ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 07 | July - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

SYSTEMATIC REVIEW ON THE EFFECTIVENESS OF DISTAL SODIUM CHANNEL BLOCK IN MANAGING LUMBOSACRAL RADICULAR SYNDROME

Orthopaedics

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ABSTRACT

Lumbosacral Radicular Syndrome (LRS), or sciatica, is a neuropathic condition caused by compression or irritation of spinal nerve roots or the spinal cord. Despite a wide range of conservative and invasive treatment options, many patients continue to experience chronic pain with varying degree of intensity of pain. Voltage-gated sodium channels have been identified as mechanism to pain transmission, so it is targeted for intervention. Distal Sodium Channel Block offers a peripheral, minimally invasive approach, an outpatient procedure, by targeting these channels. **Aims:** This review aims to assess the clinical outcome, underlying mechanisms, safety profile, and effectiveness of DSCB in LRS management. Specific objectives include exploring the pathophysiological rationale for sodium channel blockade, evaluating clinical outcomes from authentic published studies in various journals, and identifying gaps in current evidence to guide future research and better patient management. **Materials And Methods:** The careful extensive evidence-based literature review was done on different published human studies of lumbosacral radicular syndrome using DSCB. Inclusion criteria encompassed studies reporting pain intensity, functional status, route of administration and adverse effects. Data extraction included study design, sample characteristics, drug type and administration, side effects, outcome measures, and follow-up duration. Quality was assessed using appropriate methodological tools for each study type. **Results:** Across multiple studies, DSCB led to a significant reduction in pain scores, with VAS scores decreasing from an average of 7.8 pre-intervention to 1.0–3.9 post-intervention over 30 days. A study reported a ≥50% pain reduction in about 88% of patients at 15 days, sustained in approximately. 85% at 3 months. Immediate relief within 30 minutes was observed in over 90% of cases. Functional improvements, including enhanced walking ability and decreased disability scores, were consistently reported. Adverse effects were minimal or absent in the reviewed studies. **Conclusion:** DSCB is a promising, mechanism-based treatment for LRS that offers safe, cost-effective, and rapid symptom relief in appropriately selected patients. While preliminary evidence is favorable, larger randomized controlled trials with standardized protocols are needed to confirm long-term efficacy and optimize treatment parameters. Until then, DSCB can serve as an effective adjunct in the multidisciplinary management of radicular pain.

KEYWORDS

INTRODUCTION

Lumbosacral radicular syndrome is a clinical condition characterized by radiating pain, numbness, with or without motor involvement, in the distribution of a lumbosacral nerve root. It is most often caused by mechanical compression or irritation of the nerve roots as they exit the spinal canal, typically due to intervertebral disc herniation, degenerative spinal changes, spinal stenosis, or spondylolisthesis. The syndrome significantly impairs quality of life, mobility, and daily functioning. The lifetime prevalence of LRS is estimated to be around 40% [1], with peak incidence occurring in individuals between the ages of 30 and 60. While the majority of cases respond to conservative treatments, many patients continue to experience persistent or recurrent symptoms that lead to a chronic pain state[1]. Chronic radicular pain is often neuropathic and is notoriously difficult to manage, posing a significant therapeutic challenge for clinicians.

Current treatment strategies for LRS follow a stepwise approach. Initial management typically involves conservative therapies such as rest, physical rehabilitation, nonsteroidal anti-inflammatory drugs (NSAIDs), and neuropathic pain medications like gabapentin or antidepressants. For patients with persistent pain, invasive procedures are considered, including epidural steroid injections (ESIs), nerve blocks, and surgical decompression. However, both systemic pharmacotherapy and interventional procedures are associated with variable efficacy and may carry risks of adverse effects or complications. Moreover, existing treatments often fail to address the underlying neural sensitization that perpetuates chronic pain.

Recent advances in pain neuroscience have identified voltage-gated sodium channels (VGSCs) as key mediators of nociceptive transmission and neuropathic pain. These channels are essential for the initiation and propagation of action potentials in sensory neurons. Subtypes of sodium channels, Nav1.3, Nav1.7, Nav1.8, and Nav1.9, are responsible for response to insult by upregulated or redistributed along peripheral nerves and the dorsal root ganglia initially in response to insult, resulting in hyperexcitability and spontaneous ectopic discharges and it maintains radicular pain, even in the absence of ongoing mechanical compression.

These sodium channels are in the limelight to modulate abnormal neural activity and provide effective pain relief. While systemic sodium channel blockers such as carbamazepine and lignocaine patches have been used in neuropathic pain syndromes with limited success. This involves the use of distal sodium channel block (DSCB)—the targeted injection of sodium channel-blocking agents into peripheral nerve branches distant from the spinal origin of radicular pain. The rationale is that distal nerve fibers still contribute to the pain experience through sensitization and aberrant firing, and blocking sodium channels at these sites can interrupt nociceptive signaling more effectively and with fewer side effects.

DSCB represents a minimally invasive, outpatient-friendly technique that may offer significant benefits for patients with LRS, especially those with chronic symptoms or contraindications to more invasive interventions. Despite its growing clinical interest, the evidence supporting its efficacy, optimal technique, and long-term outcomes remains limited and fragmented.

This study aims to explore the current understanding of DSCB in context to management of LRS and examining its theoretical basis, practical implementation, functional outcomes, and safety profile.

Pathophysiology Of LRS And The Role Of Sodium Channels

The pathophysiology of LRS involves both mechanical and chemical components. Insult to nerve root initiates a inflammatory processes involving cytokine release, upregulation of ion channels and activation of nociceptive pathways [2]. Voltage-gated sodium channels particularly Nav1.3, Nav1.7, Nav1.8, and Nav1.9 are upregulated, contributing to hyperexcitability and spontaneous ectopic discharges.

Nav 1.7 is the most important sodium channel in peripheral nociception [3]. Mutations in the SCN9A gene, which encodes Nav1.7, have been linked to pain disorders such as primary erythromelalgia and congenital insensitivity to pain, highlighting its critical role. Nav1.8 and Nav1.9, expressed predominantly in Dorsal Root Ganglia neurons also have part to play in inflammatory and neuropathic pain states. Blocking these channels reduces neuronal excitability and relieves pain.

Technique Of Distal Sodium Channel Block
DSCB typically involves perineural or subcutaneous injection of local anesthetics (e.g., lidocaine, bupivacaine) or selective sodium channel blockers at distal nerve sites. These blocks are usually guided by anatomical landmarks or ultrasound to ensure accurate placement.

Key Advantages Of This Technique Include:
- **Selective Targeting:** Focused delivery reduces systemic exposure.
- **Approach:** safe on spine and vertebral structures
- **Repeatability:** The minimally invasive nature allows for repeated applications if needed.

Sites for DSCB in LRS include tibial or peroneal nerves, where sodium channels are responsible for radicular pain signals.

2. Objective
The primary objective of this study is to evaluate the clinical effectiveness, mechanism of action, and therapeutic relevance of distal sodium channel block (DSCB) in the management of lumbosacral radicular syndrome (LRS). This includes a detailed analysis of its impact on pain reduction, functional improvement, and safety profile. Given the increasing interest in peripheral sodium channel modulation as a target for neuropathic pain control, this study aims to critically assess the current evidence supporting the use of DSCB as an alternative or adjunct to conventional interventions such as systemic pharmacotherapy and epidural steroid injections. These include:
- Study the pathophysiology involving sodium channels in LRS.
- Evaluate techniques, approaches, targets, and drugs.
- Identify grey areas in current research and provide the valuable information for management of LRS and also for further research.

3. METHODS
3.1 Study Design
This work is based on published literature review and popular techniques, designed to asses existing clinical, experimental, and theoretical knowledge regarding the use of distal sodium channel block in patients with LRS. Appropriate methodology was used to identify relevant studies, analyses outcome and interpret results for LRS.

3.2 Inclusion And Exclusion Criteria
Inclusion Criteria:
- Human studies that were published for the use of DSCB in LRS.
- Studies reporting at least one of the following outcome measures: pain intensity (e.g., VAS/NRS), functional status (e.g., Oswestry Disability Index), quality of life, or adverse events.

Exclusion Criteria:
- Animal studies without clinical translation.
- Epidural and other Central sodium channel blockade.
- Narrative and systemic reviews, editors' opinions, and letters that do not involve original data.

3.3 Data Extraction And Outcome Measures
The following data were extracted for each study that was included
- Study design and sample size
- Patient demographics and diagnostic criteria for LRS
- Drug and dose of sodium channel blocker used
- Anatomical target and technique for DSCB
- Pain scores (VAS/NRS) pre- and post-intervention
- Oswestry Disability Index, SF-36 are used for assessment of functional outcome.
- Duration of analgesic effect
- Reported complications or adverse events

Primary Outcome:
Pain reduction measured using VAS/NRS score.

Secondary Outcomes:
- Functional improvement, measured by validated physical disability or quality-of-life scales.
- Safety, measured by incidence of adverse effects (e.g., local tissue reaction, motor block, systemic toxicity).
- Patient satisfaction or subjective response.

3.4 Quality Assessment
- Each included study was appraised for methodological quality using an appropriate tool based on study type:
- Cochrane Risk of Bias Tool, which can be used for randomized controlled trials.
- Newcastle-Ottawa Scale for observational studies.

4. Review Of Literature
4.1 Clinical Studies Supporting DSCB In Lumbosacral Radicular Syndrome
Recent clinical investigations have explored the efficacy of Distal Sodium Channel Block (DSCB) in managing Lumbosacral Radicular Syndrome (LRS), yielding promising results:

[3] Shafaat et al. (2023) conducted a pilot study involving patients with LRS who received DSCB. The study suggests pain reduction and symptomatic improvement after 4 weeks. A study conducted concluded that DSCB has immediate pain relief, ease of administration in outpatient settings, cost-effectiveness, and potential as a bridge therapy while awaiting the effects of systemic medications.

[4] Beri et al. (2023) concluded that all 60 patients showed significant improvement post-injection. The VAS score decreased tremendously. The average VAS score of the patient before the injection was 7.94, which was 5.09 after 15 minutes and 1.39 after 30 minutes of injection.

[5] Saudi J Anaesth. (2023) was a prospective study that reported that 88% of patients experienced ≥50% pain relief after 15 days, 1 month, and 2 months, with benefits observed in 85% of patients at 3 months. Additionally, there was a noticeable decrease in Roland-Morris Disability Questionnaire (RMDQ) scores, significant improvement in employment status, and a decrease in analgesic demand.

[6] Waxman et al. (2023) have researched the role of voltage-gated sodium channels. This study focused on targeting the peripheral sodium channels to treat various neuropathic pain conditions without central nervous system side effects.

[7] Jha, V Sharma, G K Singh, O, and Agarwal (2025) extensively researched single-level lumbar disc prolapse and pain radiating to the unilateral side. Injection of bupivacaine 0.5%) around painful nerves near the ankle provides pain relief and a straight leg raise test at 30 min.

The Reviewed Studies Consistently Report That DSCB Is A Safe Procedure With Minimal Adverse Effects. Its Advantages Include:
- **Less Invasive:** This procedure can be performed in an outpatient setting.
- **Rapid Pain Control:** Patients often have a rapid pain-killing response.
- **Cost-Effectiveness:** Compared to epidural steroid injections or surgical interventions, DSCB is more affordable, making it accessible in resource-limited settings.
- **Diagnostic Utility:** It is helpful in differentiating between peripheral and central sources of radicular pain, which further helps in accurate diagnosis and treatment plans.

5. DISCUSSION
The management of lumbosacral radicular syndrome (LRS) remains a clinical challenge, especially in patients who exhibit inadequate response to conventional therapies such as NSAIDs, physical therapy, or epidural steroid injections. In this context, Distal Sodium Channel Block (DSCB) emerges as a promising and minimally invasive intervention with both diagnostic and therapeutic potential

DSCB targets voltage-gated sodium channels (VGSCs) [2], [3], which play a pivotal role in the generation and propagation of action potentials along nociceptive neurons. By blocking these channels at distal peripheral nerve sites, DSCB offers a mechanism-based approach to interrupt aberrant pain signaling without the systemic side effects associated with oral medications or the procedural risks linked to central neuraxial blocks.

The evidence reviewed demonstrates that DSCB provides significant pain relief in a substantial proportion of patients with LRS. Several studies, including Shafaat et al. (2023) and Beri et al. (2023), have reported high levels of patient satisfaction, rapid onset of analgesia, and improved functional outcomes following DSCB. Moreover, the reproducibility and safety of this technique make it an attractive option for both primary care providers and pain specialists. It can also serve as a valuable diagnostic adjunct by helping to localize pain generators along the sciatic pathway or differentiate central from peripheral

mechanisms of radiculopathy.

Most available studies are small-scale, single-center trials or case series, and there is a lack of large, multicenter randomized controlled trials to establish standardized protocols for DSCB. Variables such as drug type, concentration, injection site, and number of sessions differ widely across studies, limiting the generalizability of results. Additionally, long-term follow-up data are sparse, and the durability of pain relief from DSCB over months or years remains unclear.

Another consideration is patient selection. While DSCB appears effective for radicular pain with a strong peripheral component, it may be less beneficial in cases with predominantly central sensitization or structural nerve root compression requiring surgical intervention. Therefore, patient stratification using clinical, imaging, and diagnostic block data may be essential to optimize treatment outcomes.

6. CONCLUSION

Distal Sodium Channel piece is a rising procedure that gives a focused, secure, and successful approach to lumbosacral radicular disorder, especially in patients with peripheral nerve sensitization and those unresponsive to routine medicines. By focusing on the pathophysiological role of sodium channels in neuropathic pain, DSCB represents a paradigm shift toward mechanism-based therapy.

The current body of evidence, although limited, supports its use as both a diagnostic and therapeutic modality with favorable outcomes and minimal risk. However, standardized protocols, larger-scale clinical trials, and long-term efficacy studies are essential to establish DSCB as a mainstay in the multidisciplinary management of LRS.

Until then, DSCB can be considered a valuable adjunct in individualized care, offering relief to patients seeking alternatives to systemic drugs or invasive procedures.

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