Pulsed Radiofrequency Dorsal Root Ganglion-Fluoroscopy Guide for Lumbar Radicular Pain

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ABSTRACT

Background: Lumbosacral radicular pain is the most common neuropathic pain. Pulsed Radio Frequency (PRF) is a pain management technique that believes to be safe and effective for reducing lumbosacral radicular pain.

Case: A 43-year-old woman experiences chronic right lumbar radiculopathy due to herniated nucleus pulposus (HNP) L4-5. Anamnesis and physical examination show a sign of neuropathic pain. The magnetic resonance imaging (MRI) examination shows a paracentral disc protrusion L4-5 that compresses the transversing nerve L5. The conservative management did not produce a satisfying result indicated by the patient still experience pain with the Numeric Rating Scale (NRS) 4-5. Patient unable to do activity properly. We perform pain management using the pulsed radiofrequency dorsal root ganglion-fluoroscopy guide L5. The treatment produce a positive outcome. Patients experience a decrease in pain intensity with NRS 1. The examination on one and two months post-intervention show an improvement. Patient able to do the daily activity with NRS 1-2.

Conclusion: Pulsed radiofrequency dorsal root ganglion-fluoroscopy guide that relatively safe, minimum complications, and minimal side effects, making it the preferred treatment for chronic lumbar radicular pain.

Keywords: lumbar radicular pain, dorsal root ganglion, pulsed radiofrequency, fluoroscopy

INTRODUCTION

Lumbosacral radicular pain is the most common neuropathic pain, suffered by 10-20% of the population. Patients with lumbosacral radicular pain may experience decreased functional abilities and quality of life. Lumbosacral radicular pain is a form of neuralgia caused by irritation or damage to the spinal sensory nerves. It is well known that chronic lumbar radicular pain is challenging to manage because patients often do not respond to conservative treatments. Conservative treatments (pharmacotherapy or physiotherapy) is effective in 60% of patients. However, in some cases, persistent pain develops into chronic pain, results in disability, as well as increases healthcare costs. The prevalence of radicular pain was 5.3% in men and 3.7% in women. Radicular pain due to disc protrusion resolves spontaneously in 23-48% of patients. However, 30% of patients with significant symptoms persist after one year, then 5-15% will end up on the operating table.

Radicular pain is not only caused by mechanical compression of the nerve roots. It is also triggered by pro-inflammatory chemical agents such as cytokines. Chemical mechanisms and effects of cytokines cause ectopic neuron excitation. Although many treatment modalities for radicular pain have been introduced, the evidence is insufficient to make optimal therapy recommendations. Interventional treatment are usually used in patients with recurrent pain or failing to conservative treatment. There is strong evidence that epidural steroid injection effectively reduces leg pain and disability due to acute disc herniation. However, vascular complications are common. Moreover, steroid use in lumbosacral radicular pain is still debatable.

Pulsed Radio Frequency (PRF) is a treatment method introduced by Sluijter in 1997. It is a safe and effective treatment for reducing pain and works by generating electric fields and hot flashes against the targeted nerve tissue without causing tissue damage. PRF works by generating an electric field that can change the pain signal.
Table 1. Neurological examinations

| Tests                          | Right          | Left           |
|-------------------------------|----------------|----------------|
| Straight Leg Raise (Laseque Test) | (+)            | (-)            |
| Cross Laseque (O’Connel Test)  | (-)            | (+)            |
| Dorsiflexion of the ankles and toes | Normal        | Normal         |
| Patella Reflex                | Normal         | Normal         |
| Achilles tendon reflex        | Normal         | Normal         |
| Patrick’s Test / Faber Test   | (-)            | (-)            |
| Pathological Reflex (Babinski) | (-)            | (-)            |
| Motoric                       | Normal         | Normal         |
| Sensoric                      | Normal         | Normal         |

To date, many studies have reported that PRF stimulation of the Dorsal Root Ganglion (DRG) is effective in treating lumbar radicular pain. \(^5\) Koh et al. \(^7\) conducted a study on 62 patients with HNP and radiculitis, stated that the number of successful treatments in the PRF group was higher than in the group treated with transforaminal steroids two and three months post-therapy. \(^8\) This case report presents a successful lumbar radicular pain management using pulsed radiofrequency-dorsal root ganglion under fluoroscopy guide.

**CASE**

A 43-years-old woman comes to the pain policlinic with low back pain that spread to the hip lateral side, the tibia’s front side until in the instep. The patient has suffered from pain for two years. The lower extremity pain intensity is often more dominant than in low back pain. The patient describes the pain as electric shock, burning, and often accompanied by a tingling sensation. The NRS was between 4-5. Pain intensity increase after the patient goes to walk 100 meters, up the stairs, bend over, and lift heavy things. The pain intensity reduces when the patient rest, lay down, and in the sitting position. The patient had been receiving treatment from a neurologist and physiotherapist several times. However, there is no improvement. The patient has a history of fever, lost weight, and trauma. Diabetes mellitus (DM) and hypertension denied. There is no complaint of urination and digestion.

The physical examination: the physical condition, vitals sign, and the way the patient walked were normal. From inspection and palpation in the lumbar area, it still normal. The range of motion of lumbosacral joint flexion 95° (normal), the extension was limited due to pain (-), right lateral flexion 40° with pain (+), left lateral flexion with pain (-), the right rotation was limited (+), left rotation was limited due to pain (+). The neurological examinations result can be seen in table 1.

Laboratory tests show a normal result, particularly for the blood clotting factor. Rontgen examination of lumbar vertebra anteroposterior (AP) and lateral show a normal condition. The magnetic resonance imaging (MRI) pictures an annulus protrusion in the right paracentral L4-5 (Figure 1).

The patient was diagnosed with chronic right lumbar radicular pain e/c HNP L4-5 with differential diagnoses including piriformis syndrome, facet lumbar pain, and canalis stenosis. The patient planned to receive pulsed radiofrequency dorsal root ganglion LS under fluoroscopy guidance. The patients were given informed consent regarding the diagnosis and the treatment will perform. The patient was positioned in the prone position; hemodynamic monitoring was installed, and the patient did not receive sedation. Identification and measurement were done in corpus vertebra LS. C-arm true AP with processus spinosus placed in the middle of corpus vertebra, making the C-arm position direct to the cranial in one alignment. C-arm then moved oblique ipsilateral until the facet joint was visualized, or the superior articular process (SAP) got into the 1/3 corpus vertebra until the scotty dog sign was visualized. The target point right under the scotty dog, which is 6 o’clock from the pedicles. Infiltration of local anesthetic using 1% Lidocaine in the injection site and waited one-two minutes. The 22 G, 10 cm needle was inserted into the lateral end of sacrum SAP or neural foramen (6 o’clock from the pedicle) using tunnel vision. After the needle get in the pedicle, the position of C-arm change to lateral to confirm the needle depth. The needle should be placed in the intervertebral foramen in the lateral view until the needle tip right in the chepalodorsal quadrant from the intervertebral foramen. The AP view is done to confirm the needle position stays in the intervertebral foramen and does not pass the target’s medial to prevent the needle from getting into the spinal canal.

The sensory stimulation done using 50 Hz and 0.1-0.5 V until the patient experience the tingling sensation or pain in the lower extremity. The patient starts to feel the sensation at the 0.3 V. After that, the motoric simulation was done using 2 Hz and 0.1-0.5 V. Patients did not experience a muscle contraction until 0.8 V. After the sensory and motoric test,
the patient was given 1% lidocaine 0.5 ml (aspiration before injection) and continue with PRF 45 V for 4 minutes/cycle. The temperature was maintained under 42°C. Impedance between 250–400 Ω. The evaluation was carried out for one hour in the recovery room. The NRS post-intervention was 1–2. After that, the patient was given analgesic acetamin 3x1 and pregabalin tablet 2 x 75 mg.

One month after intervention, patients experienced great improvement. The pain intensity had decreased up to 80% (NRS 2). The patient was gradually able to do everyday activities. Pregabalin still prescribes for two months. After two months, the patient feels more comfortable with NRS 1-2.

**DISCUSSION**

Chronic lumbar radicular pain described as a neuropathic pain in the particular lumbar nerve fiber due to discuss protrusion, backbone stenosis, or fibrosis following previous surgery. Chronic lumbar radicular pain's pathophysiology involves the mechanical, inflammation, and immunological factors, affecting the dorsal root ganglion function. Herniated nucleus pulposus (HNP) is the most common cause of lumbar radicular pain. HNP is defined as a condition where there is an annulus fibrosus protrusion with nucleus pulposus into the canalis vertebralis lumen. HNP may occur in all vertebrae segments. However, more often occur in L4-5 and L5-S1. HNP lumbar causes low back pain, radicular pain, muscle weakness, paresthesia, and tingling sensation in the myotome or dermatome. Patients with radicular pain experience radiate pain that follows the dermatome. Pain due to HNP usually increases when patient bent, sit, cough, and decrease during supine position. Aside from pain, the patient often reports the paresthesia in the nerve dermatome involved. Pain radiated throughout the dermatome can differ the lumbar level involved, even sometimes there is a variation of pain radiation. There are not many studies regarding the diagnostic based on the anamnesis and physical examination.

Until now, the pain distribution is the only significant parameter in anamnesis. The typical symptom of radicular pain is the pain radiates from a certain nerve dermatome. The most common test for radicular pain is the Laseque test that showed a positive result in up to 95% of patients with HNP. If pain arises below 60°, most likely that HNP causes pain. There is no consensus regarding the other neurological signs (paresis, sensory loss, or reflex loss). The radicular pain diagnosis is considered when the patient reports pain radiated in one of the feet combined with one or more neurological signs indicating a nerve irritation or decrease of neurological function.

The HNP diagnosis was supported by a positive result in straight leg raise (Laseque) and cross Laseque test. That quick test was enough to cover HNP in L4 – S1, representing 90% of HNP. Straight Leg Raise is a specific test to detect irritation of the lumbar nerve. The sensitivity of Straight-leg raise test ipsilateral is high, but not in its specificity. Both the sensitivity and specificity of the Contralateral test are high.

The sensory examination was done to find nerve impairment. After the impaired nerve is detected, the segments or the area that may affect can be determined. The examination consists of touch sensation, pain, temperature, and vibration. The adjacent radix dermatomes usually overlap. Because of that, a lesion on the certain radix often resulted in an undetectable sensory deficit or even not raises a sensory deficit. More specifically, the patient's diagnosis can be made based on the dermatomal characteristic of pain distribution and presentation. Pain that arises from the lower waist to the hip, lower lateral and posterior, then radiates to the front side of the cruris until the legs' dorsal demonstrated impairment in the L5 nerve root. Patella reflex indicates an L5 radix impairment but not significant in L2 and L3. Achilles reflex is predominant for S1.

**Figure 2.** The PRF DRG L5 procedures: A). Oblique insertion (tunnel vision), B). Lateral insertion, C). True AP insertion

**Figure 3.** The distribution of radicular pain
However, the other pathological reflex, such as Babinski, needs to be examined, especially for patients with hyperreflexia, indicating an upper motor neuron (UMN) disorder. From the reflex examination, the UMN and LMN disorder can be differentiated (Figure 3)(Table 2).\textsuperscript{12}

| Nerve Root | Intervertebral Space | Motor Function | Reflex |
|------------|---------------------|----------------|--------|
| L4         | L3-4                | Dorsiflexion of foot | Knee jerk |
| L5         | L4-5                | Dorsiflexion of the great toe | None |
| S1         | L5-S1               | Eversion of foot and plantar flexion | Ankle jerk |

In this case, there are no signs of a red flag. Red flag signs are essential in the examination of the patient with low back pain. Red flag signs such as infection, tumor, trauma, and progressive neurologic disorder indicated a severe case requiring surgery. The MRI examination shows an annulus protrusion in the right paracentral L4-5 and causes a transversing nerve root L5 compression. Those promote the formation of radicular pain on the dermatome L5. Disc bulging is often found in the normal condition (more than 60% of the population age 50 years old), disc protrusion (36% of the population age 50 years old). Because of that, a single examination using MRI is not recommended due to the possibility of misdiagnoses. The anamnesis and clinical examination are must be a standard to get the final diagnosis.

From the previous study, there is no correlation between the MRI result and the intensity of disc-related pain.\textsuperscript{13} A herniation is defined as the intervertebral disc component’s displacement out of the normal disc spaces. The disc component consists of a nucleus pulposus, annulus fibrosus, or both. Symptomatic herniations occur most often posterolateral to the disc, but midline herniation might occur. Compressed nerve fibers by the nucleus pulposus induce inflammation and compression, which causes pain. However, disc herniation does not always raise pain. Magnetic Resonance Imaging (MRI) often shows disc herniation but does not cause symptoms, especially in the elderly.\textsuperscript{14}

In this case, the comparative diagnosis has been excluded during anamnesis, physical examination, and other clinical examinations. According to the radicular lumbosacral pain management guidelines, patients who suffered from radicular pain for almost two years with NRS 4-5 and did not get a satisfactory result from conservatives treatment could receive a PRF DRG.

The sensory axon’s peripheral trauma causes a molecular and cellular change in the axon level and the dorsal root ganglion. Even the distribution of the afferent radicular signal is a complex mechanism, the inflammatory cascade was clear. The signal distribution starts with discus nerve degeneration and the production of pro-inflammatory cytokines around the affected lesion. Thus, the dorsal root ganglion’s ectopic activity increases neurotrophin production and increases the dorsal horn’s ectopic activity, resulting in central sensitization. The molecular and cellular cascade may start from disc herniation or peripheral nerve degeneration. The inflammation cascade starts with the synthesis of a specific inflammatory mediator. Cytokines and TNF-α play an essential role in inflammation, specifically in neurotrophin production. The elevation of neurotrophin production activated Glial cells and attracted other neighboring immune cells, resulting in dorsal root ganglion neurons, affecting the sensitization transmission. The material extrusion from the nucleus pulposus into the spinal nerve causes edema and ischemia (Figure 4).\textsuperscript{15}

Aside from that mechanism, other factors, including nerve root compression, mechanical irritation and inflammation, could promote radicular pain. Peripheral vasodilatation, edema, fibrin deposition, leukocyte, agglutination cell, and phagocytosis involve in the inflammation. In the last phase of inflammation, there is peripheral blood vessel proliferation, fibroblast proliferation, and collagen precipitation. After that, the nerve root shows a significant elevation of Na\textsuperscript+ and cytokines expression, make the nerve root more sensitive to sensitization. Because of that, nerve root becomes more reactive and easily exited even by a weak stimulus.\textsuperscript{16}

Pulsed radiofrequency (PRF) is widely used for disc herniation intervention. Many research stated that the PRF ablation effective in radicular pain related to disc herniation. However, the randomized control trial (RCT) study is still limited. Shanthanna et al.\textsuperscript{17} research on 31 patients with disc herniation and radiculitis found that 37% of the PRF DRG group experienced a decrease of VAS score up to 50%.\textsuperscript{17} An observational study by Van Boxem found a positive outcome in 56.9%, 52.3%, and 55.4% after six weeks, three months, and six months after PRF DRG in the 65 HNP patients.\textsuperscript{18} Most of the patients who receive PRF DRG did not report a side effect.\textsuperscript{19} PRF in the DRG done using the multifunction electrode for more than 240 seconds is safe and may be effective than the classical approach (120 seconds). For that reason, PRF considered being a great pain interventional pain management for lumbosacral radicular pain with neuropathic pain.\textsuperscript{20}

PRF produces an electromagnetic wave that can destroy the neural membrane that affects the generation of potential and ectopic action. The conventional PRF uses a high-frequency alternating current to promote necrosis on the targeted nerve tissue. Howev, this technique is less selective for nociceptive fiber. The use of high-frequency short current (20 milliseconds) followed by static phase (480 milliseconds) possibly radiates heat and preserves the targeted tissue temperature under 42 °C. The analgesic effect of PRF is unclear and still under investigation. On the histological analysis, PRF did not cause tissue damage. PRF work specifically on nociceptive axon C and A-δ fiber. Higuchi et al.\textsuperscript{16} stated that PRF increases c-fos in lamina I and II of the dorsal horn, where induce the pain inhibition mechanism. Other research found that PRF decreases microglia in the dorsal horn of the animal model. Also, and increase norepinephrine and serotonin in the descending inhibitory pathway. It is known that DRG is more sensitive to heat than other nerve tissue. PRF is selective to sensory block with the minimum motoric damage.\textsuperscript{16} PRF 42 °C also prove to be less destructive for cellular morphology compare to the 67 °C thermal RF in the clinical dose.\textsuperscript{4} Podhajsky et al.\textsuperscript{21} also found that mice receive PRF on the 42 °C show no sign of sensory and motoric deficit compare to mice receiving RF thermal 80 °C, which shows a sign of feet paralysis.

When performing a PRF in the dorsal root ganglion, the maximum effect can be obtained when the needle is placed 1-2 cm from DRG. Because of that, the DRG position in every segment must be known. In the transforaminal injection, the
The needle’s tip is placed in the safe zone called the “safe triangle.” The safe triangle area is the location where the nerve leaves the intervertebral foramen obliquely to form the hypotenuse. The lower part of the pedicle’s connected line is the bottom side, and the line forming a right angle against the pedicle’s exterior in the vertical plate (Figure 5).\(^{22}\)

The injection targets on DRG L5, through a supra-neural approach, done by moving the intensifier C-arm towards the cranial direction so that a superior endplate L5 end image is visible in one line. The target point is lateral to the pedicle’s imaginary line and below the process transfersus L5. The needle insertion must be parallel to the C-arm’s ray angle so that a line is visible (tunnel vision). The target should appear free so that the needle’s tip can get into the posterosuperior DRG L5, where there are radicular arteries and veins (both anterior and superior). The needle tip position was confirmed on an AP view, with target points lateral to the imaginary line of the pedicle and below the L5 pedicle. The dept of the needle tip is confirmed in the lateral position, and the target is the posterior of the foramen intervertebral. The needle is slowly moved forward, and the needle tip managed to keep towards the superior to avoid DRG neuron injection. The optimization of the RF needle tip can be done by giving a sensory stimulus less than 0.3 V until the tingling sensation arises in the L5 dermatome. After that, the motoric stimulus using 0.6 V. The suboptimum fluoroscopy imaging possibly cause by HNP protrusion that leads to inferior. High contrast examination is needed to confirm the needle tip position and avoid the needle getting into the blood vessel and intervertebral disc.

The intervention done to these patients is based on an evidence base, where PRF in dorsal root ganglion for radicular pain can be performed (level 2C+). In this case, we did not use a contrast agent but used stimulation as an indicator, indicating that the needle tip was close to the desired DRG. We also found that motor stimulation was two times higher than sensory stimulation, indicating that the needle tip is far from the motor component. In terms of complications than PRF, there has been much literature describing the use of PRF. More than 1200 patients received PRF, no neurologic complications and side effects were reported. Pulsed radiofrequency is one of the most widely used procedures because of its very low complication (<1%), easy-to-use procedure, and meager cost.\(^{6}\) In this case, we did not find any side effects and complications associated with PRF.

After performing the PRF DRG L5, a pain evaluation was conducted in the recovery room. The outcome was positive with NSR 1. One month later, NSR was still 1-2, and daily activities were more comfortable, pain complaints were reduced by 80% compared to before the action. We must always pay attention to side effects and complications, both intra and post-procedure. In this case, there were no complications during the intervention or observation until two months post-treatment.

In this case, the patient was given a capsule of pregabalin with a dose of 2x75 mg. Pregabalin is an anticonvulsant drug that is quite effective in managing neuropathic pain, one of which is lumbar radicular pain caused by HNP.\(^{23}\) Pregabalin is strongly bound to the α2-δ subunit of the voltage-gated Ca\(^{2+}\) channel. Pregabalin acts as an α2-δ...
ligand and as an analgesic, anti-seizure, and anti-anxiety. Pregabalin can also act at pre-synapse to decrease glutamate release. This effect may depend on decreasing pre-synaptic Ca\textsuperscript{2+} entry via the Cav-3 terminal and decreasing the release of several neurotransmitters such as glutamate, noradrenaline, serotonin, and substance P.\textsuperscript{24} Therefore, the use of 2x75 mg pregabalin may increase the efficacy of PRF DRG L5 in lumbar HNP radicular pain.

CONCLUSION

The diagnosis of a patient with chronic lumbar radicular pain must consider the anamnesis, physical examination, and confirmed by MRI examination. Paracentral HNP L4-5 may suppress L5 transversing nerve, which causes neuropathic pain symptoms according to the L5 dermatome, with NSR 4-5 scale that interferes with daily activities. Chronic radicular pain management is done using PRF DRG L5 under fluoroscopy guidance. After the PRF DRG, the pain intensity decrease with NRS 1. One month after intervention, the patient is able to do a daily activity more comfortable with NRS 1-2. Pain complaints were reduced by 80%. PRF DRG with relatively safe, minimum complications, and minimal side effects, making it the preferred treatment for chronic lumbar radicular pain.

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- CONFLICT OF INTEREST

None

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