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Original Research Article

Effect of Landmark Technique Based Caudal Epidural Steroid Injections in Resistant Low Back Pain Patients with Radiculopathy

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Abstract

Background: Chronic low back pain (LBP) with radiculopathy remains a prevalent and disabling condition leading to impairment in quality of life and productivity. Caudal epidural steroid injection (CESI) is commonly performed for refractory cases that encountered in places where sophisticated imaging for guidance may not be possible.

Materials and Methods: This prospective interventional study done from May 2021 to May 2022 involving the 52 patients of age ≥18 year who had chronic radicular pain (>6 months) not responding to conservative treatment. All patients were administered 20 ml of 0.025% bupivacaine and 8 mg dexamethasone by conventional caudal epidural block under landmark. The Numeric Rating Scale (NRS) for the assessment of pain intensity and the Oswestry Disability Index (ODI) were administered at baseline and at 1 month after treatment. The data were analyzed by paired t-test and $p<0,05$ was taken as being significant.

Results: Mean NRS score decreased significantly from 8.1 ± 0.8 at baseline to 3.4 ± 1.4 after treatment ($p<0.001$). The average ODI score decreased from 34.2 ± 2.7 to 7.9 ± 7.9 ($p<0.001$), with an over than 50% improvement in pain and function levels as well.

Conclusion: Landmark-based caudal epidural steroid injection with local anesthetic is a safe, minimally invasive and cost-effective intervention for recalcitrant low back pain with radiculopathy. Large prospective randomized controlled studies with long-term follow-up are recommended.

Keywords: Low back pain, Radiculopathy, Caudal epidural steroid injection, Landmark technique, Numeric Rating Scale, Oswestry Disability Index.

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Introduction

Low back pain (LBP) is characterized by pain or discomfort presenting between the costal margins and inferior gluteal folds with or without radiation to one or both lower extremities [1]. When pain radiates along the distribution of the sciatic nerve, it is often called sciatica. Sciatica has been referred to as one of the great curses of humanity because it is chronic, recurrent and debilitating.

Low-back pain is one of the most frequent causes of years lived with disability globally, and it has a substantial impact on both productivity and healthcare expenditure. Epidemiological studies suggest that as many as 60-80% of the population will experience at least one episode of LBP during their lifetime [2]. The radiculopathy induced by the herniated-disk is another significant factor contributing to decreasing quality of life due to intense pain and sensory loss as well as functional limitations [3]. Chronic refractory low back pain represents a significant socioeconomic strain, more so in developing countries where access to specialised interventional pain management may not be widely available [4].

The clinical entity sciatica was first recorded in 1764 by a treatise De Ischiade Nervosa Commentarius by Domenico Cotugno, who later put forward the idea of neural pain as distinguished from other musculoskeletal conditions. A significant development came in 1934 with the landmark paper by Mixter and Barr, which

suggested that herniated nucleus pulposus is a main source of radicular pain [5]. Their contribution brought attention to intervertebral disc as a focus of sciatica and provided guidelines for surgical or non-surgical management.

The development of caudal epidural injections was initiated in 1901 when Jean Athanase Sicard introduced the use of caudal local anesthetic injections. Caudal anaesthesia for surgical operations and relief of rectal pain was also described by Fernand Cathelin in the same year [6,7].

The technique subsequently evolved during the early 20th century, with development of including the introduction of epidurography and large-volume injections. A major breakthrough was the discovery of corticosteroids in 1953 and their use in the epidural space, widening the spectrum of treatment from anesthesia to chronic pain control. Subsequent to this, Caudal Epidural Steroid Injections (CESI) have emerged as a widely accepted treatment for radicular pain.

Mechanical and inflammatory factors contribute to the etiology of lumbago with radiation. Direct neural irritation can be derived from herniated disc material compressing the nerve root mechanically [8,9]. However, disc herniations are also found on imaging in asymptomatic subjects, suggesting that local compression may not entirely account for symptoms. Chemical inflammation is important because the nucleus pulposus material releases inflammatory mediators which sensitize nearby nerve roots. Intraneural edema, microcirculatory disturbance, axonal damage, and focal demyelination are also responsible for ongoing radicular pain.

The beneficial effects of corticosteroids are based mainly on an effect as anti-inflammatory drugs. They block phospholipase A2 activity, leading to a decrease in the production of pro-inflammatory mediators such as prostaglandins and leukotrienes [10,11]. Steroids also stabilize neuronal membranes, reduce ectopic neural discharges and block the dorsal horn sensitization responsible for diminished central pain amplification. Local anesthetics provide immediate analgesia and long-term anti-inflammatory benefit when used in combination with local anesthetics [12]. In addition, epidural injection can dilute or wash away chemical irritants around the inflamed nerve roots.

Advanced imaging may not be easily accessible in resource-limited areas, but the landmark technique can provide a more feasible option. Because of its simple implementation and low infrastructure demands, clinical validation is necessary to assess the potential use in treatment-resistant low back pain with radiculopathy.

Objectives

1. To assess the efficacy of landmark-guided caudal epidural steroid injection in patients with refractory lumbar radicular pain.
2. To evaluate the amount of pain intensity reduction following a landmark-based caudal epidural steroid injection using the NRS.
3. To assess the beneficial effects of functional disability and to compare pre- and post-treatment results with the ODI.

Materials and Methods

Patient Selection: The prospective interventional study was performed between May 2021 and May 2022, in patients with resistant low back pain with radiculopathy. Eligible patients were older than 18 years with a radiologically verified disc herniation/clinical radiculitis. Only patient with chronic function-limiting LBP of more than 6 months duration and for whom conservative treatment (drugs, physiotherapy & electrotherapy) had failed were enrolled in the study. Written informed consent was obtained from all patients before being enrolled.

Exclusion criteria were previous lumbar spine surgery, radiculopathy due to spinal stenosis without disc herniation, uncontrolled psychiatric or medical comorbidities, pregnancy or lactation and known hypersensitivity of local anesthetics or corticosteroids. These criteria were designed to make the study population homogeneous and eliminate confounding factors that may influence treatment results.

Pre-Enrollment Evaluation: Prior to introduction of any intervention, a complete evaluation was carried out in all patients which included demographic information (age and sex), full medical and surgical history, onset and duration of symptoms. A complete physical examination was conducted with particular care for neurological deficits. Radiological studies (eg, MRI) were checked to verify the disc pathology.

Baseline pain intensity was measured on an NRS, a validated 0–10 rating scale from 0 (no pain) to 10 (worst imaginable pain). Functional disability was assessed by the ODI version 2.0, which ranges from 0 to 50 and represents severity of functional limitation due to low back pain.

Intervention Protocol: All experiments were conducted in an sterile operating room. After induction, the patients were placed in prone position and standard monitoring was applied including intravenous access and vital signs. With the help of landmark method, sacral cornua were palpated and sacral hiatus was recognized. A 21-

gauge Tuohy needle was inserted at an initial angle of 45 degrees with bone contact, and subsequently a lower angle (approximately 0 degrees) further penetration into the epidural space. Prior to being negative aspiration, 20 ml 0.025% bupivacaine was injected and then subsequently combined with 2 ml (8 mg) dexamethasone. Sterile technique was used at every step of the operation. Patients were allowed to remain on their previous exercise programs and medications (co-interventions).

Outcome Assessment and Statistical Analysis: Pain severity (NRS) and functional disability (ODI) were re-evaluated at 1 month after injection. The paired t-test was used to assess pre- and post-treatment scores. Results were considered statistically significant if $p < 0.05$.

Results

Demographics: 52 persons were included in the study. Among them 61.5% were males and 38.5% females, a male predominance in resistant low back pain with radiculopathy.

The average age of the study population was 33.5 ± 2.12, indicating that the disease mainly attacked young and middle-aged group.

The duration of pain was 19.5 ± 2.12 months, indicating chronic nature of symptoms. 67% patients had the insidious pain started and 33% of them presented with abrupt onset. The location of pain was mainly bilateral (80.8%), and 19.2% were unilateral.

Table 1: Baseline Demographic Characteristics

Variable	Value
Total Patients	52
Men	61.5%
Women	38.5%
Mean Age (years)	33.5 ± 2.12
Mean Duration of Pain (months)	19.5 ± 2.12
Onset – Gradual	67%
Onset – Sudden	33%
Pain Distribution – Bilateral	80.8%
Pain Distribution – Unilateral	19.2%

Disc Levels: Radiological overview the most frequent intervertebral level involved was L4–L5 (58.9%), followed by L5–S1 (40.3%). L3–L4 was affected in 9.6% of cases. It was also possible for patients to have disc herniation at more than one level, so these numbers were added together and an explanation for >100% values. The higher prevalence of lower lumbar involvement corresponded with biomechanical stress patterns found in the lumbar spine.

Table 2: Distribution of Disc Herniation Levels

Disc Level	Percentage (%)
L3–L4	9.6%
L4–L5	58.9%
L5–S1	40.3%
Multiple Levels	Present in some patients

NRS and ODI Outcomes: The intensity of pain and the degree of functional disability had significantly improved after landmark- based caudal epidural corticosteroid injection. Baseline NRS of the mean was 8.1 ± 0.8 and at one-month post-treatment it was 3.4 ± 1.4. Similarly mean ODI score reduced from 34.2 ± 2.7 (at baseline) to 7.9 ± 7.9 after treatment. Reductions in both were statistically significant ($P < 0.001$).

Table 3: Comparison of Pre- and Post-Treatment Outcomes

Outcome	Baseline (Mean ± SD)	Post-Treatment (Mean ± SD)	p-value
NRS	8.1 ± 0.8	3.4 ± 1.4	<0.001
ODI	34.2 ± 2.7	7.9 ± 7.9	<0.001

The results showed significant more than 50% decrease in pain intensity (NRS) and functional disability (ODI), at one month from the pretreatment value.

The statistically significant difference shows that landmark-based caudal epidural steroid injection is effective in controlling ailment of low back pain with radiculopathy as a resistant case.

These results confirm the value of this approach for clinical purposes, in particular whenever image-guided interventions are not feasible.

Discussion

Comparison with Previous Studies: This current study demonstrated a significant reduction pain and functional disability following landmark-based CESI for refractory Low back pain with radiculopathy. These results are in line with those from prior studies. [13] Noted significant pain reduction and functional improvement in chronic lumbar radiculopathy after caudal epidural steroid injections, promoting the same as non-surgical treatment for pain gridlock. The notable decrease in NRS and ODI scores in our study is consistent with their reported effectiveness of epidural steroids for chronic discogenic and radicular pain [14].

The inflammatory nature of radiculopathy was first highlighted by [15] when inflammatory mediators were identified in the cerebrospinal fluid of patients with the condition. This finding adds to the clinical argument for steroid treatment in treating inflammation associated with compressed nerve roots. In addition, the pioneering work disc herniation as a common cause of sciatica, thereby vindicating interventional treatment for affected epidurals.

Clinical Significance of Pain and Functional Improvement: The mean improvement in NRS and ODI at 1-month follow-up was more than 50% ($p < 0.001$). More than 50% pain score reduction is commonly considered to be a clinically significant improvement in chronic pain trials. The significant reduction of ODI not only means pain relief but also reflects improvement in the daily functional activity from before treatment. These developments are of particular interest in the young and working population, given that chronic low back pain has a marked impact on productivity and quality of life.

Mechanisms of Action: Several mechanisms could have accounted for the favorable outcomes. Corticosteroids are powerful anti-inflammatory agents through inhibition of phospholipase A2 activity, leading to decreased production of pro-inflammatory mediators. They are also membrane stabilizers of nerves and they inhibit dorsal horn sensitization that decreases central pain on ramping. The local anesthetic gives quick analgesia by inhibiting the sodium channels and stopping nociceptive conduction. Furthermore, the substantially larger injectate volume may prevent or at least dilute and wash out chemical irritants around the offending nerve roots leading to a diminished neural inflammation or edema.

Limitations and Clinical Implications: There are some limitations that we have to take into account despite receiving promising results. The number of the cases we presented is small and follow-up time is short, one month only, which limits the explanation on long-term prognoses. The lack of a placebo or control group restricts comparison with natural recovery or placebo. Additionally, the study sample was predominantly younger and this may affect generalisability.

However, the results indicate that landmark-based caudal epidural steroid injection is a safe, minimally invasive, and efficient treatment for intractable low back pain with radiculopathy. Due to its cost-effectiveness and practicality, it has tremendous utility in low-resource areas where fluoroscopic guidance may not be immediately accessible.

Conclusion

This study shows that caudal epidural injection of steroid and local anaesthetic is highly effective for patients with intractable low back pain and radiculopathy, where the only parameters are consistent neurologic problem (including motor deficit) as well as low back pain. NRS scores for pain and the ODI scoring of functional level showed significant changes at one month after therapy. The results suggest the efficacy of this minimally invasive approach in terms of anti-inflammatory effect, relief from radicular symptoms and daily functional performances. Due to its simplicity, safety and cost effectiveness as compared to fluoroscopy-guided techniques, landmark approach has the greatest applicability especially in resource-poor settings where fluoroscopy may not be available. However, the study's limitations, the sample size and follow-up period underscore the necessity for future investigation. Further research with larger sample sizes, longer duration of follow-up, and randomized controlled design are suggested to confirm and confirm these results.

Recommendations

On the basis of data obtained in this study, further research is encouraged to improve the reliable evidence on effectiveness of landmark-based caudal epidural steroid injections in chronic low back pain with radiculopathy not responding to conservative therapy. Further investigations with longer follow-up are needed to assess long-term durability of pain relief and functional improvement. Randomized controlled trials would reduce the bias the provide the stronger evidence by comparing the outcomes with the placebo or other interventions. Increasing sample size would also improve the statistical power and generalization to a wider range of patient populations. Comparative studies evaluating the landmark-based approaches as well as fluoroscopy-guided caudal epidural injection would be useful to establish the relative effectiveness, safety and cost-effectiveness.

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