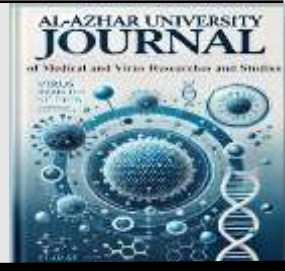




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Bipolar versus Unipolar Pulsed Radio Frequency in Chronic Lumbosacral Radicular Pain

**Marwa Shaban Mohammed Ramadan¹, Nour El-Hoda Nasr Abou Elnasr¹ Rasha lofty
Elsaid Said¹ and Rasha Abd-Elhamed Zaky¹**

**¹Department of Anaesthesiology & Intensive Care and Pain Management, Faculty of
Medicine for Girls, Al-Azhar University, Cairo, Egypt.**

***E-mail: RashaZaki99@gmail.com**

Abstract

One of the most frequent complaints in neurosurgical practice is lumbar radicular pain (LRP), which poses a challenge in achieving proper pain control. To evaluate the effect of bipolar Pulsed radio frequency and monopolar Pulsed radio frequency on the dorsal root ganglia for the management of lumbosacral radicular pain. Primary outcomes measure the degree of pain and Functional ability in the 1st, 3rd month by using Numerical Pain Rating scale and Oswestry Low Back Pain Disability Questionnaire. Secondary outcomes measure the degree of pain and functional ability at 6th month by using Numerical Pain Rating scale and Oswestry Low back Pain Disability Questionnaire. This is a randomized comparative uncontrolled clinical study that was certified by the approval of Ethical Committee of Al-Azhar Faculty of Medicine and conducted in the department of Anesthesia, Al-Zahraa University hospital. A total of 90 patients with low back pain were randomly allocated into two groups, 45 patients in each: Monopolar Pulsed radio frequency group and Bipolar Pulsed radio frequency group. in the first group each patient will be treated with monopolar Pulsed radio frequency on the affected DRG at 42 °C for 360 second only with injection of 1.5 mg dexamethasone plus 2 ml of 1% lidocaine per root. in the second group each patient will be treated with bipolar Pulsed radio frequency on the affected DRG at 42 °C for 360 second only and injection of 1.5 mg dexamethasone plus 2 ml of 1% lidocaine per root. No statistically significant difference between the two studied groups as regard Numerical Pain Rating scale (NRS) assessed at baseline and after 1 month ($p=0.504$ & 0.095). A statistically significant higher mean NRS after 3 months among monopolar than bipolar groups (3.20 ± 1.56 versus 2.36 ± 0.82 , $p=0.002$). Also, statistically significant higher mean NRS after 6 months among monopolar group than bipolar group (2.83 ± 1.35 versus 2.28 ± 0.82 , $p=0.016$). No statistically significant difference between the two studied groups as regards Oswestry Low Back Pain Disability index (ODI) assessed at baseline and after 1 month ($p=0.396$ & 0.291). A statistically significant difference of ODI after 3 months & 6 months with better improvement among bipolar group than unipolar group of PRF. The current study found that both monopolar PRF and bipolar PRF stimulation to the DRG effectively reduced chronic lumbosacral radicular pain. Furthermore, we showed that bipolar PRF provided excellent pain alleviation and little impairment.

Keywords: Bipolar, Chronic pain, Dorsal root ganglion, Lumbosacral radicular pain, Monopolar, Pulsed radiofrequency

1. Introduction

Discomfort, stiffness, or muscular tension that is situated above the inferior gluteal folds and below the costal edge, with or without leg discomfort (sciatica), is commonly referred to as low-back pain. Between 9.9% and 25% of people have low-back pain each year together with leg discomfort that travels below the knee [1]. Approximately 90% of those who have low back pain will not have a known cause for their symptoms. Problems with the nerve roots are a sign of potential underlying disease [2].

Intervertebral disc herniation (DH) is the most frequent cause of LRP, followed by spinal stenosis (SS) and failed back surgery syndrome (FBSS) [3].

Radicular discomfort may be treated with medication (paracetamol, NSAIDs, opioids), however there is little data to support the prescription of any specific medication [4].

Physical exercise, manual therapy, or psychological therapy are examples of noninvasive, non-pharmacological interventions that frequently produce short-lived results [5].

Although there are no long-term side effects to anticipate, epidural corticosteroid injections have been used extensively in clinical practice for many years. However, they should be advised as a short-term pain reliever, with a 0% to 9.65% chance of complications.

Because it permits the injection of the lowest volume to the anterior epidural space, the site of pathology in lumbar disc prolapses with radiculopathy, transforaminal epidural steroid injection (TFESI) under radiological guidance appears to be more successful than epidural injection [4].

In certain patients with severe symptoms and no benefit from conservative treatment, surgery is typically advised.

This procedure offers better short-term pain relief than long-term conservative care, but after one or two years, no discernible differences between surgery and conservative treatment have been found [6]. Additionally, a number of adverse consequences, including infection, hemorrhage, dural rupture, nerve damage, and paralysis, are linked to surgery [7].

By administering high-frequency current intermittently, pulsed radiofrequency (PRF), a relatively novel noninvasive approach, prevents the temperature from rising over the crucial 42°C threshold [8]. The impact of PRF has been explained by three main analgesic pathways. First, by increasing the expression of the C-fos gene in the superficial lamina and reducing glial cell activation, it may alter the way pain signals are transmitted in the dorsal horn. Second, by raising Met-enkephalin levels, it can trigger the release of endogenous opioids. Lastly, since serotonin and alpha-adrenergic antagonists counteract PRF's effects, it may function by promoting the descending inhibitory pain pathway. The PRF's delay might be explained by these factors [9].

In monopolar radiofrequency we use 1 PRF cannulae but in bipolar PRF we use 2 parallel PRF cannulae which provide denser and larger electrical fields [8].

The purpose of this study was to assess how bipolar PRF affected the dorsal root ganglia in order to treat lumbosacral radicular pain. Furthermore, we contrast the effects of monopolar and bipolar pulsed radio frequencies.

2. Patients and Methods

After signed informed consent and approval by the research ethical committee of the Al-Azhar University's college of medicine for girls in Cairo, Egypt. Ninety

individuals suffering from low back pain will participate in this prospective randomized controlled clinical investigation. December 2023 until March 2024. Patients will be divided into two groups at random, with 45 patients in each group: Each patient in the monopolar group (45 patients total): received treatment with monopolar pulsed radio frequency on the affected DRG at 42 °C for 360 seconds only, along with an injection of dexamethson and local anesthetic, employing C-arm and contrast media.

Each patient in the bipolar group (a total of 45 patients): received treatment with bipolar pulsed radio frequency on the affected DRG at 42 °C for 360 seconds only, along with an injection of dexamethson and local anesthetic, employing C-arm and contrast medium.

The study included patients aged 21 to 70 who were classified as ASA I or II, had persistent low back pain lasting more than six months with signs and symptoms of nerve root compression (radicular pain), had no indication for open surgical intervention, had no significant sensory deficit, no chronic or progressive motor deficit, and had persistent radicular pain rated at least 4 on the NRS. The study excluded patients with coagulopathy or an INR greater than 1.2, advanced cancer, known neurological or neurodegenerative diseases, including those with impaired neurotransmission, active mental or psychiatric conditions, uncontrolled respiratory conditions, including obstructive sleep apnea, other uncontrolled medical conditions, indications for open surgery, significant sensory deficit, and chronic or progressive motor deficit.

Following the surgery, all patients were monitored in the post-operative care unit (POCU) for a minimum of half an hour, during which time any problems were noted. Continuously monitored blood pressure and pulse oximetry will be used to record any discomfort, nausea, hypotension, or weakness in the legs.

After being reassured, patients with paralysis in their lower limbs waited for an hour. Antiemetic medications such as

intravenous ondansetron 4 mg and intravenous fluids were used to treat vomiting, while analgesic medications such as paracetamol 10-15 mg/kg and reassurance were used to address leg or back discomfort. All patients were given the required instructions and phone numbers prior to being released.

At the first, third, and sixth months, all patients were followed up with either a phone interview or follow-up visits to the pain clinic.

A conventional 10-point NRS was used to rate pain, with 10 denoting the worst possible agony and 0 denoting no pain at all.

At the first, third, and sixth months, functional capacity was assessed using the ODI.

The sample size calculation was estimated using the MedCalc program version 11.3.0.0 and based on recent research by Chang et al. [10], who found that the decreases in NRS scores over time were considerably bigger in the bipolar PRF group three months following treatment. 19 patients (76.0%) in the bipolar PRF group and 12 patients (48.0%) in the monopolar group reported effective pain reduction (pain alleviation of $\geq 50\%$). The confidence interval was adjusted to 95%, the margin of error accepted to 5%, the power of the test to 80%, and the ratio between the two groups to 1:1. The minimal sample size for this study will be 88 patients (44 in each group). We raised the number of patients in each group to 45 to improve the paper's accuracy.

2.1 Equipment and material used:

- C-arm fluoroscopy for screening: Siemens, ziehm
- Anesthesia machine with its monitor: Drager, Fabius Plus
- Instruments for tracheal intubation: Endotracheal tube and Laryngoscope
- Cannula (22 gauge), Intravenous (IV) line.
- Drugs can be used for conscious sedation as: midazolam and fentanyl.

- All resuscitation medication that can be used when any expected adverse effect occurs such as: Ephedrine, Hydrocortisone, Atropine, etc.
- Drugs used for injection at the study:
 - Local anesthetic (lidocaine HCL 1 %) 2 ml/ root, PFIZER INC, Hospira
 - Steroids (dexamethazone) 1.5 mg/ root, EIPICO
 - Water soluble contrast solution (Ultravist)
- Radiofrequency Sharp Needle ,20-gauge curved tip (blunt needle-Neuro Thermo, 100 mm with 10 mm active tip) it is a uniform-tapered insulation, enhanced dielectric strength, and hub-reference indicator, highly radiopaque, and it is designed to work with non-epimed manufactured RF thermocouples
- Reusable RF thermocouples 27 Gauge (Neuro Therm, Epimed) Available in diameter (18, 20, 21, 22 and 27 gauge) Available lengths - 50mm, 54mm, 100mm, 145 mm, 200 mm Colour coded for identification. Matching probes with matching size cannula. The risks and advantages of the operation should be reviewed with the patient, and if they accept, they must sign a written consent. Then all patients were subjected to history taking to avoid exclusion criteria, general, local and physical examination and preoperative laboratory tests.
- Radiofrequency generator: Dior's, Cosman G4.

2.2 Pulsed Radiofrequency procedures:

- a. Positioning the patient prone on OR table using horseshoe pillow, making sure that soft tissues are free to avoid pressure atrophy and supporting pressure areas.
- b. Exposure of low area of the back and sterilization by betadine
- c. Under complete aseptic conditions, the skin and underlying tissue are injected with local anesthetic (lidocaine 2%)
- d. Anteroposterior fluoroscopy views are taken to determine the target root level.

e. Cranial/caudal tilting is done to align the vertebral endplates at the target level.

f. Oblique view toward the affected side is then used to obtain the Scotty dog appearance at the target level.

g. In Safe triangle approach: the superior articular process, SAP, (ear of the dog) of the lower level is in line with the 6 o'clock position of the pedicle (eye of the dog) of the upper level. The entry site is anesthetized. Using the tunnel (end-on) technique, RF needle is directed just below the pedicle at 6 o'clock of upper vertebra OR just above SAP of lower vertebra.

h. In Kambin's triangle approach: the target is the junction of SAP and transverse process or infero-lateral part of SAP. In monopolar PRF: one RF needle used only. In bipolar pulsed radiofrequency: two RF needles are placed bilaterally around the DRG, the distance between the 2 needle tips is less than 1 cm but not in contact with each other tip.

i. To confirm the target location:

j. Sensory stimulation at 0.4-0.7 V on the affected nerve roots to avoid the intraganglion placement.

k. Motor stimulation at 0.8-1.3 V on the affected nerve roots to avoid placement of needle near anterior nerve root.

l. Radiculography by injection of 0.5 ml of water-soluble contrast solution (Ultravist) in AP view to confirm the appropriate placement, the nerve root should be outlined, and the contrast may flow medially into the epidural space.

m. Lateral view is used to confirm the location of the needle tip in the IVF.

n. Negative aspirations are made to exclude intravascular entry.

o. inject 1.5 ml of 1 mg/ml dexamethasone solution in normal saline plus 2 ml of 1% lidocaine per root.

p. administered Pulsed radio frequency treatment on the affected DRG at 5 Hz and 5-ms pulsed width for 360 seconds only at 45 V with temperature does not exceed 42 °C.

q. The needle is removed with LA or saline flush to clear the needle of steroid.

r. The skin area of needle entry is cleansed, and a bandage is placed.

s. The patient is then taken to a recovery area where monitoring for complications of the procedures is undertaken.

t. Procedure-related complications such as Infect, Nerve root injury, Injury or occlusion of lumbar segmental arteries especially the artery of Adamkiewicz, Intradiscal injection, Local anesthetic toxicity, allergic reaction, nausea and vomiting.

u. To avoid the complications:

1. Give patient antibiotic pre procedure and after the procedure

2. Confirm the correct position of needle avoid.

3. Minimize vascular injury by A blunt needle, non-particulate steroids and the needle is directed towards lower part of IVF.

The primary outcome measures the level of pain and functional capacity in the first and third months using the ODI to assess functional ability and a conventional 10-point NRS, where 0 denotes no pain and 10 the worst possible pain.

However, the secondary outcome uses the ODI and a NRS to quantify the level of pain and functional abilities after six months.

2.3 Statistical Analysis:

Data was gathered, edited, coded, and loaded into SPSS version 23 (Statistical Analysis for Social Science). Whereas the qualitative data was displayed as numbers and percentages, the quantitative data was displayed as the mean, standard deviations, and ranges where it was normally distributed, and the median with inter-quartile range when it wasn't. Based on the kind of data (parametric or non-parametric), the appropriate test was employed to compare the two groups under study. A 95% confidence interval and a 5% acceptable margin of error were established

3. Results

In order to assess the impact of bipolar PRF on the dorsal root ganglia for the treatment of lumbosacral radicular pain, the current study was a randomized clinical trial that involved 90 patients with low back pain who were divided into two equal groups of 45 patients each: the monopolar PRF group and the bipolar pulsed radio frequency PRF group. Furthermore, we contrast the impact of monopolar and bipolar PRF. As show in Table .1 no statistically significant difference was detected between studied groups as regard age, sex, body mass index and ASA classification. Data expressed as mean $\pm$ SD (Min-Max). P-value ≤ 0.05 was considered significant. P-value ≤ 0.001 was considered as highly significant. P-value > 0.05 was considered insignificant. As shown in Table .2 data expressed as mean $\pm$ SD (Min-Max). P-value ≤ 0.05 was considered significant. P-value ≤ 0.001 was considered as highly significant. P-value > 0.05 was considered insignificant as shown in Table .3 Numerical pain rating scale between the two groups studied statistically significant lower mean Numerical Pain rating scale among bipolar than monopolar groups. As shown in Table .3 Numerical pain rating scale between the two studied groups statistically significant lower mean Numerical Pain Rating scale among bipolar than monopolar groups. As shown in Table .4 numerical pain rating

scale during follow up for bipolar group. statistically significant decrease in Numerical Pain Rating scale during follow up. As shown in Table .5, numerical pain rating scale during follows up for mono polar group Table .5: statistically significant decrease in Numerical Pain Rating scale during follow up.

As shown in Table .6 Oswestry Low Back Pain Disability index during follow up between the two stable groups studied. A statistically significant difference of

Oswestry Low Back Pain Disability index with better improvement among bipolar than mono polar groups.

As shown in Table .7 Oswestry Low Back Pain Disability index during follow up for bipolar group demonstrated statistically significant improvement.

As shown in Table .8 Oswestry Low Back Pain Disability index during follow-up for mono polar group demonstrated statistically significant improvement

Table 1: Comparison of demographic characteristics between the two groups studied.

	Bipolar N=45	Monopolar N=45	Test of significance	P value
Age / years Mean $\pm$ SD	35.64 $\pm$ 11.38	32.38 $\pm$ 6.66	t=1.66	0.100
Sex				
Male	28(62.2)	29(64.4)	X ² =0.048	P=1.0
Female	17(37.8)	16(35.6)		
BMI (Kg/m ²) Mean $\pm$ SD	30.31 $\pm$ 2.84	30.78 $\pm$ 4.46	t=0.593	0.555
ASA				
I	43(95.6)	41(91.1)	FET=0.714	0.677
II	2(4.4)	4(8.9)		

t: Student t test, FET: Fisher exact test, X²=Chi-Square test.

Table 2: Comparison of pain duration between the two studied groups.

	Bipolar N=45	Monopolar N=45	Test of significance	P value
Pain duration (years) Mean $\pm$ SD	8.67 $\pm$ 1.54	8.47 $\pm$ 1.69	t=0.588	0.558

t: Student t: test

Table 3: Comparison of NRS between the two studied groups.

Numerical Pain Rating scale	Bipolar N=45	Monopolar N=45	Test of significance	P value
Baseline	5.82 $\pm$ 1.05 (4-8)	5.69 $\pm$ 0.82 (4-7)	t=0.671	0.504
1 month	2.35 $\pm$ 0.82 (1-4)	2.73 $\pm$ 1.25 (1-6)	t=1.69	0.095
3 months	2.36 $\pm$ 0.82 (1-4)	3.20 $\pm$ 1.56 (1-6)	t=3.20	0.002*
6 months	2.28 $\pm$ 0.82 (1-4)	2.83 $\pm$ 1.35 (1-6)	t=2.45	0.016*

t: Student t test, data expressed as mean $\pm$ SD (Min-Max), P $\leq$ 0.05 *statistically significant.

Table 4: Comparison of NRS change during follow up for bipolar group.

Bipolar	Baseline	1 month	3 months	6 months
Numerical Pain Rating scale	5.82±1.05 (4-8)	2.35±0.82 (1-4)	2.36±0.82 (1-4)	2.28±0.82 (1-4)
#1		P<0.001*	P<0.001*	P<0.001*
#2			P=1.0	P=0.083
#3				P=0.083

Data expressed as mean ± SD (Min-Max) used test: Paired t test

Table 5: Comparison of NRS change during follow up for monopolar group.

Monopolar	Baseline	1 month	3 months	6 months
Numerical Pain Rating scale	5.69±0.82 (4-7)	2.73±1.25 (1-6)	3.20±1.56 (1-6)	2.83±1.35 (1-6)
#1		P<0.001*	P<0.001*	P<0.001*
#2			P=0.009*	P=0.542
#3				P=0.024*

Data expressed as mean ± SD (Min-Max) used test: Paired t test

Table 6: Comparison of ODI change during follows up between the two studied groups.

Oswestry Low Back Pain Disability index (ODI)		Bipolar N=45	Monopolar N=45	Test of significance	P value
Baseline	Moderate Severe	22(48.9) 23(51.1)	18(40) 27(60)	X ² =0.720	0.396
1 month	Moderate Severe	26(57.8) 19(42.2)	21(46.7) 24(53.3)	X ² =1.11	0.291
3 months	Moderate Severe	36(80.0) 9(20.0)	26(57.8) 19(42.2)	X ² =5.18	0.023*
6 months	Moderate Severe	39(86.7) 6(13.3)	27(60) 18(40)	X ² =8.18	0.004*

χ²=Chi-Square test, *statistically significant ≤ 0.05

Table 7: Comparison of ODI change during follows up for bipolar group.

Bipolar N=45		Baseline	1 month	3 months	6 months
Oswestry Low Back Pain Disability index (ODI)	Moderate Severe	22(48.9) 23(51.1)	26(57.8) 19(42.2)	36(80.0) 9(20.0)	39(86.7) 6(13.3)
#1			P=0.046*	P=0.001*	P=0.001*
#2				P=0.002*	P=0.001*
#3					P=0.083

#1: difference between baseline and after 1 month, #2: difference between baseline and after 3 months, #3: difference between 3 and 6 months

*Highly statistically significant P ≤ 0.001

Table 8: Comparison of ODI change during follows up for monopolar group.

Monopolar N=45		Baseline	1 month	3 months	6 months
Oswestry Low Back Pain Disability index (ODI)	Moderate Severe	18(40) 27(60)	21(46.7) 24(53.3)	26(57.8) 19(42.2)	27(60) 18(40)
#1			P=0.083	P=0.01*	P=0.003*
#2				P=0.132	P=0.058
#3					P=0.317

#1: difference between baseline and after 1 month, 2: difference between baseline and after 3 months, 3: difference between 3 and 6 months, *Statistically significant $P \leq 0.001$

4. Discussion

In order to alleviate lumbosacral radicular pain, the current study set out to assess the impact of bipolar pulsed radio frequency on the dorsal root ganglia. Furthermore, we contrast the effects of monopolar and bipolar pulsed radio frequencies.

Ninety individuals with low back pain participated in this prospective randomized controlled clinical research, which ran from March 2023 to 12–24 months. Monopolar Pulsed Radio Frequency and Bipolar Pulsed Radio Frequency were the two groups (n=45) into which they were randomly assigned.

The demographic parameters of the two groups under study that showed insignificant variations among Age, sex, BMI, and ASA.

These statistics showed that the two groups were similar and therefore had no bearing on the study's overall findings.

Chang and his colleagues [10], Lee and his colleagues [11] and Yang and his colleagues [12]. These studies revealed that no significant intergroup differences were observed for demographic data $p > 0.05$.

In terms of comparison of pain duration, the current study displayed no statistically significant difference between the two studied groups as regard pain duration ($p=0.06$). Mean pain duration is 7.14 ± 2.01 and 6.40 ± 1.67 for bipolar and monopolar groups respectively in spite of the same dose of dexamethasone and lidocaine used in the two groups.

Chang and his colleagues revealed that no significant intergroup differences were observed regard pain duration ($p=0.920$). Mean pain duration is 9.7 ± 5.7 and 10.9 ± 9.1 for bipolar and monopolar groups respectively [10].

On the other hand, Lee and his colleagues revealed that previous studies have reported that the early treatment of neuropathic pain can be more effective in reducing neuropathic pain thus, if we recruited patients with a shorter period between symptom onset and bipolar PRF or if we did not only recruit patients with intractable pain, the outcomes of the bipolar PRF may be improved. All patients were more than six months passed by the time when pain started, with an average of 13.1 months separating the onset of symptoms and the bipolar PRF surgery. Given these data, we think that our patients' pain had plateaued and that the decreased pain following the bipolar PRF was not due to lumbosacral radicular discomfort occurring naturally [11].

In terms of the NRS, there is no statistically significant difference between the two groups under study when comparing the scores at baseline and one month later ($p=0.504$ & 0.095). After three months, the mean NRS was significantly higher for monopolar groups than bipolar groups (3.20 ± 1.56 versus 2.36 ± 0.82 , $p=0.002$). Additionally, after six months, the mean NRS was statistically significantly higher in monopolar groups than in bipolar groups (2.83 ± 1.35 versus 2.28 ± 0.82 , $p=0.016$).

This was consistent with the findings of Chang and colleagues [10], who found that when compared to baseline NRS values, patients in both groups had a substantial drop in NRS ratings at 1-, 2-, and 3-months posttreatment. The bipolar PRF group observed significantly greater reductions in NRS scores over time. Three months following therapy, 19 patients (76.0%) in the bipolar PRF group and 12 patients (48.0%) in the monopolar PRF group reported effective pain alleviation (pain reduction of $\geq 50\%$).

Therefore, they came to the conclusion that bipolar PRF on the DRG can be a safe and successful interventional approach for chronic refractory lumbosacral radiculopathy, especially in patients whose pain does not respond to monopolar PRF stimulation or epidural steroid injection [10].

Accordingly, Lee and his associates [11] carried out their retrospective analysis on 102 patients who had been treated for lumbosacral radiculopathy at the DRG using monopolar PRF. Of them, 32 patients experienced radicular discomfort that persisted and received a numeric rating scale (NRS) value of at least 5. Of them, twenty-three were included in this research and had the DRG's bipolar PRF. Over time, the NRS scores underwent significant alteration. The NRS ratings were significantly lower after 1, 2, and 3 months following bipolar PRF than they were prior to therapy. Three months following bipolar PRF, twelve (52.2%) of the 23 patients reported satisfactory pain alleviation and were happy with the outcomes of their therapy.

They came to the conclusion that, at 1, 2, and 3 months following bipolar PRF on DRG, there was a significant reduction in persistent lumbosacral radicular pain that was unresponsive to monopolar PRF on DRG and TFESI [11].

Accordingly, Yang & Chang [12] studied 20 patients with persistent cervical radicular pain who had undergone bipolar PRF of their cervical dorsal root ganglion (DRG) and were not responsive to monopolar PRF and TFESI. At 1, 2, and 3

months after PRF, there was a significant reduction in cervical radicular discomfort ($P < 0.001$). Furthermore, half of the patients experienced a favorable response and expressed satisfaction with the treatment outcomes three months after PRF.

Similarly, Yang & Chang [12] showed that the postoperative NRS scores were significantly lower than the preoperative NRS scores for post herpetic neuralgia; at all time points from 6 months to 2 years after the procedure, the NRS scores of the double needles radiofrequency thermocoagulation (DCRF) group were lower than those of the radiofrequency thermocoagulation (CRF) group. Two years after the procedure, the DCRF group's overall effective rate was significantly higher than the CRF group's. Compared to the CRF group, the DCRF group experienced a greater incidence of numbness. According to the ovalbumin in vitro trials, radiofrequency thermocoagulation worked best when there was a 5 mm gap between the two needles. Similarly, Huang and colleagues' [13] experimental research on neuropathic pain caused by spare nerve injury (SNI) in mice showed that PRF temporarily reduces both inflammatory and neuropathic pain. Significant analgesia is produced by bipolar PRF using a lot less electrical power than unipolar PRF. In the meanwhile, PRF-DRG and PRF-SN's slight variation effects could point to different pathways. Repetitive treatments' persistent analgesia indicates that the implantation approach may be a good option.

Following PRF to the DRG, Choudhary et al. [15] discovered elevated c-fos in the dorsal horn's laminae I and II. Certain pain-inhibition pathways were proposed to be activated by increased c-fos expression.

In a rat model of lumbar DH, Jordan et al. [16] found that PRF of the DRG reduced microglia activity in the spinal dorsal horn. Downregulating microglia activity may help manage neuropathic pain since these cells emit a number of cytokines and chemokines that affect pain signaling.

Furthermore, PRF enhances serotonergic and noradrenergic descending pain inhibitory pathways, according to Park and Chang [14], which contributes to its analgesic effects. These experimental findings support the widespread use of monopolar PRF to treat neuropathic pain originating from the spinal nerve roots. However, it has been proposed that bipolar PRF might generate bigger and denser electrical fields than monopolar PRF [17]. Monopolar RF may therefore not adequately cover the DRG, depending on where the RF stimulation point is placed around the DRG. Bipolar RF can more adequately cover the DRG since the mean lesion size utilizing parallel cannulae spaced 10 mm apart was 15.5 mm × 11.8 mm (length × breadth). Although it would be challenging to directly compare PRF with conventional RF, we believe that the PRF approach can yield outcomes that are comparable. Based on this idea, we administered bipolar PRF to the DRG of patients who had chronic lumbosacral radicular pain [18]. Bipolar PRF provided better pain alleviation than monopolar PRF, according to the current study.

However, a number of studies have shown that monopolar PRF to the DRG is effective in treating lumbosacral radicular pain [19–21].

Mousa (2020): 37 patients with persistent lumbosacral radicular pain were treated with monopolar PRF by Moussa et al. [22]. About half of the patients reported satisfactory pain reduction for three months following the PRF to the DRG.

Koh et al (2015): 31 patients with persistent radicular pain who got both PRF and TFESI had better treatment outcomes for at least three months than 31 patients who received TFESI alone [23].

Van Boxem et al. [21] conducted PRF on the DRG of 65 patients with persistent lumbosacral radicular pain the same year, 50% to 60% of them responded favorably to treatment; the result lasted for at least six months. Nevertheless, no research has been done to date to assess the bipolar PRF's therapeutic effectiveness in treating lumbosacral radicular pain.

The current study found that the bipolar group's NRS changed statistically significantly during follow-up, going from 5.82 ± 1.05 at baseline to 2.35 ± 0.82 after one month ($p < 0.001$), 2.36 ± 0.82 after three months ($p < 0.001$), and 2.28 ± 0.82 after six months ($p < 0.001$).

The mean NRS score reduced dramatically from 6.5 ± 0.8 to 1.1 ± 0.7 at 2 weeks postoperatively, to 1.3 ± 0.7 at 3 months postoperatively, and to 1.7 ± 1.0 at 6 months postoperatively (all $P < 0.001$), according to Luo and his colleagues [24].

The current study found that the NRS for the monopolar group decreased statistically significantly during follow-up, from 5.69 ± 0.82 at baseline to 2.73 ± 1.25 after one month ($p < 0.001$), 3.20 ± 1.56 after three months ($p < 0.001$), and 2.83 ± 1.35 after six months ($p < 0.001$). Additionally, there was a statistically significant difference between 1 and 3 months ($p = 0.009$) and between 3 and 6 months ($p = 0.024$).

The Oswestry Low Back Pain impairment Index (ODI), which was measured at baseline and one month later, showed no statistically significant differences between the two groups under investigation in terms of impairment ($p = 0.396$ & 0.291). After three months ($p = 0.023$) and six months ($p = 0.004$), there was a statistically significant difference in the ODI, with bipolar groups showing more improvement than monopolar groups.

Additionally, the ODI improved statistically significantly from baseline to one month after surgery ($p = 0.046$), from baseline to three months ($p = 0.001$), and from baseline to six months ($p = 0.001$). The bipolar group also showed statistically significant improvement in the 1 and 3 months ($p = 0.002$) and between 1 and 6 months ($p = 0.001$).

The mean Oswestry Disability Index (ODI) score decreased significantly from 43.5 ± 2.5 to 22.5 ± 4.3 at 2 weeks postoperatively, to 20.0 ± 3.5 at 3 months postoperatively, and to 19.5 ± 3.6 at 6 months postoperatively (all $P < 0.001$), according to Luo and his colleagues [24].

Yang and his colleagues also found that, according to the 7-point Likert scale,

patients' satisfaction with therapy was as follows: 1 patient (5%), 9 patients (45%), and 2 patients (10%) had very excellent (scoring =7), good (score =6), and pretty good (score =5) ratings. Eight patients (40%) reported no change (score = 4). No patient reported feeling that their treatment satisfaction was very bad (score = 1), terrible (scoring = -2), or somewhat bad (score = 3). Consequently, at three months after the treatment, 10 out of 20 patients, or half of all included patients, expressed satisfaction with the bipolar PRF of cervical DRG [12].

The current study found that there was a statistically significant improvement in the ODI between baseline and three months postoperatively ($p=0.01$) and between baseline and six months ($p=0.003$) for the monopolar group's follow-up.

De and his colleagues [25] found that the Oswestry Disability Index (ODI) improved functional status after two weeks, one, two, three, and six months, as shown by a 71.11% decrease in ODI scores compared to baseline.

5. Conclusion

The current investigation discovered that both monopolar PRF and bipolar PRF stimulation of the DRG successfully decreased chronic lumbosacral radicular pain in one, three, and six months after the procedure. Additionally, we demonstrated that bipolar PRF reduced disability and improved pain relief compared to monopolar PRF.

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