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PATIENT REPORTED OUTCOMES AFTER ULTRASOUND GUIDED HIATAL EPIDURAL STEROID INJECTION FOR LUMBAR RADICULOPATHY.

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ABSTRACT

BACKGROUND: Ultrasound-guided hiatal epidural steroid injection is a minimally invasive intervention for lumbar radiculopathy. This study evaluates patient-reported outcomes following this procedure. **OBJECTIVE:** The objective of this study is to assess patient-reported outcomes, including pain relief, functional improvement, and the need for additional interventions, following ultrasound-guided hiatal epidural steroid injection for lumbar radiculopathy. **METHODS:** This retrospective study analyzed 200 patients undergoing ultrasound-guided hiatal epidural steroid injection (2022–2024). Outcomes included VAS pain scores, functional improvement, additional interventions, satisfaction, and adverse events. Statistical analyses involved paired t-tests, chi-square tests, and multivariate regression. **RESULTS:** The mean age of participants was 48.3 ± 10.2 years, with 56% males. Baseline mean VAS was 7.2 ± 1.3, which significantly decreased to 4.3 ± 1.2 at one week, 3.1 ± 1.4 at one month, and 2.5 ± 1.2 at three months ($p < 0.001$). At three months, 62% of patients reported full functional recovery, 14% required repeat injections, and 6% were referred for surgery. Patient satisfaction was high, with 79% expressing a positive response. Adverse events occurred in 11% of patients, primarily transient pain flare-ups (9%). Regression analysis identified baseline VAS and BMI as significant predictors of pain relief ($p < 0.05$). **CONCLUSION:** Ultrasound-guided hiatal epidural steroid injection significantly improves pain and functional outcomes in lumbar radiculopathy patients, with minimal adverse effects. Higher baseline pain and BMI predict lower pain relief.

KEYWORDS: Lumbar radiculopathy, Epidural steroid injection, Ultrasound guidance, Pain relief, Patient-reported outcomes

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INTRODUCTION

Lumbar radiculopathy (LR) is a pain syndrome that can result from degenerative arthritis, lumbar stenosis, intervertebral disc degeneration or herniation, bone or muscle tumors, infections, inflammation, or other disorders that compress and/or irritate the lumbar nerve roots[1,2]. Terms such as leg discomfort, sciatica, and lumbar radicular syndrome are often used interchangeably. Patients frequently seek consultations at spine surgery clinics due to radicular pain[3]. Epidural steroid injections (ESIs) are commonly employed as a therapeutic option, particularly in the lumbar region, to reduce inflammation and alleviate pain[4]. Depending on the affected nerve root(s), common symptoms of LR include numbness, tingling, weakness with myotomal distribution, radiating pain with dermatomal distribution, and altered deep tendon reflexes[5]. Radiculopathy is frequently accompanied by radicular pain[6]. For patients with LR, conservative management is recommended as the first-line treatment by the North American Spine Society[7]. However, there is no conclusive evidence that one conservative approach is superior to another [8] or even to placebo[7, 8] f, g. Noninvasive treatments for LR include pharmacologic and nonpharmacologic interventions such as medication, physical therapy, manipulation, and alternative therapies[9]. Surgery, the most invasive option, is often reserved for cases of degenerative spondylolisthesis, spinal canal stenosis, axial or discogenic pain, and persistent disc herniation with or without radiculopathy[10]. Unfortunately, the failure rate for lumbar spine surgery remains as high as 25%, even in well-evaluated patients. Not all symptomatic individuals are candidates for surgery due to various factors, including the nature of the disc pathology, such as minor herniations or protrusions, which are not always surgically treatable[11].

Several epidural injection techniques exist, each with distinct advantages and disadvantages. While the interlaminar approach is preferred for bilateral cases, the foraminal technique allows for corticosteroid administration in close proximity to the affected nerve root[12]. A caudal approach through the sacral hiatus (SH) is another alternative for epidural drug delivery[13]. Among these, epidural steroid injection (ESI) is one of the most widely used nonsurgical treatments for LR[14]. Different access methods include interlaminar, caudal, and transforaminal approaches[15]. Hiatal epidural steroid injection (HESI) is considered a safe and minimally invasive technique with a lower risk of dural puncture, making it particularly suitable for patients with post-surgical syndrome[16]. However, accurate needle placement through the SH into the epidural space is critical for a successful caudal HESI. Blind HESI, even when performed by experienced clinicians, has been associated with incorrect needle placement in 25–38% of cases[17]. Fluoroscopy (FL)-guided injections improve accuracy, but concerns regarding ionizing radiation exposure necessitate cautious application[18]. Ultrasound (US) has emerged as an effective alternative for locating the SH and ensuring precise needle guidance into the caudal epidural region[19].

Despite the widespread use of ultrasound-guided HESI for lumbar radiculopathy, there is limited data on patient-reported outcomes following this procedure. Most available studies focus on technical feasibility and anatomical accuracy rather than patient-centered effectiveness. This study aims to evaluate pain relief, functional improvement, need for additional interventions, patient satisfaction, and adverse events associated with ultrasound-guided HESI in patients with lumbar radiculopathy.

METHODOLOGY

The present retrospective study aimed to evaluate patient-reported outcomes following ultrasound-guided hiatal epidural steroid injection for lumbar radiculopathy. Ethical approval was obtained from the Ethical Committee of Bahria International Hospital, Rawalpindi, Pakistan (Ref No. BARMT-BIH-8-RWP-HR-F-37), dated February 14, 2025. The study involved a detailed review of electronic medical records to extract baseline characteristics, procedural details, and follow-up outcomes. Data collection was conducted in accordance with ethical guidelines, ensuring patient confidentiality and anonymity.

The sample size was determined using a power analysis based on prior studies of epidural steroid injections for lumbar radiculopathy. Assuming a mean difference of 2.0 points on the Visual Analog Scale (VAS) for pain reduction with a standard deviation of 3.5, a power of 80%, and an alpha of 0.05, the required sample size was calculated to be approximately 200 patients. Patients who underwent ultrasound-guided hiatal epidural steroid injection between January 2022 and December 2024 were included, ensuring a sufficient follow-up period for outcome assessment.

Patients were eligible for inclusion if they were aged 18–70 years, had clinically and radiologically confirmed lumbar radiculopathy with symptoms persisting for at least six weeks despite conservative treatment, and had undergone a single ultrasound-guided hiatal epidural steroid injection [20] at the study center. Exclusion criteria included a history of lumbar spine surgery, spinal infections, malignancies, coagulation disorders (INR > 1.5 or platelet count < 100,000/µL), use of additional interventional pain procedures within the study period, and incomplete follow-up data.

To control for confounding factors, patients were stratified based on baseline VAS scores 21 (mild: 1–3, moderate: 4–6, severe: 7–10), age groups (18–40, 41–55, 56–70 years), and presence of comorbidities such as diabetes and hypertension. Multivariate linear regression was performed to adjust for potential confounders, including baseline pain severity, symptom duration, body mass index (BMI), and pre-procedure analgesic use.

Patient-reported outcomes were assessed based on follow-up medical records. The primary outcome was pain relief, measured using VAS scores recorded at baseline, one week, one month, and three months post-procedure. A reduction of at least 50% in VAS score from baseline was considered a clinically significant improvement. Secondary outcomes included functional improvement, assessed through documented changes in mobility status categorized as no improvement, partial improvement, or full return to normal activity, as recorded in follow-up notes. The need for additional interventions was also analyzed, including the proportion of patients requiring repeat steroid injections or escalation to surgical treatment. Patient satisfaction was inferred from documented subjective reports explicitly stating whether the patient perceived the intervention as beneficial or unsatisfactory. Adverse events such as post-injection pain flare-ups, transient symptom exacerbation, or complications like dural puncture headache were identified through follow-up records.[21]

Statistical analysis was conducted using SPSS version 26. Pain relief was analyzed using a paired t-test to compare mean VAS scores at different time points, given the expected normal distribution of data. Functional improvement and patient satisfaction were analyzed using the chi-square test. Logistic regression was applied to identify predictors of treatment response, adjusting for confounding variables such as age, BMI, and baseline pain severity. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of the participants was 48.3 ± 10.2 years, with 112 (56%) males and 88 (44%) females. Comorbid conditions were present in 78 (39%) patients, with hypertension in 50 (25%) and diabetes in 28 (14%). The mean body mass index (BMI) was 27.5 ± 3.6 kg/m². The majority of patients (66%) had severe baseline pain (VAS 7–10). The average symptom duration before intervention was 10.4 ± 3.2 weeks. Comorbidities, including hypertension and diabetes, were prevalent in 39% of cases (**Table 1)**.

TABLE 1: BASELINE CHARACTERISTICS OF STUDY PARTICIPANTS.

Characteristic	Mean ± SD / n (%)
Age (years)	48.3 ± 10.2
Gender (Male/Female)	112 (56%) / 88 (44%)
BMI (kg/m²)	27.5 ± 3.6
Symptom duration (weeks)	10.4 ± 3.2
Baseline VAS score	7.2 ± 1.3
Hypertension	50 (25%)
Diabetes	28 (14%)
Severe pain (VAS 7–10)	132 (66%)

Pain relief was assessed using VAS scores at different time points. A significant reduction in pain was observed post-procedure, with mean VAS scores decreasing from 7.2 ± 1.3 at baseline to 4.3 ± 1.2 at one week, 3.1 ± 1.4 at one month, and 2.5 ± 1.2 at three months). A significant reduction in pain was observed at all follow-up intervals ($p < 0.001$), with 84% of patients achieving at least a 50% reduction in VAS scores at three months. A paired t-test confirmed a statistically significant reduction at each follow-up ($p < 0.001$) (**Table 2)**. Changes in mobility and activity levels were documented in follow-up notes. At three months, 124 (62%) patients reported full functional recovery, while 58 (29%) experienced partial improvement, and 18 (9%) had no significant change (**Table 3**).

TABLE 2: PAIN REDUCTION (VAS SCORES) AT DIFFERENT TIME POINTS

Time Point	Mean VAS Scor ± SD	p-value (Paired t test)
Baseline	7.2 ± 1.3	-
1 Week	4.3 ± 1.2	< 0.001
1 Month	3.1 ± 1.4	< 0.001
3 Months	2.5 ± 1.2	< 0.001

TABLE 3: FUNCTIONAL IMPROVEMENT AT THREE MONTHS POST-PROCEDURE

Functional Outcome	n (%)
Full improvement	124 (62%)
Partial improvement	58 (29%)
No improvement	18 (9%)

At three months, 28 (14%) patients required a repeat steroid injection, while 12 (6%) were referred for surgical evaluation due to persistent symptoms (**Table 4**).

TABLE 4: NEED FOR ADDITIONAL INTERVENTIONS POST-PROCEDURE

Intervention	n (%)
Repeat injection	28 (14%)
Surgery referral	12 (6%)

Patient satisfaction was inferred from documented subjective reports in follow-up notes. At three months, 158 (79%) patients reported a positive response, 30 (15%) were neutral, and 12 (6%) were dissatisfied (**Table 5**).

TABLE 5: PATIENT SATISFACTION AT THREE MONTHS POST-PROCEDURE

Satisfaction Level	n (%)
Satisfied	158 (79%)
Neutral	30 (15%)
Dissatisfied	12 (6%)

Post-procedural adverse events were noted in 22 (11%) patients, with transient pain flare-ups being the most common that is 18 (9%). No serious complications, such as dural puncture headaches or infections, were reported **Table6**. A multivariate linear regression model was used to identify predictors of pain relief at three months. Baseline VAS score and BMI were significant predictors, with higher baseline pain and increased BMI correlating with reduced pain relief **Table 7**.

TABLE 6: ADVERSE EVENTS FOLLOWING THE PROCEDURE

Adverse Event	**n (%)**
Transient pain flare-up	18 (9%)
Mild dizziness	4 (2%)
Dural puncture headache	0 (0%)
Infection	0 (0%)

TABLE 7: MULTIVARIATE REGRESSION ANALYSIS OF FACTORS AFFECTING PAIN RELIEF

Variable	**Beta Coefficient**	**95% CI**	**p-value**
Baseline VAS	-0.45	-0.58 to -0.32	< 0.001
BMI	-0.32	-0.48 to -0.15	0.002
Age	-0.12	-0.26 to 0.04	0.128
Hypertension	-0.08	-0.22 to 0.06	0.210
Diabetes	-0.14	-0.30 to 0.02	0.085

DISCUSSION

Lumbar epidural steroid injection as part of the conservative management of radicular pain due to disc herniation is extremely popular in everyday clinical practice. The lumbar epidural space is accessible either by caudal, inter-laminar, or transforaminal routes [22].

In routine clinical practice, lumbar epidural steroid injections are a highly common conservative treatment for radicular pain brought on by disc herniation. There are three ways to enter the lumbar epidural space: caudal, inter-laminar, or transforaminal[22]. Among the many benefits of the caudal epidural injection include its effectiveness in treating multilevel disc prolapse, less risk of dural or subarachnoid penetration, and convenience of use in patients who have had prior spinal surgery[5].

The mean age of the study participants was 48.3 ± 10.2 years, which aligns with prior studies indicating that lumbar radiculopathy predominantly affects middle-aged adults [23]. Male predominance (56%) was observed, consistent with previous epidemiological studies suggesting a higher prevalence of lumbar disc herniation and radiculopathy in men due to occupational and lifestyle factors [24]. The prevalence of hypertension (25%) and diabetes (14%) among participants reflects common comorbidities associated with chronic pain conditions, as systemic inflammation and microvascular compromise may contribute to nerve dysfunction and delayed healing[25]. Our findings are consistent with those of Parket al.[26], Park et al.[17], and Akkaya et al.[27], who found no significant differences between the US and FL groups in age, BMI, sex distribution, and duration of disease.

In our study, obesity was not always linked to challenging CESI, despite Park et al.[17] pointing out that one of his study drawbacks was that US-guided CESI was performed in patients with BMI < 30 kg/m2. Both groups of patients in our study had a mean BMI of 30 kg/m2. None, though, had dense subcutaneous fat in the sacral region, which could make ultrasonography more difficult. The current study additionally made use of a

bent transducer for deeper structures. According to Klunklin et al.[28], it is simple to identify the SH in obese patients by US. This result is consistent with that reported by Tsai et al.[29], who reported that 67.6% of their patients were overweight or pre-obese and did not have excess fat tissue covering the sacrum, which would have obscured the SH's anatomical characteristics. A significant reduction in pain scores was observed across all follow-up periods, with mean VAS decreasing from 7.2 ± 1.3 at baseline to 2.5 ± 1.2 at three months. This substantial improvement aligns with previous research demonstrating the efficacy of epidural steroid injections in reducing inflammation and alleviating radicular pain[30]. In comparison to before injection, there was a highly statistically significant improvement in VAS at one and three-months following injection. As evidenced by improvements in VAS and ODI following injections compared to before, Park et al.[26], Park et al.[17], Hazra et al.[31], and Akkaya et al. 2017 20 showed a significant improvement in pain and function in the US-guided CESI. The current study's results are in line with these findings.

Furthermore, in their randomized controlled clinical experiment to determine the efficacy of CESI, Manchikanti et al.[32] observed a significant statistical difference in the SLRT, modified Schober test, VAS, and ODI before versus 1 month after CESI and before against 3 months after CESI.

There are several different theories regarding how ESI works. Both mechanical compression and chemical radiculitis, which are caused by inflammatory cytokines acting on the dorsal root ganglion, can experimentally result in radicular discomfort. As a result, local anesthetic and corticosteroid administration to the afflicted nerve root appear to be sensible options[33]. Where the steroid is administered, it is said to have a lipophilic property that permits prolonged release from the plentiful epidural fat [34].

Functional improvement was noted in 91% of patients at three months, with 62% reporting full recovery and 29% experiencing partial improvement. This finding is consistent with earlier studies indicating that pain relief following epidural steroid injections is associated with enhanced mobility and daily function[35]. The reduction in pain likely facilitated greater engagement in physical activity, preventing muscle deconditioning and promoting overall recovery. Patients with persistent symptoms may have had underlying structural issues, such as disc extrusion or severe stenosis, limiting their functional recovery[30].

Multivariate regression analysis identified baseline VAS score and BMI as significant predictors of pain relief, with higher baseline pain and increased BMI correlating with reduced improvement. These findings align with previous literature, suggesting that higher initial pain levels may indicate greater nerve root compression or inflammation, necessitating more aggressive managemen[36]. Obesity is well-documented as a risk factor for chronic pain due to increased mechanical stress on the lumbar spine and systemic inflammation[37]. Hypertension, diabetes, and age did not significantly impact pain relief, which is consistent with previous studies indicating that these factors play a more indirect role in lumbar radiculopathy outcomes[38].

At three months, 14% of patients required a repeat injection, and 6% were referred for surgical evaluation. These rates are in line with previous studies reporting that while ESIs are effective, a subset of patients may require additional interventions due to progressive degenerative changes or inadequate steroid dispersion[39]. Repeat injections have been shown to provide additional pain relief in some cases, particularly in patients with recurrent inflammatory flare-ups[40].

Patient satisfaction was high, with 79% reporting a positive response at three months. This is comparable to previous

reports demonstrating that patient satisfaction correlates strongly with pain relief and functional improvement[41]. Neutral and dissatisfied responses (15% and 6%, respectively) may be attributed to residual pain, limited improvement in mobility, or unrealistic expectations regarding pain resolution[42].

Post-procedural adverse events were reported in 11% of patients, primarily transient pain flare-ups (9%). This incidence is consistent with prior findings, which indicate that corticosteroid injections can cause short-term pain exacerbation due to fluid-induced pressure changes and temporary irritation of neural structures[43]. Accordingly, unlike local analgesics, which provide immediate pain relief, corticosteroids decrease nerve swelling and increase the transcription of anti-inflammatory genes[44].

Dizziness and a brief headache were the main problems we noted in this trial, and there was only one instance of a vasovagal crisis. With a low risk of coincidental dural puncture, caudal epidural injections are thought to be the safest and most straightforward epidural treatments[45.]

There are many reasons why the operation may not have worked in circumstances when the injection did not improve the situation. The results may be impacted by individual differences in the receptor responsiveness to steroids[31]. No serious complications, such as dural puncture headaches or infections, were observed, supporting the safety of ultrasound-guided HESI [46].

The findings of this study reinforce the utility of ultrasound-guided HESI as an effective, minimally invasive treatment for lumbar radiculopathy. Given the high success rate in pain reduction, functional recovery, and patient satisfaction, this technique should be considered as a first-line intervention for patients who are not immediate surgical candidates. The role of BMI in predicting outcomes highlights the need for comprehensive patient counseling regarding weight management as part of a multimodal approach to managing lumbar radiculopathy.

Despite its strengths, this study has certain limitations. The retrospective design may introduce selection bias, and the lack of a control group limits direct comparisons with other treatment modalities. Additionally, while subjective patient-reported outcomes were utilized, objective functional assessments such as gait analysis or electromyography could provide a more comprehensive evaluation of recovery. Future studies should include randomized controlled trials to validate these findings and explore long-term outcomes beyond three months.

CONCLUSION

Ultrasound-guided HESI is an effective intervention for managing lumbar radiculopathy, leading to significant pain relief, improved functional outcomes, and high patient satisfaction with minimal adverse effects. Higher baseline pain and increased BMI were associated with reduced pain relief, underscoring the need for personalized treatment approaches. These findings support the continued use of HESI as a valuable tool in the conservative management of lumbar radiculopathy.

ETHICS APPROVAL: The ERC gave ethical review approval.

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

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AUTHORS' CONTRIBUTIONS:

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated in the work to take public responsibility of this manuscript. All authors read and approved the final manuscript.

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