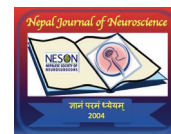


# Efficacy of Radiofrequency Ablation in Chronic Pain Management



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Date of submission: 24<sup>th</sup> January 2022

Date of acceptance: 16<sup>th</sup> October 2022

Date of publication: 30<sup>th</sup> October 2022

## Abstract

The aim of this study is to determine the efficacy of radiofrequency ablation in management of chronic pain. Radiofrequency ablation in pain management was done in 21 patients who were experiencing chronic pain in different regions of the body. Patients were divided into three groups according to region of pain i.e. chronic lower back pain, trigeminal neuralgia, and osteoarthritis. Pre-treatment and Post-treatment pain score were taken with numeric rating scale (NRS). Denervation was achieved in the pain originating region with the help of Cosman RFG-1A radiofrequency generator under fluoroscopy obtained from Axiom Artis U. The comparison between pre pain score and post pain score revealed the pain was almost nullified in 52% of the patients whereas in 33% it was reduced to tolerable levels and 15% still had some trouble, though pain was slightly reduced as compared before ablation. Radiofrequency ablation alleviated the pain in cases where oral medications were not enough and surgical management could not be done or had a failure.

**Key words:** Radiofrequency ablation, chronic back pain, trigeminal neuralgia, osteoarthritis, pain management.

## Introduction

Radiofrequency has a wide range of medical application including in oncology, vascular surgery, cardiac and pain management.(1,2) Radiofrequency is a form of electromagnetic energy. It is non-ionizing radiation, unlike x-rays and gamma rays. It is absorbed by any living

tissue in the form of heat. Radiofrequency ablation is used in pain management to destroy the conduction pathway of the nerve fibers responsible for transmitting the pain signals.(3) Regardless of whatever the heat source, the nerve fibers are destroyed when a maximum threshold is reached causing irreversible damage; inducing tissue necrosis through heating.(4) The main effect of radiofrequency occurs due to the absorption of these electromagnetic energies by the living tissues in the form of heat, without alteration of basic chemical structure in the cells.(5,6) Heating a cell at 45°C causes irreversible damage of the cells, however for complete destruction of cell requires a longer exposure. Cells are damaged within 1-2 minutes of exposure, when the exposure temperature is increased to 60°C.

Radiofrequency ablation for alleviation of pain has been used since 1900's. Percutaneous radiofrequency ablation of trigeminal nerve divisions was first attempted by Hartel in early 1900s and later by Sweet in 1970s. (7) Later, Choi and the team investigated the use of RF treatment to alleviate chronic knee osteoarthritis pain. The randomized controlled trial demonstrated greater improvements in pain, function, and satisfaction for patients treated with RF than for controls.(8) The use of RF ablation in pain management has been one of the good choices for a patient with chronic pain, but this technique has been out shadowed by newer techniques like laser therapy, gamma knife and micro-vascular decompression (MVD). In context of Nepal, for the patient who do not

### Access this article online

Website: <https://www.nepjol.info/index.php/NJN>

DOI: <https://doi.org/10.3126/njn.v19i3.42581>

### HOW TO CITE

Dhungel P, Dabadi S, Dhungel RR, Gurung P, Shrestha R, Acharya S, Dhakal S, Shrestha P, Rajbhandari P. Radiofrequency ablation in chronic pain management: aid or option. NJNS. 2022;19(3):39-45.



**Conflict of interest:** None of the authors have potential conflicts of interest to be disclosed.

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ISSN: 1813-1948 (Print), 1813-1956 (Online)



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choose surgical procedure as a treatment option as well as patient where MVD results were not successful can go for RF ablation.

### Method and Materials

This study was approved by the medical ethics committee of Annapurna Neurological Institute and Allied Sciences (ANIAS). The medical ethics committee approved a waiver of consent for the collection of data. A retrospective series study was conducted between January 2016 and November 2019. All patients who underwent RF ablation for various pain in ANIAS were included in this study. The analysis was done based on pre operative and post operative pain score rating. This study includes descriptive analysis for efficacy of RF ablation.

A total of 22 patients of chronic pain who underwent radiofrequency ablation were enrolled. Patients who previously had surgical intervention for the management of pain were also included in the study.

Cases were categorized as chronic back pain, knee osteoarthritis and trigeminal neuralgia. Chronic pain was considered only for the patients who had been experiencing pain for at least 4 months. The pain analysis was done based on the pain score assigned to patient pre-treatment and post treatment. The pain score was assigned on the scale of 0 to 10 based on numeric rating scale (NRS), 0 being the condition with no pain and 10 being the worst possible pain.(9) The pain score was assigned by visual and verbal examination of each patient.

Patients were taken a brief oral history about their chief complaint, duration of pain and pain scale rating. History of drug used for pain relief, other medications and previous surgical history were taken. Some patients were injected with steroids and some with local anesthesia and asked for a follow up when the pain initiates. On the next follow up, the patients were taken for ablation.

#### RF Generator

Cosman RFG-1A, radiofrequency generator, was used to produce the required radiofrequency waves. The Cosman RFG-1A produces radiofrequency waves of 480kHz which is in the range of medically used radio frequency signal.(10) Cosman RFG-1A provides a good user interface through which various parameters can be altered. For stimulation, the stimulation button and frequency for sensory and motor stimulation can be selected. The stimulation pulse (V/ma) can be varied through a knob. Continuous as well as pulsed mode RF can be generated.

In this study, a continuous RF signal was used. The time for exposure and the target temperature can be set and is displayed on a Liquid crystalline display (LCD). Once the grounding pad was attached to patient's body and the active electrode is placed on the target nerve the

device displays the impedance value of the nerve. The impedance was maintained in between 200-300 ohm. Also, the temperature of the nerve during exposure is displayed which is near about the target temperature initially set by the user.

#### Trigeminal Neuralgia

For the treatment of chronic facial pain patient was placed in supine position with head extended. The grounding pad was attached to the scapula. The interventional procedure was performed under the fluoroscopic image guidance. The image was taken with Axiom artis U, an interventional lab from Siemens. The C arm was positioned in a way to access the Foramen Ovale. With local anesthesia, a 22-gauge 10cm RF guide cannula was then inserted directed towards the pupil, followed by the insertion of RF electrode. Once the electrode was placed on the Foramen Ovale targeted to trigeminal ganglion [Figure 1], a stimulation pulse of 2 Hz is supplied with amplitude of around 1.5volts/amp. This pulse causes the muscle contraction of lower jaw which justifies the electrode placed on the trigeminal nerve. The motor stimulation was then followed by a sensory stimulation at 50Hz, application of which induces the pain similar to the patient's complain, which justifies the correct positioning of electrode. Then, a lesion with RF pulse was made by setting the electrode tip temperature to 60°C and maintained for 60 secs. The lesion was repeated 2 to 3 times on trigeminal nerve to prevent nerve conduction of pain signal.

#### Chronic Back pain

The patient was placed in a prone position to access the vertebral column and lumbar medial nerve. The grounding pad was place on thigh. The guide tube and needle were then inserted directed towards the lumbar facet. The procedure was performed under the fluoroscopic image guidance. Once the needle was placed on lumbar facet and alongside of lumbar medial branch the RF electrode was inserted via the guide tube. [Figure 2] Then sensory stimulation of 50 Hz and motor stimulation of 2 Hz with pulse width of 1 sec was applied to confirm the correct placement of the electrode. Once confirmed, the lesion was made by application of RF pulse generating the temperature of 60°C for 60 sec. The lesion was repeated three times to ascertain the complete ablation of the pain carrying nerve.

#### Osteoarthritis

Diagnostic criteria includes

- (a) severe knee OA, pain lasting more than 3 months,
- (b) positive response to a diagnostic genicular nerve block and
- (c) no response to conservative treatments.

## Radiofrequency ablation in management of chronic pain

Patient was placed on supine position to access the genicular nerve in knee. The grounding pad was placed on the thighs. For the pain management three nerves, superolateral (SL), superomedial (SM) and infero-medial (IM) branches of genicular nerve were ablated. As in facial pain and back pain the guide cannula and needle was first inserted under the fluoroscopic image guidance and once placed on target the RF electrode was inserted through guide cannula. The sensory and motor stimulation of 50 Hz and 2 Hz respectively were applied for confirmation of target and RF pulse at 60°C for 60 sec was then applied to ablate the nerve carrying pain signal.

### Post interventional procedure

For all the cases, patients were injected with some local anesthesia and steroids to comfort him/her about needle penetration pain. The wound was cleaned and the patient was shifted to ward for observation. The patients were discharged on same day if no any complications or side-effects were seen during observation. The patients were asked for follow up on necessity.

## Results

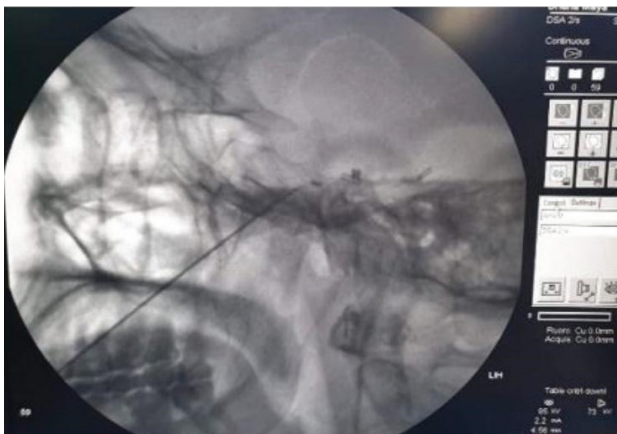
Out of 22 cases, 13 cases of chronic back pain, 6 cases of facial trigeminal neuralgia and 3 cases of osteoarthritis were analyzed. [Figure 5] Among the cases studied, 16 patients undergoing the radiofrequency ablation did not have any past surgical history for same pain management while 6 patients were previously operated for the management of same pain. [Figure 3] Male to female ratio

was 4:1, with 17 male and 5 female were included in the study. [Figure 4]

Among the 13 (60%) patients treated for chronic back pain, 10 were diagnosed with the lower back pain, 1 was diagnosed with the discogenic pain and 2 with back pain in gluteal region. The average time span of complain for back pain was 31 months ranging from 4 months to 8 years. The average age of patients treated for back pain was 43±15 years. The pre-treatment pain score ranged from 8 to 10. [Figure 6] While the pain score reduced to the range of 0 to 3 after the radiofrequency ablation.

Six patients (27%) with trigeminal neuralgia, five were diagnosed with trigeminal neuralgia and one with post herpetic neuralgia. The average time span of complain was 6 years ranging from 2 years to 10 years. Four male and two females were treated with radiofrequency ablation. Among the six cases one male diagnosed with trigeminal was previously operated for the same pain. The average age of the patients was 54±15years. The pre-treatment pain score ranged from 8 to 10. And the post treatment pain score did not exceed 2. [Figure 7] This suggests the complete alleviation of pain in patients treated for facial pain with radiofrequency ablation.

Similarly, three (13%) of the patients treated for chronic knee pain included three females with average age of 70±13 years, diagnosed with osteoarthritis. Their time span of complaint was 5years, 3years and 2years respectively. Their average pre-treatment pain score was 9 which reduced to 2 after the radiofrequency ablation. The patient followed up with decreased pain and reported the easiness in movement.



*Figure 1: Fluoroscopic image during radiofrequency ablation*



*Figure 2: Fluoroscopic image of RF ablation in lumbar facet.*

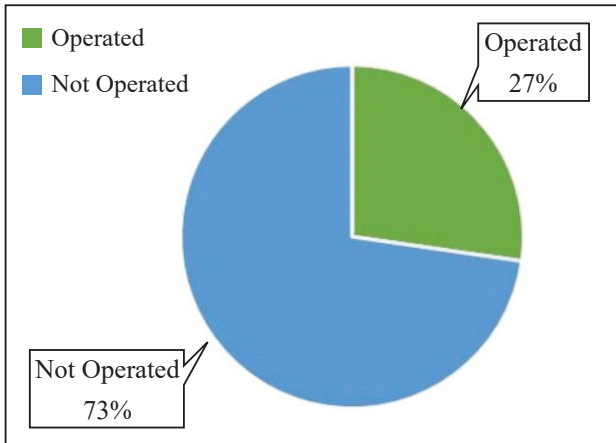


Figure 3: Classification based on previous surgical management.

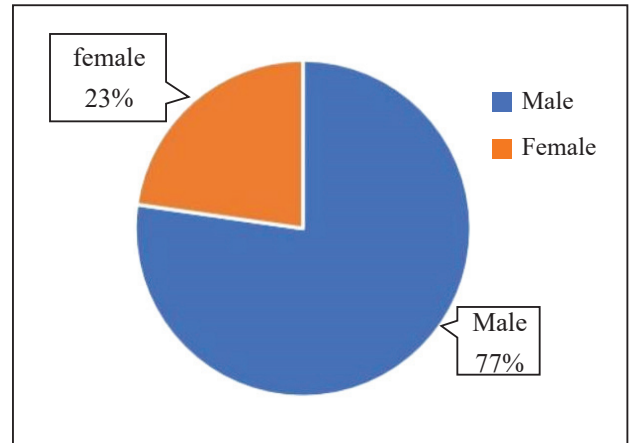


Figure 4: Classification of patients based on gender

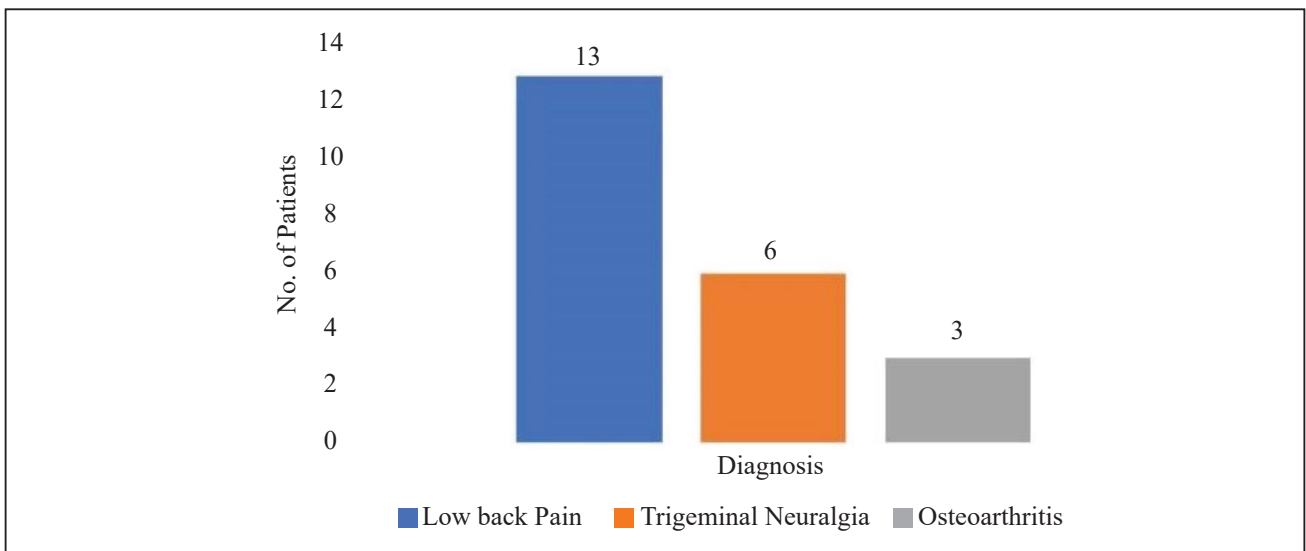


Figure 5: Number of patients categorized based on their diagnosis.

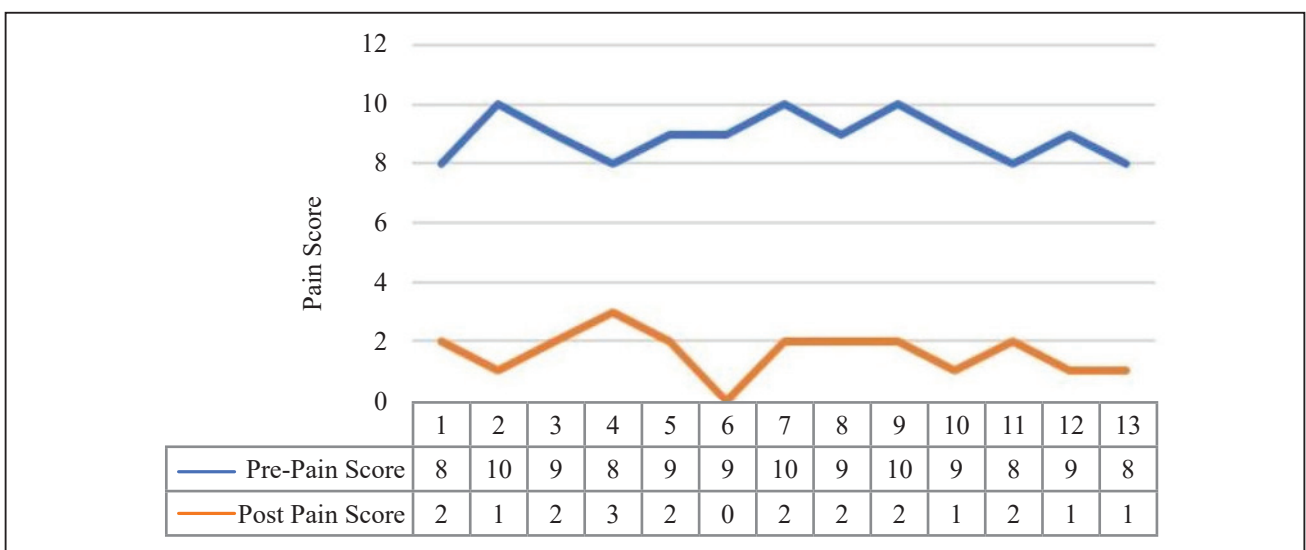


Figure 6: Pain score for back pain.





Figure 7: Pain score for facial pain.

## Discussion

Pain has been affecting quality of life in multiple ways. Some impacts of lower back-pain, to include, are experiencing a sense of disablement, changes in mood, and a lack of understanding from other people. Pain due to Trigeminal Neuralgia are often aggravated through basic life activities like chewing, speaking and swallowing. Osteoarthritis on the other hand has led people to complete restriction of movement.(11) Pain in whatever regions of body has affected people in both mental and physical aspect. Radiofrequency ablation, which is one of the technique or interventional procedure for pain management was studied to enhance its benefits over other surgical or non-surgical procedures.(12)

For patients with trigeminal neuralgia, whose annual incidence is about 0.0047%, had the options of microvascular decompression, radiosurgery and radiofrequency ablation for pain management.(13,14) Post RF treatment pain scores shows the efficacy of RF ablation among patients who were unfit for MVD or refused invasive treatment, even though reputed techniques like MVD and newer techniques like gamma knife therapy are available. In this study, RF ablation of trigeminal neuralgia performed on six patients showed 100% improvement in their pain, which suggests RF ablation to be a better option for pain relief in case of trigeminal neuralgia.

Similarly, the Symptomatic impact of knee osteoarthritis is estimated at 240/100,000 people per year. (15)Symptoms presented by patients with osteoarthritis include pain, stiffness, joint instability, functional limitations, and muscle weakness.(16) Study done on two of the patients with osteoarthritis treated with RF ablation, whose post interventional pain score was satisfactorily

decreased and showed easier and smoother movement. The results obtained in this study is supported by the findings of Choi et al, where 19 patients treated for osteoarthritis reported with decreased pain after RF ablation of genicular nerve. In the study 50% of the patient reported to be pain free while remaining followed up with decreased pain.(8) However, all the three patients with osteoarthritis treated in our center reported their pain subsided after ablation and did not complain of recurrence during their follow up.

Likewise, Low back pain (LBP) affects 9–17% of the world’s population annually, and is the foremost cause of years lived with disability.(17) We were able to mitigate the pain for 13 patients with the complaint of chronic low back pain. Among the 13 cases 47% of the patients reported they were pain free while remaining patients followed up with improvement in pain and increase in flexibility as compared to pre-intervention. This data suggests that though pain cannot be completely eliminated through RF ablation, it can improve the patients’ lifestyle by suppressing the pain to tolerable range. Similar study on 252 patients by Martinez-Suarez et al. reported 74% of the patient had symptomatic improvement of low back pain.(18) Radiofrequency ablation on 324 patients reported by Cho et al suggested the efficacy of RF ablation to 90%, where 45% patients were completely pain free and 55% had improvement in their condition.(19) These data in coherence with our studies proves the efficiency of treatment in low back pain with RF ablation.

Above all, the accuracy of target and correct performance is the crucial for a correct radiofrequency ablation. This accuracy and preciseness were confirmed with sensory and motor stimulation along with real time imaging. The results, however, does not compare the effect of radiofrequency. The objective of our study was

to reduce the pain in patients experiencing chronic pain that was either way not relieved by medication, refused to surgical management or where surgical management was not able to manage the pain. Ablation on different regions of body was done and the variation in results was due to uneven number of patients in each group, the patient selection criteria, and nature of pain.

In our study, radiofrequency ablation at 60°C limiting temperature over 60 seconds for three cycles was used. This radiofrequency approach used a time and temperature that are between typical pulsed radiofrequency modulation (40 °C) and continuous radiofrequency ablation (80°C or above) times and temperatures.(20) It was found that using this RF time and temperature protocol, the nerves were ablated enough to cause significant relief without completely damaging the nerve, causing profound numbness and complete loss of motor function.

This interventional procedure also incorporated patients with past history of surgery for same pain, patients who were not suitable for surgical management, and also patients with surgical failures. Few follow ups and no overnight hospital stay and short operative period can also be an add-on to the benefits of radiofrequency ablation that include minimal invasiveness, no chemical drug consumption and quick relief of pain. Furthermore, Radiofrequency ablation was not associated with any post-operative complications and recurrence of same pain. No complain of recurrence of same pain was observed from the patients. With all these evidences, radiofrequency ablation can be a go-to option for people dealing with chronic pain as compared to other surgical or non-surgical techniques being used for pain management.

The patients with RF ablation in our center did not report any recurrence of the same pain. This proves the RF ablation to be very effective in pain management.

## Conclusion

Regarding its efficiency, procedural time, recovery time and cost, Radio frequency ablation can be one of the go-to option in treatment of chronic pain associated with lower back, knee or trigeminal nerve.

## Acknowledgement

We would like to express our gratitude to the staff of the neuro-intervention team, and anesthesiologists from the Annapurna Neurological Institute and Allied Sciences.

## Abbreviation

RF: radiofrequency

RFA: radiofrequency ablation

TN: Trigeminal Neuralgia

MVD: Microvascular Decompression

LBP: Lower Back Pain

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