

CASE SERIES REPORT: PERCUTANEOUS LUMBAR PLASMA DISC DECOMPRESSION

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SUMMARY

Case 1: A 45-year-old male presented with lumbar pain radiating to the buttocks, posterior thigh, and left leg, with symptoms persisting for more than 3 months. He had received non-steroidal anti-inflammatory drugs, muscle relaxants, and rehabilitation for 2 weeks without improvement. On clinical examination, his VAS score was 8, Lasegue's test was positive at 45°, and he had difficulty walking. MRI revealed herniated discs at L3/4 and L4/5. The patient underwent percutaneous plasma disc decompression at the L3/4 and L4/5 levels under CT guidance. After nearly 2 months, his symptoms improved markedly, with a VAS score of 2. Follow-up MRI demonstrated a reduction in the degree of posterior disc herniation.

Case 2: A 54-year-old male presented with lumbar pain radiating to the buttock, lateral aspect of the right thigh, and calf, with a 2-week history of symptoms and a VAS score of 8, accompanied by difficulty walking. MRI revealed a disc protrusion at L3/4 with a right paracentral convexity. The patient initially received conservative treatment with medication and rehabilitation. After 4 weeks, symptoms improved slightly (VAS 6), but pain persisted with prolonged walking. He then underwent percutaneous plasma disc decompression at the L3/4 level under CT guidance. More than 2 months after the procedure, the patient reported significant improvement, walking normally with only mild lumbar pain and fatigue (VAS 1–2). Follow-up MRI showed no evidence of disc herniation.

Case 3: A 66-year-old female presented with lumbar pain radiating to the buttock, lateral aspect of the right thigh, and calf, with a VAS score of 7 and difficulty walking. Symptoms had progressed for approximately 8 months. She had undergone multiple conservative treatments, including traditional medicine, acupuncture, thread implantation, herbal poultices, and rehabilitation, without improvement. MRI demonstrated a disc protrusion at L4/5 with right paracentral convexity, causing moderate (2/4) spinal canal narrowing. The patient underwent percutaneous plasma disc decompression at the L4/5 level under CT guidance. After one month, symptoms did not improve significantly, and a repeat MRI showed no change in the L4/5-disc herniation.

Discussion: Percutaneous Plasma Disc Decompression (PPDD) is a minimally invasive procedure for treating herniated or bulging intervertebral discs. The technique employs thermal energy to ablate disc tissue, thereby reducing intradiscal pressure and alleviating pain. It involves percutaneous insertion of a needle into the disc, advancement of a catheter, and controlled heating of the needle tip to coagulate and remove part of the nucleus pulposus. Previous studies have demonstrated the safety and efficacy of PPDD. However, treatment outcomes depend on both clinical features and MRI findings. Careful patient selection is therefore essential to achieve optimal therapeutic results.

Keywords: *Percutaneous Plasma Disc Decompression, Disc Herniation, MRI.*

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I. INTRODUCTION

Lumbar radiculopathy occurs when nerve roots are irritated as a result of compression from intervertebral discs or other causes, such as radiculitis or degenerative spinal disease. It is a leading cause of disability worldwide and one of the most common health problems. Epidemiological studies have shown that the prevalence of persistent sciatica is 1.6% in a given population group, while this rate increases to 25% when life expectancy reaches 64 years, with the most common cause being herniated discs.

In fact, there are many treatment methods for lumbar spinal radiculopathy, including medical treatment, physiotherapy, acupuncture, surgery, etc. Each method has its own advantages and disadvantages. However, to achieve high treatment effectiveness, appropriate indications, a combination of methods, and a prolonged treatment period are necessary.

For patients who respond poorly to conservative treatment, surgical intervention may be considered. The optimal timing for surgical intervention remains unknown. Over the years, many efforts have been made to minimize spinal surgery. To this end, a minimally invasive technique has been developed to relieve intradiscal pressure through a device inserted directly through the skin into the discs, known as percutaneous plasma disc decompression (PPDD). Several observational studies have been conducted to evaluate the safety and clinical outcomes of the PPDD procedure in the lumbar spine for radiculopathy.

The method uses a guide needle with a diameter of 1.3 mm and a length of 150 mm. The plasma ablation needle is 185 mm long, 1.1 mm in diameter, with a 6 mm long ablation tip angled at 7°. The MECHAN PLA800 plasma system meets ISO 13485 standards, used for procedures like tissue destruction (ablation) and bleeding control (hemostasis), activated by yellow (destruction) and blue (hemostasis) foot pedals for distinct functions. Each needle pass to activate the disc destruction process takes 8-10 seconds, and the process is performed 6 times in 6 different directions.

II. CASE SERIES REPORT

1. Case Study 1

A 45-year-old male presented with lumbar pain radiating to the buttocks, posterior thigh, and left leg, with symptoms persisting for more than 3 months. He had received non-steroidal anti-inflammatory drugs, muscle relaxants, and rehabilitation for 2 weeks without improvement. On clinical examination, his VAS score was 8, Lasegue's test was positive at 45°, and he had difficulty walking. MRI revealed herniated discs at L3/4 and L4/5. The patient underwent percutaneous plasma disc decompression at the L3/4 and L4/5 levels under CT guidance. After nearly 2 months, his symptoms improved markedly, with a VAS score of 2. MRI scans showed a reduction in the extent of posterior disc herniation, decreasing from 4mm to 1mm at the L3/4 disc level and from 5mm to 1mm at the L4/5 disc level. (The distance measured was from the posterior border of the L4, L5 vertebrae to the posterior border of the disc).

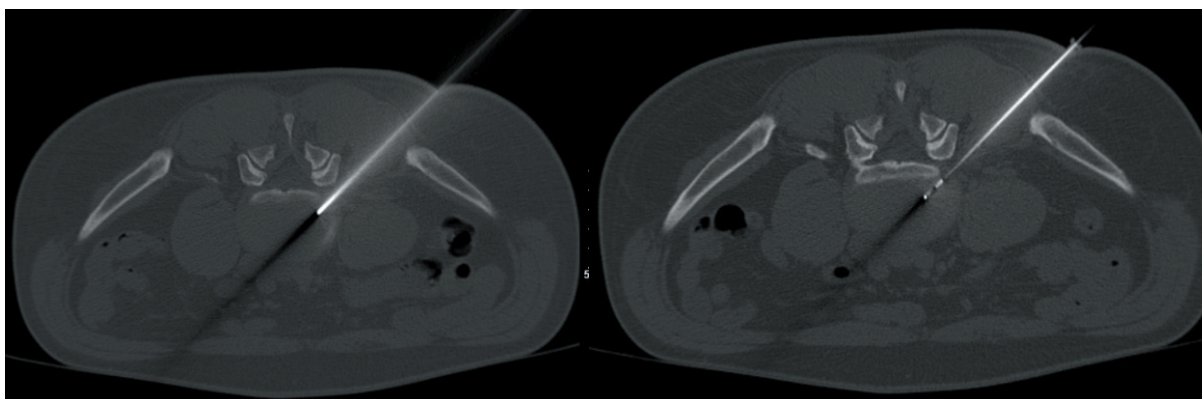


Figure 1. Percutaneous plasma disc decompression under CT guidance.

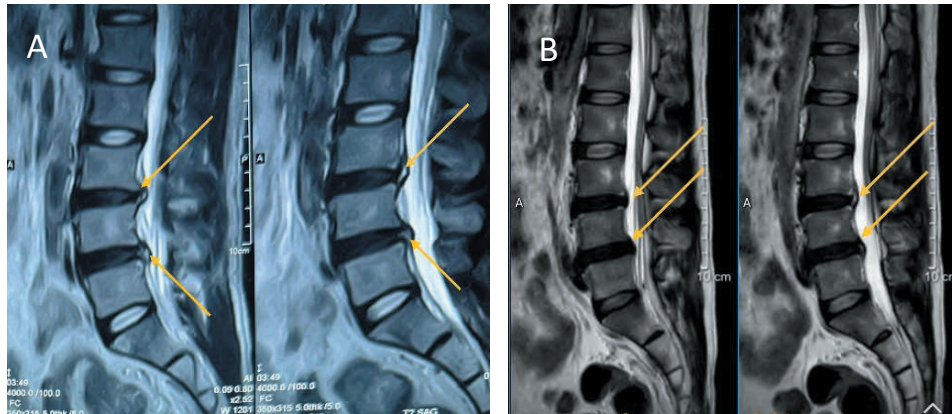


Figure 1.2. A: MRI images of the lumbar spine before intervention.
B: MRI images of the lumbar spine 2 months after intervention.

2. Case Study 2

A 54-year-old male presented with lumbar pain radiating to the buttock, lateral aspect of the right thigh, and calf, with a 2-week history of symptoms and a VAS score of 8, accompanied by difficulty walking. MRI revealed a disc protrusion at L3/4 with a right paracentral convexity. The patient initially received conservative treatment with medication and rehabilitation. After 4 weeks, symptoms

improved slightly (VAS 6), but pain persisted with prolonged walking. He then underwent percutaneous plasma disc decompression at the L3/4 level under CT guidance. More than 2 months after the procedure, the patient reported significant improvement, walking normally with only mild lumbar pain and fatigue (VAS 1–2). Follow-up MRI showed no evidence of disc herniation.

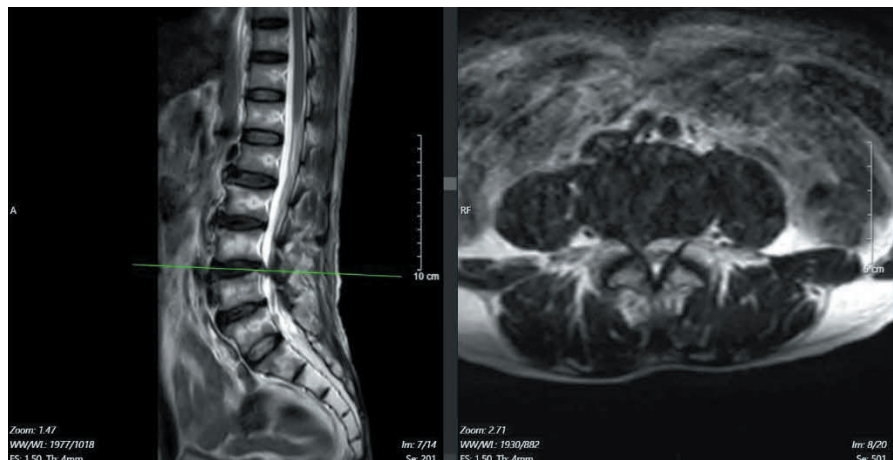


Figure 2.1. MRI images of the lumbar spine on December 27, 2024: Right paracentral disc protrusion at L3/4.

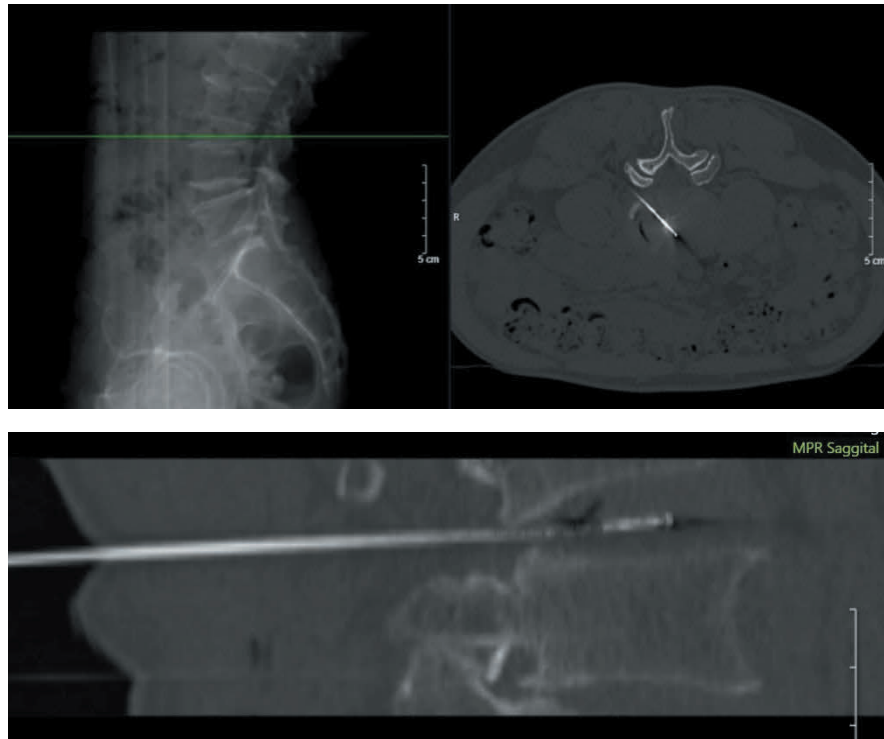


Figure 2.2. Percutaneous plasma decompression of the L3/4 disc under CT guidance on February 17, 2025.

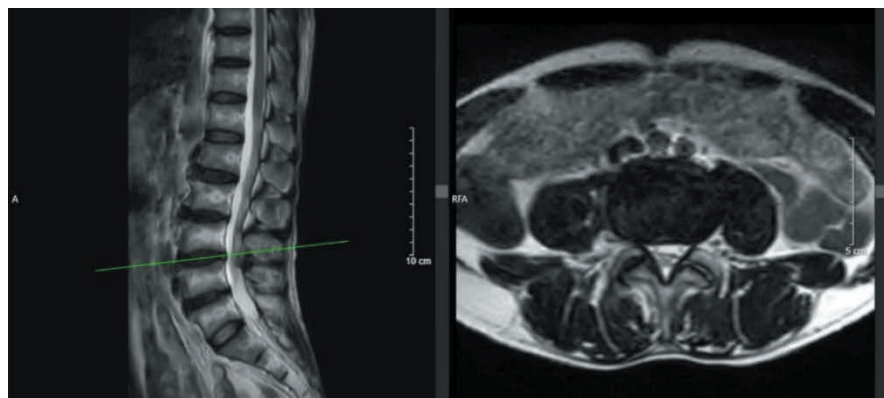


Figure 2.3. MRI images of the lumbar spine more than 2 months after intervention: no L3/4 disc herniation was observed.

3. Case Study 3

A 66-year-old female presented with lumbar pain radiating to the buttock, lateral aspect of the right thigh, and calf, with a VAS score of 7 and difficulty walking. Symptoms had progressed for approximately 8 months. She had undergone multiple conservative treatments, including traditional medicine, acupuncture, thread implantation, herbal poultices, and rehabilitation, without improvement.

MRI demonstrated a disc protrusion at L4/5 with right paracentral convexity, causing moderate (2/4) spinal canal narrowing. The patient underwent percutaneous plasma disc decompression at the L4/5 level under CT guidance. After one month, symptoms did not improve significantly, and a repeat MRI showed no change in the L4/5-disc herniation.

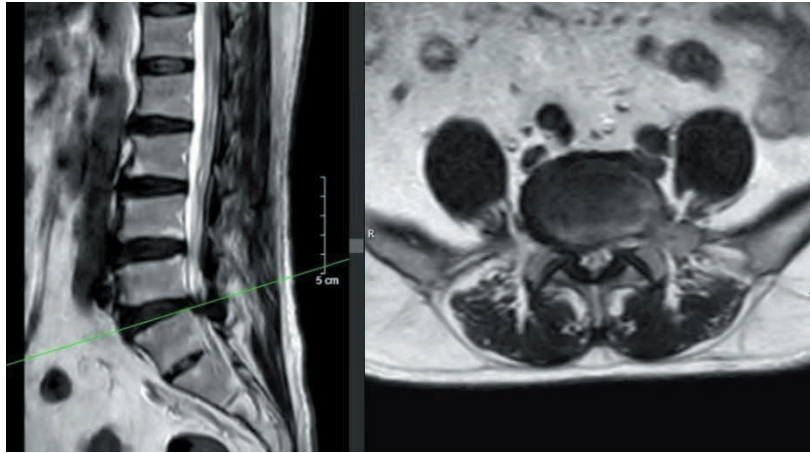


Figure 3.1. MRI image of Lumbar spine from August 8, 2024: disc protrusion at L4/5 with right paracentral convexity, causing moderate (2/4) spinal canal narrowing.

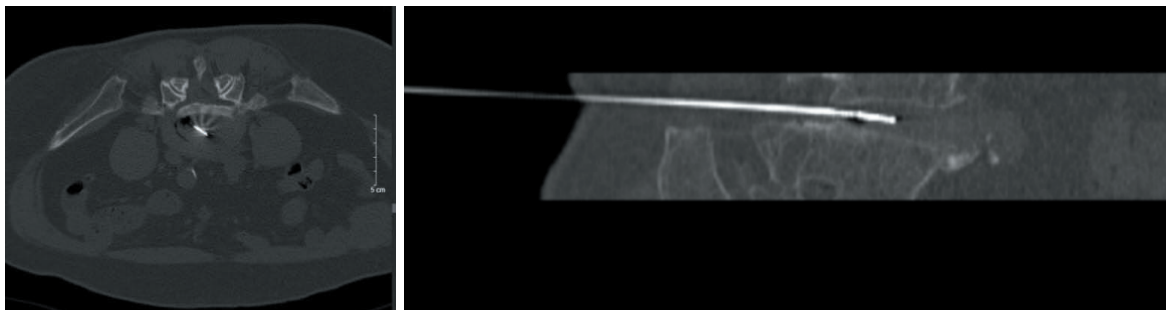


Figure 3.2. Percutaneous plasma decompression of the L4/5 disc under CT guidance, August 10, 2024.

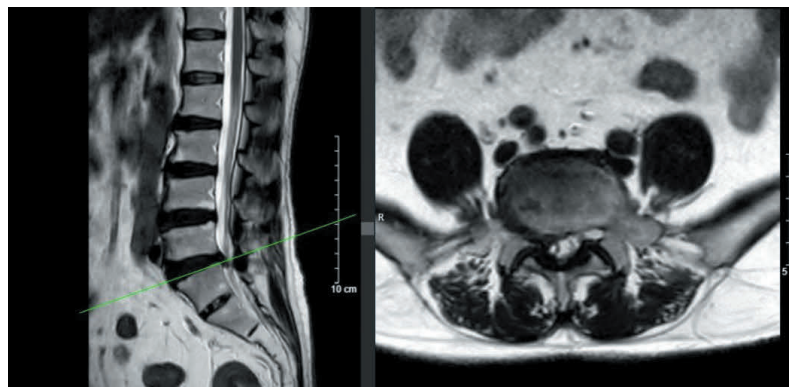


Figure 3.3. MRI image of Lumbar spine from September 10, 2024: no change in L4/5 disc herniation.

III. DISCUSSION

Plasma is one of the four common states of matter - solid, liquid, gas, and plasma. Currently, plasma is used in many different fields, especially in medicine. Percutaneous plasma disc decompression (PPDD) is a minimally invasive procedure used to treat herniated

or bulging discs. The method uses thermal energy to remove a portion of the disc tissue, reducing pressure and relieving pain.

The mechanism of PPDD on the intervertebral disc has been clearly defined. PPDD demonstrates its effects by downregulating local inflammatory mediators, reducing

disc size, and initiating repair processes. Ren et al. found that PPDD effectively degraded phospholipase A2 (PLA2) activity. PLA2 activity is closely associated with intervertebral disc degeneration, intervertebral disc herniation, radicular pain, and lumbar discogenic pain. It is considered the rate-limiting enzyme in the inflammatory cascade reaction. They suggest that when intervertebral disc degeneration occurs, PLA2 is activated by various proinflammatory mediators, such as interleukin-1, tumor necrosis factor- α , and interleukin-6, which are secreted by the degenerative intervertebral disc. Interleukin-1, especially, is an important pathophysiologic factor in painful disc disorders.

The disc volume reduction effect of PPDD has been demonstrated in several studies. Chen et al. in a human cadaveric study showed that PPDD reduced intradiscal pressures significantly, especially in younger, healthy discs as compared to degenerative discs. Consequently, PPDD can alleviate nerve root compression and discogenic low back pain. Kasch et al. evaluated this effect using 7.1 Tesla ultrahigh-field MRI in porcine discs. They showed volume reductions of 0.114 (SD: 0.054) mL, or 14.72% (thoracic) and 0.093 (SD: 0.081) mL, or 11.61% (thoracolumbar) compared with the placebo group.

Numerous studies have found favorable results with PPDD in the treatment of discogenic low back pain and herniated lumbar disc, especially contained disc protrusion. Most studies have reported a success rate of >50%. Sharps and Isaac showed the efficacy of PPDD. Overall, 79% of 49 patients had a minimum of 2-point reduction on a VAS. Liliang et al. reported that 21 patients (21/31, 67.7%) experienced substantial pain relief for an average period of 10 months (4–17 months). In a systemic review and meta-analysis study, PPDD reduced VAS scores in the long term (24 months) and improved ODI scores. In addition, the review suggested that PPDD is a more effective, low-complication, and minimally invasive procedure compared to other treatments.

The safety and efficacy of the PPDD procedure using Coblation technology have been analyzed. PPDD achieved a volumetric reduction of the disc tissues without overt thermal or structural damage to adjacent tissues. Lee et al. showed that PPDD does not rely on

heat for tissue removal, and, therefore, does not introduce excessive heat that causes tissue damage in the disc. The temperature during PPDD is typically 40 °C to 70 °C, and the total reduction of thermal influence was 5 mm from the tip. In a porcine model, the coblation channel had a clear coagulation boundary of the nucleus pulposus. In addition, there was no evidence of direct mechanical or thermal damage to the annulus and endplate, and neural elements of the spinal cord and nerve roots at the level of the procedure were observed in the histologic examination.

Currently, there are many methods for percutaneous disc decompression, such as ozone therapy or laser intervention. Ozone is a gas mixture injected directly into the disc, acting to oxidize and reduce disc volume and pressure. Additionally, its natural antiseptic properties help reduce pain and inflammation. However, the technique for ozone injection, particularly regarding concentration, volume, and precise anatomical placement, has not been standardized, leading to varying treatment effectiveness. Laser percutaneous disc decompression uses a directed laser beam to generate high temperatures to remove the nucleus pulposus, creating space and reducing disc pressure. In contrast, the principle of plasma therapy involves using an alternating current instead of directly targeting the tissue. The plasma is then used to size the tissue, and the tissue is then treated to complete the excision process. Therefore, the tissue receives very little thermal energy, ensuring low temperatures and precise treatment, while protecting surrounding tissues. However, a study by Song Hongmei et al. comparing the efficacy and safety of percutaneous laser and plasma disc decompression in 97 patients (62 patients receiving laser intervention, 35 patients receiving plasma intervention) showed that the treatment efficacy and safety of the two methods were similar.

Through three case studies, we observed that in two cases, patients aged 45 and 54, with disease durations of 2 weeks and >3 months respectively, MRI images showed disc herniation causing mild spinal stenosis. Both had previously been treated with conservative methods that were ineffective or only minimally effective. After treatment with PPDD, the results were very good,

both clinically and in terms of changes in MRI images. However, in the third case, a 66-year-old patient with a disease duration of >8 months, MRI images showed disc herniation causing moderate spinal stenosis. After PPDD treatment, symptoms did not significantly improve, and the MRI images remained unchanged. Therefore, in addition to disc herniation identified on MRI, treatment outcomes may depend on other factors such as age, body mass index, Modic degeneration, and the degree of spinal stenosis; thus, patient selection and appropriate treatment recommendations are necessary.

Indications:

- Lower back pain > 4 weeks or pain that has failed with other treatments.
- Sciatica > 4 weeks.
- MRI: Disc bulging/Disc protrusion.
- Disc height > 50%.

Contraindications:

- Disc extrusion, disc height < 50%.
- Migratory herniation.

- Moderate to severe spinal stenosis.
- Spinal trauma.
- Spinal tumors.
- Patients over 80 years old.

V. CONCLUSION

Percutaneous plasma disc decompression (PPDD) is a minimally invasive procedure used to treat herniated or bulging discs. The effectiveness and safety of PPDD have been demonstrated in studies. Currently, there are several other percutaneous disc decompression methods such as ozone therapy, laser therapy, etc. Each method has its own advantages and disadvantages. The choice of method depends on many factors such as the severity of the herniation, the patient's condition, and the doctor's experience.

Through three cases, we observed that treatment outcomes depended on clinical characteristics and magnetic resonance imaging. Therefore, selecting the right patients for intervention can yield positive results. This serves as a foundation for our upcoming research on evaluating the effectiveness of percutaneous plasma disc decompression.

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