned to radiofrequency neurotomy of the facet joints C2-C6 ipsilateral to the pain. Participants were observed for two years, with pain diaries kept for 14 days at intervals of one, three, six, 12, 18 and 24 months. Algometry and measurements of neck mobility were also taken at three, 12 and 24 months. At discharge from the hospital one to two days following the treatment, more participants in the radiofrequency group (4/6) than in the sham group (1/6) reported increasing neck pain. Only one participant in the treatment group and none in the sham group experienced increased neck pain after being discharged from the hospital after three months. At three months, four of the treatment group's participants and two of the sham group's participants had a significant clinical response (30.0% improvement), however at 24 months, only 1/5 of the radiofrequency group and 3/5 of the sham group had the same result **(refer Table 1).**[30, level I]

Table 1: Treatment effect in individual participants (global impression/days with intense headache from pain diary), relation to trauma and litigation and side-effects reported after the procedure and at three months.[30, level I]

Patient no.	Sex	Age (year)	Global impression of effect/% change from baseline days with intense headache: 3 months	12 months	24 months	Trauma related	Litigation	Side-effects reported: after procedure	at 3 months follow up
RF group									
1	M	47	↑/−57	↑/−64	↑/−30	Y	Y	Increased neck pain	No
2	M	43	→/0	→/0	→/0	Y	Y	Increased neck pain	Neck tenderness lasting some days
3	F	45	↑/−100	–	–	Y	Y	No	No
4	F	34	→/+55	–*/0	↑/−11	N	N	Increased neck pain	Increased head and neck pain
5	F	52	↑↑/−36	↑/0	↑/0	N	N	Slightly increased neck pain	No
6	M	44	→/−30	→/+57	→/+71	N	N	Increased neck pain, headache, nausea	Subjective sensory loss in small area in neck
Sham group									
7	M	43	↓/−50	→/−58	→/−50	Y	N	Slightly increased neck pain	No
8	F	41	→/0	↓/+11	→/− **	Y	Y	No	No
9	F	48	→/+27	→/−9	↓/+27	N	N	No	Slightly increased neck pain
10	M	64	↑/−71	→/−86	→/−92	N	N	No	Fasciculations in right cheek for some weeks
11	M	57	↑/0	→/−60	↑/−60	N	N	No	No
12	F	58	→/0	→/0	→/0	N	N	Dizziness	No

M, male; F, female; Y, yes; N, no; ↓, worse; →, No change; ↑, Improved; ↑↑ Markedly improved; – patient unavailable. *Patient could not attend consultation but filled in pain diary at month 3**Patient attended to consultation but did not fill in pain diary at 24 months.

A case series was conducted by Huang JHY et al. (2012) to provide outcome data on the largest study to date evaluating pulsed radiofrequency for occipital nerve and, to determine whether any demographic, clinical or treatment characteristics were associated with success. For a primary diagnosis of occipital nerve or migraine headache with occipital nerve discomfort and a good response to diagnostic blocks, 102 included patients received treatment with pulsed radiofrequency of the GON and/or LON. The International Headache Society definition of occipital nerve served as the basis for the diagnostic criteria. Clinical signs included paroxysmal shooting or stabbing pain in the affected nerve(s)' distribution, frequently accompanied by hypo- or dysesthesias in the affected area(s). Physical exam results included a positive Tinel's sign or discomfort evoked by pressure over the GON or LON. A diagnostic block using a local anaesthetic and temporary improvement was necessary in every case to confirm the diagnosis. The study reported that, 52 (51.0%) patients experienced ≥50.0% pain relief and satisfaction with treatment lasting at least three months. Among the variables linked to a positive outcome, a traumatic inciting event (65.7% success rate; p=0.03), reduced diagnostic block volumes (odds ratio [OR]: 0.72; 95% confidence interval [CI]: 0.62-0.82; p<0.0001), and the use of multiple rounds of pulsed radiofrequency (OR: 2.95; 95% CI: 1.77-4.92; p<0.0001). The factors associated with treatment failure included extension of pain anterior to the scalp apex (OR: 0.32; 95% CI: 0.14-0.73; p=0.006) and persistent secondary gain problems (OR: 0.19; 95% CI: 0.11-0.33; p<0.0001).[25, level III]

SAFETY

There were two studies reported on the safety of radiofrequency ablation for GON and LON neuralgia.

Cohen SP et al. (2015) in an RCT reported that, there were nine participants experienced complications, none of which were serious. In the steroid group, one participant had postoperative dizziness lasting less than two days, two had increased swelling at the injection site (lasting less than a week), two had temporary headache worsening, one of whom also had vomiting (lasting up to two weeks) and another had new-onset eye pain and blurred vision which were not attributable to treatment. There was also one report of worsening headaches (over 10 days), one of oedema (over four days), and one report of a rash that began two days after treatment and continued for one week, were reported in the radiofrequency group.[26, level I]

Doran J et al. (2017) conducted a systematic review to enhance the understanding of the complication profile for occipital nerve stimulation. The results of adverse events were obtained from the MAUDE data base for occipital nerve stimulation device used between June 2007 and June 2017 from the United States of Food and Administration (USFDA) website. All studies were organised into a general classification for distinct device-related problems, patient complaints and adverse event types. The total number of adverse event reports that included each patient complaint and device-related consequence were then counted. The study showed, there were 822 records classified as surgically treatable post-operative difficulties, 121 as device malfunctions, 29 as patient compliance issues and 27 as intra-operative complications. Moreover, patient complaints were found in 683 records in total, including 467 complaints about inefficient stimulation, 122 complaints about inappropriate or excessive stimulation, 50 complaints about device shock and 44 complaints on pain at the implanted pulse generator site. There were 581 post-operative device-related complications, which included 206 instances of lead migration, 157 reports of lead erosion, 155 infections, 46 lead-fractures and 17 lead disconnections.[30, level I]

According to the Medical Device Authority Malaysia, there were several types and brands of radiofrequency ablation devices manufactured by various manufacturer registered.[31] The devices had also received 510(k) from the USFDA.[32]

COST-EFFECTIVENESS

There was no evidence retrieved on cost-effectiveness of radiofrequency ablation for GON and LON neuralgia.

Nevertheless, the cost of radiofrequency ablation greatly depended on the chosen professional and the geographical location. In several countries, the patients had to pay cash or arrange a payment plan with the provider or a third-party source. That being said, the patients would be expected to pay anywhere betwee[redacted] and [redacted] for the procedure, with the results lasting one to two years.[33] Meanwhile in Malaysia, the cost related to radiofrequency ablation in Malaysia range[redacted][34]

CONCLUSION

There were limited evidence on radiofrequency ablation for GON and LON neuralgia. The evidence showed small or no effect in reducing pain in occipital neuralgia, insomnia problem, painkiller consumption, headache frequency and intensity.

In terms of safety, the radiofrequency ablation was reported to cause non-serious adverse events and device-related consequences. Several brands of radiofrequency ablation devices had been registered with the Medical Device Authority Malaysia and cleared by the USFDA.

There was no study retrieved on cost-effectiveness of the radiofrequency ablation for GON and LON neuralgia.

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