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CT-Guided Versus Ultrasound-Guided Nerve Root Block in Lumbar Radiculopathy: A Comparative Prospective Study.

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Abstract

Background: Lumbar radiculopathy is a common cause of low back pain and lower limb disability. Selective nerve root block (SNRB) is widely used both diagnostically and therapeutically. Computed tomography (CT)-guided SNRB provides excellent anatomical visualization but exposes patients to ionizing radiation. Ultrasound-guided SNRB has emerged as a radiation-free alternative with real-time needle visualization. ***Objective:*** To compare the clinical efficacy, procedural characteristics, safety, and patient outcomes of CT-guided and ultrasound-guided nerve root blocks in patients with lumbar radiculopathy. ***Methods:*** A prospective comparative study was conducted among 80 patients diagnosed with unilateral lumbar radiculopathy. Patients were allocated into two groups: CT-guided SNRB (n=40) and ultrasound-guided SNRB (n=40). Pain intensity was assessed using the Visual Analog Scale (VAS), while functional disability was measured using the Oswestry Disability Index (ODI). Outcomes were evaluated at baseline, 1 week, 1 month, and 3 months post-procedure. Procedure time, complications, radiation exposure, and patient satisfaction were also recorded. ***Results:*** Both groups demonstrated significant reductions in VAS and ODI scores at all follow-up periods ($p<0.001$). At 3 months, mean VAS scores decreased from 7.8±1.1 to 2.4±1.2 in the CT group and from 7.6±1.0 to 2.6±1.3 in the ultrasound group ($p=0.41$). Mean procedure duration was significantly shorter in the ultrasound group (12.8±3.2 min) compared with the CT group (18.6±4.1 min; $p<0.001$). Radiation exposure was present only in the CT-guided group. No major complications were observed. ***Conclusion:*** Ultrasound-guided nerve root block provides pain relief and functional improvement comparable to CT-guided procedures while avoiding radiation exposure and reducing procedure time. Ultrasound guidance may represent a cost-effective and safer alternative for lumbar radiculopathy management.

Keywords: Lumbar radiculopathy, selective nerve root block, ultrasound guidance, computed tomography, low back pain, interventional pain management.

INTRODUCTION

Lumbar radiculopathy is characterized by radiating leg pain resulting from nerve root compression or inflammation, most commonly due to lumbar disc herniation or spinal stenosis. It affects quality of life and contributes substantially to disability worldwide. Conservative management includes analgesics, physiotherapy, and epidural steroid injections.

Selective nerve root block (SNRB) is a minimally invasive intervention that provides both diagnostic and therapeutic benefits. Traditionally, CT-guided SNRB has been considered a reliable technique because of precise anatomical localization. However, CT guidance exposes patients and healthcare personnel to ionizing radiation and increases procedural costs.

Recent advances in musculoskeletal ultrasonography have enabled visualization of spinal structures and peripheral nerve roots. Ultrasound-guided SNRB offers real-time imaging, portability, and elimination of radiation exposure. Several studies have reported comparable efficacy between ultrasound-guided and radiologically guided procedures.

The present study aimed to compare CT-guided and ultrasound-guided nerve root block techniques in patients with lumbar radiculopathy.

MATERIALS AND METHODS

Study Design

Prospective comparative observational study.

Study Setting
Department of Radiology and Pain Medicine, tertiary care teaching hospital.

Sample Size
80 patients.

Inclusion Criteria
- Age 18–75 years.
- MRI-confirmed lumbar disc herniation.
- Unilateral lumbar radiculopathy.
- Symptoms persisting for >6 weeks despite conservative treatment.

Exclusion Criteria
- Previous lumbar spine surgery.
- Coagulopathy.
- Local infection.
- Pregnancy.
- Severe neurological deficits.

Procedure
CT-Guided Group
Patients were placed prone on the CT table. After localization of the affected nerve root, a 22-gauge spinal needle was advanced under CT guidance. Following confirmation of needle position, a mixture of corticosteroid and local anesthetic was injected.

Ultrasound-Guided Group
Using a low-frequency curvilinear transducer, the lumbar transverse processes and exiting nerve roots were identified. Needle advancement was monitored in real time until the target area was reached. The same medication mixture was administered.

Outcome Measures
1. VAS pain score.
2. Oswestry Disability Index.
3. Procedure duration.
4. Patient satisfaction score.
5. Complications.

Statistical Analysis
Data were analyzed using SPSS version 26. Continuous variables were expressed as mean ± SD. Student's t-test and repeated-measures ANOVA were used. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics
A total of 80 patients diagnosed with unilateral lumbar radiculopathy were included in the study. Of these, 40 patients underwent CT-guided selective nerve root block (CT group) and 40 patients underwent ultrasound-guided selective nerve root block (US group). The demographic and baseline clinical characteristics of the participants are presented in Table 1.

The mean age of patients in the CT-guided group was 48.3 ± 11.2 years, while that in the ultrasound-guided group was 46.9 ± 10.8 years. The difference was not statistically significant ($p = 0.56$), indicating comparable age distribution between the groups. Male participants constituted 57.5% of the CT group and 55.0% of the US group ($p = 0.81$), demonstrating a similar gender profile.

Baseline pain severity, assessed using the Visual Analog Scale (VAS), was comparable between groups. The mean baseline VAS score was 7.8 ± 1.1 in the CT group and 7.6 ± 1.0 in the US group ($p = 0.39$). Similarly, baseline functional disability measured using the Oswestry Disability Index (ODI) showed no significant difference between the CT-guided group (54.6 ± 8.3) and the ultrasound-guided group (53.8 ± 7.9) ($p = 0.64$). These findings indicate that both groups were well matched at the start of the study.

Table 1. Baseline Characteristics of Study Participants

Variable	CT Group (n=40)	US Group (n=40)	p-value
Age (years)	48.3 ± 11.2	46.9 ± 10.8	0.56
Male (%)	57.5	55.0	0.81
Baseline VAS	7.8 ± 1.1	7.6 ± 1.0	0.39
Baseline ODI	54.6 ± 8.3	53.8 ± 7.9	0.64

Pain Outcomes

Both CT-guided and ultrasound-guided nerve root blocks resulted in substantial pain reduction during the follow-up period. Mean VAS scores showed progressive improvement at 1 week, 1 month, and 3 months following the intervention.

At one week, the mean VAS score decreased from 7.8 ± 1.1 to 4.2 ± 1.3 in the CT-guided group and from 7.6 ± 1.0 to 4.4 ± 1.2 in the ultrasound-guided group. Although both groups demonstrated marked pain relief, the difference between groups was not statistically significant ($p = 0.47$).

At one month, further reduction in pain intensity was observed. Mean VAS scores decreased to 3.0 ± 1.2 in the CT group and 3.1 ± 1.1 in the US group ($p = 0.72$). By the end of the three-month follow-up period, mean VAS scores were 2.4 ± 1.2 and 2.6 ± 1.3 in the CT and US groups, respectively ($p = 0.41$).

Within-group analysis demonstrated a statistically significant reduction in pain scores from baseline to all follow-up visits in both groups ($p < 0.001$). However, no significant differences were observed between the two techniques at any follow-up interval, indicating comparable efficacy in pain control.

Table 2. Comparison of VAS Scores During Follow-up

Follow-up	CT Group	US Group	p-value
Baseline	7.8 ± 1.1	7.6 ± 1.0	0.39
1 Week	4.2 ± 1.3	4.4 ± 1.2	0.47
1 Month	3.0 ± 1.2	3.1 ± 1.1	0.72
3 Months	2.4 ± 1.2	2.6 ± 1.3	0.41

Functional Outcomes

Functional disability was evaluated using the Oswestry Disability Index (ODI). Both groups demonstrated significant improvement in functional status following the procedure.

The mean ODI score in the CT-guided group improved from 54.6 ± 8.3 at baseline to 24.3 ± 6.7 at three months. Similarly, patients in the ultrasound-guided group showed improvement from a baseline ODI score of 53.8 ± 7.9 to 25.6 ± 7.2 at three months.

Repeated-measures analysis revealed statistically significant improvement in ODI scores within both groups over the study period ($p < 0.001$). However, intergroup comparison showed no significant difference in functional recovery between CT-guided and ultrasound-guided procedures ($p > 0.05$).

These findings suggest that both techniques are equally effective in improving daily activities and reducing disability associated with lumbar radiculopathy.

Procedural Characteristics

Procedural parameters were compared between the two groups to assess efficiency and feasibility.

The mean procedure duration was significantly shorter in the ultrasound-guided group (12.8 ± 3.2 minutes) compared with the CT-guided group (18.6 ± 4.1 minutes). This difference was statistically significant ($p < 0.001$), indicating improved procedural efficiency with ultrasound guidance.

Radiation exposure was observed exclusively in the CT-guided group, whereas ultrasound-guided procedures were performed without any ionizing radiation exposure. This represents an important safety advantage of ultrasound-guided interventions, particularly in patients requiring repeated procedures.

Patient satisfaction scores were high in both groups. The mean satisfaction score was 8.1 ± 1.0 in the CT group and 8.4 ± 0.8 in the ultrasound-guided group. Although satisfaction was marginally higher among patients undergoing ultrasound-guided procedures, the difference did not reach statistical significance ($p = 0.17$).

Table 3. Procedural Characteristics

Parameter	CT Group	US Group	p-value
Procedure Time (min)	18.6 ± 4.1	12.8 ± 3.2	<0.001
Radiation Exposure	Present	None	—
Patient Satisfaction Score	8.1 ± 1.0	8.4 ± 0.8	0.17

Safety and Complications

Both techniques were found to be safe, with a low incidence of adverse events. Minor transient pain at the injection site was reported in three patients (7.5%) in the CT-guided group and two patients (5.0%) in the ultrasound-guided group. These symptoms resolved spontaneously within 24–48 hours and required no additional treatment.

No major complications were observed in either group during the study period. Specifically, there were no cases of infection, hematoma formation, vascular injury, allergic reaction, nerve damage, worsening neurological deficit, or procedure-related hospitalization.

The overall complication rate was low and comparable between the two groups, confirming the safety profile of both CT-guided and ultrasound-guided nerve root block procedures.

Summary of Findings

The present study demonstrated that both CT-guided and ultrasound-guided selective nerve root blocks produced significant reductions in pain intensity and disability among patients with lumbar radiculopathy. Clinical outcomes were comparable between the two techniques throughout the three-month follow-up period. However, ultrasound-guided procedures required significantly less procedure time and completely avoided radiation exposure while maintaining a similar safety profile and patient satisfaction level. These findings support the use of ultrasound guidance as an effective and safe alternative to CT-guided nerve root block in appropriately selected patients.

DISCUSSION

The present study demonstrated that ultrasound-guided nerve root block achieved pain relief and functional improvement comparable to CT-guided procedures. These findings are consistent with previous studies showing similar efficacy between ultrasound and radiological guidance techniques. Ultrasound guidance significantly reduced procedure duration and eliminated radiation exposure.

CT guidance remains advantageous in patients with complex anatomy or obesity where sonographic visualization is difficult. Nevertheless, increasing expertise in musculoskeletal ultrasound may overcome many of these limitations. Recent comparative studies have reported similar accuracy and therapeutic outcomes while highlighting reduced costs and improved procedural efficiency with ultrasound guidance.

The absence of radiation exposure is particularly important in younger patients and those requiring repeated interventions. Safety outcomes in our study were favorable and consistent with published literature regarding both CT-guided and ultrasound-guided techniques.

Limitations

- Single-center study.
- Relatively small sample size.
- Follow-up limited to three months.
- Lack of cost-effectiveness analysis.

CONCLUSION

Ultrasound-guided nerve root block is an effective and safe alternative to CT-guided nerve root block for lumbar radiculopathy. It provides comparable clinical outcomes while reducing procedure time and eliminating radiation exposure. Wider adoption of ultrasound-guided techniques may improve accessibility and cost-effectiveness of interventional pain management.

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