Journal of Pain Research

Dovepress
Taylor & Francis Group

Open Access Full Text Article

REVIEW

Intradiscal Procedures for Discogenic Low Back Pain: Considerations and Implications – A Narrative Review

Min Cheol Chang[1], Seoyon Yang[2]

[1]Department of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, Daegu, Republic of Korea; [2]Department of Rehabilitation Medicine, College of Medicine, Ewha Woman's University, Seoul, Republic of Korea

Correspondence: Seoyon Yang, Department of Rehabilitation Medicine, College of Medicine, Ewha Woman's University, Ewha Woman's University Seoul Hospital, 260 Gonghang-daero, Gangseo-gu, Seoul, 07804, Republic of Korea, Tel +82-2-1522-7000, Email seoyonyang@gmail.com

Abstract: Discogenic low back pain (DLBP) is a prevalent contributor to chronic low back pain, often resulting from intervertebral disc degeneration associated with inflammation. Various intradiscal therapeutic procedures have been developed to address DLBP, including intradiscal steroid injections, methylene blue injections, platelet-rich plasma (PRP) injections, intradiscal electrothermal therapy (IDET), and both continuous (CRF) and pulsed (PRF) radiofrequency techniques. Intradiscal therapeutic procedures refer to minimally invasive interventions targeting the intervertebral disc, typically performed through percutaneous access under fluoroscopic or computed tomography guidance. These procedures aim to modulate nociceptive signaling or reduce intradiscal inflammation to relieve pain. This review aims to evaluate the existing evidence regarding the efficacy of intradiscal procedures for DLBP while assessing their potential risks, particularly concerning the acceleration of disc degeneration. Although certain interventions, specifically PRP and PRF, have yielded promising results in alleviating DLBP, the overall number of studies reporting positive therapeutic outcomes remains insufficient, and most lack long-term follow-up data. Significant concerns also arise regarding the potential for disc degeneration owing to needle insertion associated with intradiscal therapeutic procedures. Furthermore, IDET and CRF techniques can result in thermal injury to the disc. Evidence from discography studies suggests that disc degeneration may be accelerated, especially when larger needles are employed during the procedure. In addition, repeated interventions may lead to further intradiscal injury and accelerate disc degeneration. Despite these concerns, we propose that performing the procedure once or twice using a thin needle may be justifiable for patients with severe DLBP. Taken together, current evidence suggests that while selected intradiscal procedure, such as PRP and PRF, may provide transient benefit, heterogeneity in study design, short follow-up durations, and procedural risks limit definitive recommendations for routine clinical use. Future high-quality, long-term studies are crucial to enhance our understanding of the therapeutic benefits and associated risks of these interventions.

Keywords: discogenic pain, low back pain, procedure, pulsed radiofrequency, discography

Introduction

Low back pain (LBP) represents a significant global health concern, imposing considerable economic burdens on society.[1] Discogenic LBP (DLBP) is one of the most prevalent forms of chronic LBP, affecting approximately 39% of individuals with this condition.[2] The primary contributor to DLBP is intervertebral disc degeneration, often associated with inflammatory processes.[3] This condition not only compromises physical function but also detracts from the quality of life in affected individuals.[4] Various treatment approaches, including physiotherapy, exercise, and oral medication, have been employed to address DLBP;[5] however, their effectiveness remains limited. Recently, several intradiscal therapeutic procedures have been introduced and their outcomes evaluated.[6–11] Despite the positive effects of these procedures on pain reduction, concerns have emerged regarding their uncertain long-term therapeutic effects and the potential for disc injury, which may accelerate disc degeneration and worsen outcomes over time.

https://doi.org/10.2147/JPR.S579829
Received: 7 November 2025
Accepted: 17 January 2026
Published: 24 January 2026

This review aims to examine the current evidence regarding the effects of intradiscal therapeutic procedures for DLBP, considering both their therapeutic potential and the possibility of accelerating disc degeneration. Additionally, it explores strategies to enhance the therapeutic effects of these procedures.

Effects of Intradiscal Therapeutic Procedures

Intradiscal Steroid Injection

Numerous studies have evaluated the efficacy of intradiscal steroid injection in patients with DLBP.[9,12–14] Most of these studies have indicated that its pain-relieving effects are merely sustained in the short term. A recent meta-analysis by Mishra et al reported that the pain reduction following intradiscal steroid injection was not maintained beyond 1 month.[13] Furthermore, improvements in physical function were not observed, even within the first month post-injection.[13] Considering the transient nature of pain relief and the risk of disc injury associated with needle insertion, intradiscal steroid injection cannot be regarded as an optimal treatment option for DLBP. Regarding side effects, injected steroids presumably inhibit the activity of anti-inflammatory cytokines and cells within the disc, potentially increasing the risk of post-procedural intradiscal infection.[15] Nevertheless, evidence has not substantiated an elevated overall risk of infection associated with intradiscal steroid injections.[13]

Intradiscal Methylene Blue Injection

Methylene blue, a low-molecular-weight compound, has emerged as a potential therapeutic option for managing DLBP.[10] Previous studies indicate that intradermal methylene blue injection operates by ablating sensory nerve endings in the skin.[10] This ablation diminishes the sensation of itch transmitted by unmyelinated C-fibers, which share a pathway with neuropathic pain.[10] Building on this mechanism, several studies have explored the potential effects of intradiscal methylene blue injection to specifically target unmyelinated C-fibers within the disc, offering a novel approach to managing DLBP.[10,16–18] A five-study meta-analysis conducted by Guo et al in 2019 demonstrated significant reductions in both DLBP and the Oswestry Disability Index (ODI), with positive effects persisting for up to 1 year post-procedure.[19]

In contrast, a recent multicenter, double-blind, randomized, placebo-controlled trial by Kallewaard et al reported unfavorable outcomes regarding intradiscal methylene blue injection.[17] The study involved 84 patients and evaluated pain reduction resulting from intradiscal methylene blue injection relative to a placebo. The primary outcomes included treatment success, defined as a $\geq$ 30% reduction in pain intensity, and the Patient Global Impression of Change (PGIC) score 6 months post-treatment. The results revealed that 35% of patients in the "methylene blue plus lidocaine" group achieved treatment success, compared to 26.8% in the "placebo plus lidocaine" group, with no significant difference between the two groups ($P = 0.426$). Additionally, 27% of patients in the methylene blue group reported substantial health improvement according to their PGIC scores, compared to 25.6% in the placebo group ($P = 0.958$). These findings indicate that intradiscal methylene blue injections do not significantly alleviate pain or improve overall health compared to placebo, leading the authors to conclude that methylene blue injections should not be recommended for DLBP treatment. Consequently, intradiscal methylene blue injection is not widely adopted in current clinical practice.

Intradiscal Platelet-Rich Plasma (PRP) Injection

PRP injection is extensively utilized in the treatment of diverse musculoskeletal conditions.[20–22] PRP exhibits a platelet concentration approximately three to eight times greater than that of whole blood and is enriched with cytokines and growth factors that facilitate tissue repair and healing.[21] Platelets release several bioactive molecules, including insulin-like growth factor, epidermal growth factor, transforming growth factor-beta, platelet-derived growth factor, vascular endothelial growth factor, and basic fibroblast growth factor, all of which are essential for tissue healing and repair.[21] These components promote angiogenesis, enhance endothelial regeneration, and increase collagen content across various tissue types. In addition, they can stimulate quiescent stem cells, further advancing tissue healing and repair. Based on these mechanisms, intradiscal PRP injections have been proposed as a therapeutic option for DLBP. Previous studies have reported successful treatment outcomes in patients with DLBP following intradiscal PRP injection.[23–25] A three-

study meta-analysis conducted by Chang et al in 2021 demonstrated significant reductions in Visual Analog Scale (VAS) and ODI scores at 6 months post-injection.[7]

However, the limited number of studies renders current evidence insufficient to definitively establish the therapeutic efficacy of intradiscal PRP injections. Therefore, further high-quality, large-scale randomized controlled trials are essential to validate these findings. Additionally, the long-term effects of treatment remain uncertain and warrant further investigation.

Intradiscal Electrothermal Therapy (IDET)

IDET is a minimally invasive procedure employed to treat DLBP.[8] It entails the insertion of a thermal catheter into the intervertebral disc to deliver heat at 90°C.[8] IDET aims to modify disc biomechanics, thereby mitigating intradiscal pressure, denervating the sinuvertebral nerves within the annular fibers, and sealing annular tears.[8] Despite some clinical studies reporting positive outcomes, including sustained pain reduction and improved physical function post-treatment, the overall effectiveness of IDET remains contentious, with no consistent evidence supporting its superiority over placebo or sham procedures.[8,26–28] Furthermore, concerns regarding potential adverse effects have been raised, including radiculopathy, accelerated disc degeneration, endplate deformation, spondylodiscitis, vertebral osteonecrosis, cauda equina syndrome, and post-procedural headaches resulting from transthecal puncture. Consequently, owing to ongoing debates regarding its efficacy and the associated risks, the clinical use of IDET has significantly declined in recent years.

Continuous Radiofrequency (CRF)

CRF operates by applying high-frequency electrical currents to nociceptive nerves, generating heat between 70 and 90°C. This process ablates pain-transmitting nerves, thereby reducing the transmission of pain signals.[29,30] This mechanism has been proposed as a potential treatment for DLBP by specifically targeting the nerves responsible for transmitting pain from degenerated intervertebral discs.[29,30] Conversely, previous studies have presented conflicting evidence regarding the effectiveness of CRF in treating DLBP.[6,31] Barendse et al reported only one successful outcome following CRF treatment among 13 patients with DLBP, in contrast to two successes in the control group.[6] Moreover, changes in VAS and ODI scores did not significantly differ between the CRF and control groups.

Furthermore, CRF stimulation generates intense electrical energy within a radius of 2–3 mm from the catheter tip.[30] Consequently, the area affected by CRF appears to be restricted to a small portion of the nociceptive nerves near the catheter tip, rendering it unlikely to ablate most of the pain-transmitting fibers implicated in DLBP. Therefore, to date, no conclusive evidence corroborates the efficacy of CRF in managing DLBP, and the underlying mechanisms for the use of CRF in controlling this condition remain uncertain.

Pulsed Radiofrequency (PRF)

PRF offers an alternative approach. Unlike CRF, which poses a risk of thermal damage to surrounding tissues, PRF delivers short bursts of electrical fields at temperatures not exceeding 42°C, allowing for the modulation of nociceptive signaling without causing structural destruction.[32] Additionally, while CRF has a limited therapeutic field around the catheter tip, PRF can influence a relatively larger area of nociceptive nerves in the vicinity of the catheter tip.[30] To date, approximately 10 studies have evaluated the effectiveness of intradiscal PRF in treating DLBP.[11] Most of these studies reported favorable outcomes, including significant pain reduction and functional improvement, although their overall methodological quality was limited.

The proposed mechanisms by which PRF operates include the inhibition of nociceptive transmission, anti-inflammatory effects, and the suppression of microglial activation.[32] No serious adverse events have been reported; however, the long-term therapeutic effects of intradiscal PRF remain unproven, and concerns exist regarding the potential for repeated procedures to accelerate disc degeneration.

Potential Risk of Accelerated Disc Degeneration Following Intradiscal Procedures

Intradiscal therapeutic procedures necessitate the insertion of a needle or catheter into the intervertebral disc following a puncture of the disc annulus. A primary concern regarding these procedures is the potential for accelerated disc

degeneration post-intervention. The risk often leads clinicians to hesitate in performing intradiscal procedures. However, research investigating whether disc degeneration is indeed accelerated following intradiscal interventions for the treatment of DLBP remains limited.

Instead, several studies have focused on the impact of discography on disc degeneration.[33–37] As the gold standard for diagnosing DLBP, discography is performed to identify suitable candidates for subsequent intradiscal therapeutic procedures. This technique involves the insertion of a needle into the disc to inject a contrast dye. Similar to discography, intradiscal therapeutic procedures for treating DLBP entail needle insertion, accompanied by the injection of therapeutic agents or the application of heat to the disc. Consequently, the acceleration of disc degeneration following intradiscal therapeutic procedures may be comparable to, or even more pronounced than, that associated with discography. By examining research on the effects of discography on disc degeneration, we can gain insight into the potential for accelerated disc degeneration following intradiscal therapeutic interventions.

The initial study addressing this issue was conducted by Flanagan et al in 1986.[36] They followed 128 patients who underwent discography, utilizing radiographic images to monitor changes over a period of 10–20 years. Disc narrowing was observed in most patients, predominantly within the first 3–4 months, with minimal additional narrowing in subsequent years. Notably, no correlation occurred between degenerative changes and the patients' symptoms. Flanagan et al concluded that discography is a safe diagnostic tool that does not adversely affect patients, as the observed post-procedural disc narrowing did not correlate with clinical symptoms. Notwithstanding, this study has limitations, including its exclusive focus on radiographic changes without magnetic resonance imaging (MRI) and a lack of thorough examination of clinical symptoms. Additionally, the absence of a control group further constrains the findings.

In 2009, Carragee et al conducted a prospective matched-cohort study to investigate the long-term effects of discography on disc degeneration.[34] The study included a total of 155 discs at the L3–4, L4–5, or L5–S1 levels that underwent discography, which were compared to 150 control discs that did not receive this intervention. The findings indicated that disc degeneration in the discs subjected to discography was more pronounced than that in the control discs. Furthermore, new instances of disc herniation and endplate changes occurred more frequently following discography. Moreover, the loss of disc height and nuclear signal was greater in the discs that had undergone the procedure. Notably, disc herniation occurred more frequently on the side where the needle was inserted during discography. While these results suggest a causal relationship between discography and accelerated disc degeneration, several limitations of the study warrant consideration. Carragee et al did not detail the discography procedure, including the gauge of the needle utilized. Furthermore, they allowed the contrast injection pressure to reach 100 pounds per square inch (psi), which exceeds the usual pressure applied in clinical practice.

In 2016, Cuellar et al conducted a follow-up study involving 57 participants who had undergone discography and 53 control participants, monitoring them over a 10-year period.[35] All participants reported no prior history of low back pain. Among those who received discography, 16 patients underwent lumbar surgeries, compared to only four in the control group. The discography group exhibited a higher frequency of medical visits, computed tomography/MRI examinations, work-related issues, and prolonged episodes of back pain than the control group. Cuellar et al similarly did not disclose the needle size used during discography or the maximum intradiscal pressure that was permitted.

In 2019, McCormick et al conducted a 7-year matched cohort study to determine whether low-pressure, low-volume lumbar provocation discography—utilizing a 22-gauge spine needle—accelerates disc degeneration in patients with DLBP.[37] In contrast to earlier studies by Carragee et al and Cuellar et al,[34,35] which suggested accelerated degeneration, McCormick et al found no significant differences between punctured discs and matched controls regarding Pfirrmann grade progression, disc height loss, T2 signal intensity reduction, Modic changes, new high-intensity zones, or new herniations. Importantly, all discography procedures employed fine-gauge (22-gauge) needles, adhering to strict pressure (< 50 psi) and volume (< 3 mL) limits. The authors concluded that low-pressure, low-volume discography using a 22-gauge spine needle does not appear to cause long-term disc injury, thereby providing reassurance regarding the safety of intradiscal access for both diagnostic and therapeutic purposes.

Table 1 Comparison of Intradiscal Procedures for Discogenic Low Back Pain

Procedure	Proposed Mechanism	Level of Evidence for Efficacy	Key Risks	Current Clinical Utilization
Steroid Injection	Anti-inflammatory effect; short-term pain relief	Low – short-term benefits only; limited randomized controlled trials/meta-analysis support	Infection, needle-induced disc injury	Declining; not preferred as first-line
Methylene Blue	Ablation of C-fibers/nerve endings within the disc	Very Low – randomized controlled trials show no significant benefit; inconsistent outcomes	Neurotoxicity concerns, unnecessary intervention risk	Rarely used in current practice
Platelet-Rich Plasma (PRP)	Tissue regeneration via growth factors; anti-inflammatory and nociceptive modulation	Moderate – promising, but small sample sizes and lack of long-term data	Needle-induced injury, variability in preparation protocols	Increasing; emerging modality
Intradiscal Electrothermal Therapy (IDET)	Thermal modification of annulus and nociceptive pathways; biomechanical alteration	Low – inconsistent outcomes, placebo comparison inconclusive	Thermal injury, disc deformation, infection, neurological complications	Markedly decreased use
Continuous Radiofrequency (CRF)	Neuroablation with thermal lesioning (70–90°C)	Very Low – limited evidence, questionable mechanistic validity	Thermal damage, limited lesion field, disc injury	Limited adoption
Pulsed Radiofrequency (PRF)	Non-destructive neuromodulation: modulation of nociceptive signaling, inflammatory pathways, microglial suppression	Moderate – repeated positive outcomes, but methodological heterogeneity persists	Potential cumulative injury with repeated procedures; uncertain long-term durability	Increasing clinical interest

Discussion

Several intradiscal therapeutic procedures have been introduced as potential treatment options for DLBP (Table 1).[6–11] When compared to alternative conservative treatments, such as physiotherapy, oral medications, and epidural injection, intradiscal procedures are positioned as an intermediate option situated between conservative non-invasive treatments and surgical approaches. Their role is primarily considered in patients who fail to respond to conservative non-invasive management yet do not meet the criteria for surgical treatment. Most of intradiscal therapeutic procedures lack sufficient evidence to support their efficacy. Additionally, numerous studies on intradiscal therapeutic procedures have not adequately investigated the duration of therapeutic effects. As with multiple pain relief interventions for musculoskeletal disorders, it is unlikely that long-term benefits extending beyond 1 year would be observed following intradiscal therapeutic procedures. In particular, the analgesic effect of intradiscal steroid injections has not been sustained beyond 1 year.[13]

Among intradiscal therapeutic options, intradiscal PRF has been relatively well studied, with most investigations reporting positive therapeutic outcomes.[11] Nevertheless, concerns persist regarding the potential for intradiscal procedures to accelerate disc degeneration. Numerous studies indicate that disc degeneration may be accelerated following discography.[33–35] Therefore, it is reasonable to consider that intradiscal therapeutic procedures performed in a similar manner could also contribute to disc degeneration. Specifically, procedures involving the application of high temperatures, such as IDET and CRF, are more likely to exacerbate degenerative changes.

However, the studies that aimed to determine whether discography accelerates disc degeneration exhibit significant shortcomings. Earlier research suggesting discography's harmful effects lacked critical details, such as the gauge of the needle used, as well as the volume and pressure of the injected contrast.[33–36] Subsequent investigations have indicated that when a fine needle (22-gauge) is employed and the injection volume and pressure are strictly controlled, discography does not appear to accelerate disc degeneration.[37] Nonetheless, the number of high-quality studies remains insufficient, preventing definitive conclusions. Notably, repeated intradiscal procedures, even when utilizing a fine needle, can cumulatively damage the disc and contribute to its degeneration. Therefore, it is advisable to minimize the number of procedures and employ a thin needle whenever intradiscal access is necessary.

Ultimately, the decision to perform intradiscal procedures necessitates careful consideration of the therapeutic benefits against the risk of accelerating disc degeneration. For patients with severe DLBP, performing one or two intradiscal procedures with thin needles to minimize disc injury appears reasonable. Furthermore, selecting procedures that inflict minimal disc injury and are less controversial regarding their effectiveness is crucial. Notwithstanding, repeated and

https://doi.org/10.2147/JPR.S579829

frequent procedures should be avoided. Further well-designed, long-term studies are warranted to elucidate both the durability of therapeutic benefits and the risks of disc degeneration following intradiscal interventions. Also, while selected intradiscal procedures may offer short-term symptomatic relief, the current evidence base is limited by methodological heterogeneity, insufficient reporting of bias, and a lack of standardized outcome measures. Given the absence of robust statistical rigor across existing studies, future research should incorporate clearer risk-of-bias assessments, standardized protocols, and transparent reporting frameworks to establish more reliable and clinically meaningful conclusions.

Funding

This work was supported by the National Research Foundation of Korea grant funded by the Korean government (MSIT) (No. RS-2023-00219725).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Fatoye F, Gebrye T, Mbada CE, Useh U. Clinical and economic burden of low back pain in low- and middle-income countries: a systematic review. *BMJ Open*. 2023;13(4):e064119. doi:10.1136/bmjopen-2022-064119
2. Zhang YG, Guo TM, Guo X, Wu SX. Clinical diagnosis for discogenic low back pain. *Int J Biol Sci*. 2009;5(7):647–658. doi:10.7150/ijbs.5.647
3. Mohd Isa IL, Teoh SL, Mohd Nor NH, Mokhtar SA. Discogenic low back pain: anatomy, pathophysiology and treatments of intervertebral disc degeneration. *Int J Mol Sci*. 2022;24(1):208. doi:10.3390/ijms24010208
4. Li Y, Zou C, Guo W, et al. Global burden of low back pain and its attributable risk factors from 1990 to 2021: a comprehensive analysis from the global burden of disease study 2021. *Front Public Health*. 2024;12:1480779. doi:10.3389/fpubh.2024.1480779
5. Peng BG. Pathophysiology, diagnosis, and treatment of discogenic low back pain. *World J Orthop*. 2013;4(2):42–52. doi:10.5312/wjo.v4.i2.42
6. Barendse GA, van Den Berg SG, Kessels AH, Weber WE, van Kleef M. Randomized controlled trial of percutaneous intradiscal radiofrequency thermocoagulation for chronic discogenic back pain: lack of effect from a 90-second 70 C lesion. *Spine (Phila Pa 1976)*. 2001;26(3):287–292. doi:10.1097/00007632-200102010-00014
7. Chang MC, Park D. The effect of intradiscal platelet-rich plasma injection for management of discogenic lower back pain: a meta-analysis. *J Pain Res*. 2021;14:505–512. doi:10.2147/jpr.S292335
8. Freeman BJ, Fraser RD, Cain CM, Hall DJ, Chapple DC. A randomized, double-blind, controlled trial: intradiscal electrothermal therapy versus placebo for the treatment of chronic discogenic low back pain. *Spine*. 2005;30(21):2369–2377. doi:10.1097/01.brs.0000186587.43373.f2
9. Khot A, Bowditch M, Powell J, Sharp D. The use of intradiscal steroid therapy for lumbar spinal discogenic pain: a randomized controlled trial. *Spine*. 2004;29(8):833–836. doi:10.1097/00007632-200404150-00002
10. Kim SH, Ahn SH, Cho YW, Lee DG. Effect of intradiscal methylene blue injection for the chronic discogenic low back pain: one year prospective follow-up study. *Ann Rehabil Med*. 2012;36(5):657–664. doi:10.5535/arm.2012.36.5.657
11. Yang S, Boudier-Revéret M, Chang MC. Use of pulsed radiofrequency for the treatment of discogenic back pain: a narrative review. *Pain Pract*. 2021;21(5):594–601. doi:10.1111/papr.12978
12. Marcus JL, Westerhaus BD, Fleming J, et al. Intradiscal steroid injections for degenerative disc disease with modic changes: a retrospective study of therapeutic and diagnostic features. *Cureus*. 2024;16(4):e58333. doi:10.7759/cureus.58333
13. Mishra P, Goyal S, Makker R. Intradiscal steroid therapy in chronic discogenic pain: a systematic review of literature. *Palliative Medicine in Practice*. 2023;17(3):152–163.
14. Tavares I, Thomas E, Cyteval C, et al. Intradiscal glucocorticoids injection in chronic low back pain with active discopathy: a randomized controlled study. *Ann Phys Rehabil Med*. 2021;64(2):101396. doi:10.1016/j.rehab.2020.05.003
15. Benzon HT, Provenzano DA, Nagpal A, et al. Use and safety of corticosteroid injections in joints and musculoskeletal soft tissue: guidelines from the American Society of Regional Anesthesia and Pain Medicine. the American Academy of Pain Medicine, the American Society of Interventional Pain Physicians, and the International Pain and Spine Intervention Society. *Reg Anesth Pain Med*. 2025. doi:10.1136/rapm-2024-105656
16. Kallewaard JW, Geurts JW, Kessels A, Willems P, van Santbrink H, van Kleef M. Efficacy. Safety, and predictors of intradiscal methylene blue injection for discogenic low back pain: results of a multicenter prospective clinical series. *Pain Pract*. 2016;16(4):405–412. doi:10.1111/papr.12283
17. Kallewaard JW, Wintraecken VM, Geurts JW, et al. A multicenter randomized controlled trial on the efficacy of intradiscal methylene blue injection for chronic discogenic low back pain: the IMBI study. *Pain*. 2019;160(4):945–953. doi:10.1097/j.pain.0000000000001475
18. Levi DS, Horn S, Walko E. Intradiskal methylene blue treatment for diskogenic low back pain. *PM R*. 2014;6(11):1030–1037. doi:10.1016/j.pmrj.2014.04.008
19. Guo X, Ding W, Liu L, Yang S. Intradiscal methylene blue injection for discogenic low back pain: a meta-analysis. *Pain Pract*. 2019;19(1):118–129. doi:10.1111/papr.12725
20. Masiello F, Pati I, Veropalumbo E, Pupella S, Cruciani M, De Angelis V. Ultrasound-guided injection of platelet-rich plasma for tendinopathies: a systematic review and meta-analysis. *Blood Transfus*. 2023;21(2):119–136. doi:10.2450/2022.0087-22
21. Thu AC, Kwak SG, Shein WN, Htun M, Htwe TTH, Chang MC. Comparison of ultrasound-guided platelet-rich plasma injection and conventional physical therapy for management of adhesive capsulitis: a randomized trial. *J Int Med Res*. 2020;48(12):300060520976032. doi:10.1177/0300060520976032

22. Wang X, Zhang Y. Therapeutic interventions of platelet-rich plasma versus corticosteroid injections for lumbar radicular pain: a systematic review and meta-analysis. *J Orthop Surg Res*. 2025;20(1):306. doi:10.1186/s13018-025-05725-z
23. Jain D, Goyal T, Verma N, Paswan AK, Dubey RK. Intradiscal platelet-rich plasma injection for discogenic low back pain and correlation with platelet concentration: a prospective clinical trial. *Pain Med*. 2020;21(11):2719–2725. doi:10.1093/pm/pnaa254
24. Levi D, Horn S, Tyszko S, Levin J, Hecht-Leavitt C, Walko E. Intradiscal platelet-rich plasma injection for chronic discogenic low back pain: preliminary results from a prospective trial. *Pain Med*. 2016;17(6):1010–1022. doi:10.1093/pm/pnv053
25. Tuakli-Wosornu YA, Terry A, Boachie-Adjei K, et al. Lumbar Intradiskal Platelet-Rich Plasma (PRP) injections: a prospective, double-blind, randomized controlled study. *PM R*. 2016;8(1):1–10. doi:10.1016/j.pmrj.2015.08.010
26. Lee MS, Cooper G, Lutz GE, Lutz C, Hong HM. Intradiscal electrothermal therapy (IDET) for treatment of chronic lumbar discogenic pain: a minimum 2-year clinical outcome study. *Pain Physician*. 2003;6(4):443–448.
27. Pauza KJ, Howell S, Dreyfuss P, Peloza JH, Dawson K, Bogduk N. A randomized, placebo-controlled trial of intradiscal electrothermal therapy for the treatment of discogenic low back pain. *Spine J*. 2004;4(1):27–35. doi:10.1016/j.spinee.2003.07.001
28. Wetzel FT, McNally TA, Phillips FM. Intradiscal electrothermal therapy used to manage chronic discogenic low back pain: new directions and interventions. *Spine*. 27(22):2621–2626. doi:10.1097/00007632-200211150-00043
29. Li Q, Yang J, Liu T, et al. Percutaneous intradiscal radiofrequency thermocoagulation combined with sinuvertebral nerve ablation for the treatment of discogenic low back pain. *Pain Physician*. 2024;27(7):e705–e714.
30. Vatansever D, Tekin I, Tuglu I, Erbuyun K, Ok G. A comparison of the neuroablative effects of conventional and pulsed radiofrequency techniques. *Clin J Pain*. 2008;24(8):717–724. doi:10.1097/AJP.0b013e318173c27a
31. Niemisto L, Kalso E, Malmivaara A, Seitsalo S, Hurri H. Radiofrequency denervation for neck and back pain. A systematic review of randomized controlled trials. *Cochrane Database Syst Rev*. 2003;(1):CD004058. doi:10.1002/14651858.Cd004058
32. Park D, Chang MC. The mechanism of action of pulsed radiofrequency in reducing pain: a narrative review. *J Yeungnam Med Sci*. 2022;39 (3):200–205. doi:10.12701/jyms.2022.00101
33. Carragee EJ, Chen Y, Tanner CM, Hayward C, Rossi M, Hagle C. Can discography cause long-term back symptoms in previously asymptomatic subjects? *Spine (Phila Pa 1976)*. 2000;25(14):1803–1808. doi:10.1097/00007632-200007150-00011
34. Carragee EJ, Don AS, Hurwitz EL, Cuellar JM, Carrino JA, Herzog R. ISSLS prize winner: does discography cause accelerated progression of degeneration changes in the lumbar disc: a ten-year matched cohort study. *Spine (Phila Pa 1976)*. 2009;34(21):2338–2345. doi:10.1097/BRS.0b013e3181ab5432
35. Cuellar JM, Stauff MP, Herzog RJ, Carrino JA, Baker GA, Carragee EJ. Does provocative discography cause clinically important injury to the lumbar intervertebral disc? A 10-year matched cohort study. *Spine J*. 2016;16(3):273–280. doi:10.1016/j.spinee.2015.06.051
36. Flanagan MN, Chung BU. Roentgenographic changes in 188 patients 10-20 years after discography and chemonucleolysis. *Spine (Phila Pa 1976)*. 1986;11(5):444–448. doi:10.1097/00007632-198606000-00009
37. McCormick ZL, Lehman VT, Plastaras CT, et al. Low-pressure lumbar provocation discography according to spine intervention society/international association for the study of pain standards does not cause acceleration of disc degeneration in patients with symptomatic low back pain: a 7-year matched cohort study. *Spine*. 2019;44(19):e1161–e1168. doi:10.1097/brs.0000000000003085