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Research Article

Clinical and Radiological Correlates of Unilateral Lower Limb Radicular Pain: An Analytical Study (February 2025)

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ABSTRACT

Background: ULLRP is usually blamed on lumbosacral disc pathology, but may also be caused by a dysfunction of the sacroiliac (SI) joints and piriformis syndrome. It is essential to achieve perfect clinical-radiological correlation to prevent any type of misclassification as well as to direct specific therapy. Clinical profile, spinopelvic morphology and MRI in adults with ULLRP who were treated in a tertiary facility at Sikkim, India, were analysed and the relation between lifestyle and work-related variables in the varied ethnic groups of the region was studied.

Methods: We recruited a cohort of the Department of Orthopaedics, Central Referral Hospital, Gangtok in a prospective analytical study (May 2023 -December 2024) among adults (>18 years) who were not incapacitated, were in an upright position, and gave consent upon presenting with ULLRP. Exclusions were bilateral radiculopathy, non-ambulatory, spinal deformity, previous lumbosacral, fracture, tumours, malignancy/therapy, hip-pelvic pathology and imaging contraindications. Clinical assessment was standardized VAS (leg), SLR, sitting SLR, slump, FABER, FAIR, and in tests, femoral stretch assessments, plus motor, myotomal and dermatomal testing. Lateral radiographs in the standing positions gave pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS) and lumbar lordosis (LL). The interpretations of MRI (1.5T) were done with ASNR nomenclature; nerve root sleeve angulation (NRSA) was assessed on T1 coronal images (affected side vs unaffected side). Clinical and radiologic profiles were the primary outcomes; lifestyle and occupational correlates were the secondary outcomes.

Results: Seventy-five patients (mean age 44.5±12.5 years; 56% female) were analyzed. Mean VAS was 6.7±1.4. IVDP accounted for 76% (L4–L5 36%; L5–S1 36%), with SI joint dysfunction (16%) and piriformis syndrome (8%) comprising the remainder. Sitting SLR and slump tests were significantly associated with IVDP (p=0.001 and <0.001, respectively); the piriformis stress test was positive exclusively in piriformis syndrome (p<0.001). LL differed across diagnoses (IVDP 44.2°±8.4 vs SI 36.9°±12.2 vs piriformis 43.5°±7.6; p=0.045). NRSA was substantially greater on the affected side in IVDP (32.7°±9.4) than in SI dysfunction (16.8°±18.3) or piriformis (7.0°±17.0) and was similarly differentiated on the unaffected side (both p<0.001). Ethnicity, smoking, alcohol use, diet, and occupation showed descriptive differences without statistical significance.

Conclusion: In adults with ULLRP, careful synthesis of symptom-limited straight-leg tests with MRI—particularly NRSA—and sagittal alignment improves diagnostic specificity. IVDP predominates at L4–L5/L5–S1, yet SI joint and piriformis etiologies are not rare. LL and NRSA add discriminative value and may refine triage toward conservative care or targeted intervention.

Keywords: Unilateral Radiculopathy, Sciatica, Intervertebral Disc Prolapse, Sacroiliac Dysfunction, Piriformis Syndrome, Spinopelvic Parameters, Nerve Root Sleeve Angulation, MRI, Sikkim.

INTRODUCTION

Unilateral lower limb radicular pain (ULLRP), often labeled "sciatica," is a frequent reason for musculoskeletal consultation and lost productivity worldwide [1,2]. Although lumbar intervertebral disc prolapse (IVDP) compressing or inflaming the L5 or S1 root is the canonical cause, clinical experience and contemporary series underscore relevant mimics—most notably sacroiliac (SI) joint dysfunction and piriformis syndrome—that can present with lateralized buttock and leg pain, paresthesia, and functional limitation [3–5]. Distinguishing among these entities early is essential because management pathways diverge: analgesia and physical therapy for most disc herniations; image-guided SI joint injections for inflammatory arthropathy; and focused piriformis stretching or botulinum toxin in refractory cases [3,5].

The physical examination remains the first diagnostic stratifier. The straight leg raise (SLR) and slump tests stress the lumbosacral nerve roots and dura; pooled estimates show moderate accuracy for radiculopathy secondary to disc herniation, with better rule-out than rule-in characteristics [6,7]. Conversely, FABER and provocation clusters may better implicate the SI joint [4], while FAIR maneuvers explore the deep gluteal space and piriformis-related entrapment [5]. Yet, overlap is common, and exam positivity may be influenced by pain behavior, psychosocial factors, and coexisting degenerative change.

Imaging can be conclusive in cases where the symptoms do not reduce or where there is the provision of neurological impairments. MRI shows the morphology of the discs, the lateral recess and compromise of the foramina, and contact of the nerve roots. Simultaneously, it is nonexpressive that imaging anomalies are the most widespread in non-symptomatic adults, and clinically, they have to be correlated to prevent false diagnoses and re-treatment [8]. Simultaneously across the studies, there has been an equally large proportion of interest in sagittal spinopelvic parameters, including pelvic incidence (PI), pelvic tilt (PT), and sacral slope (SS) and lumbar lordosis (LL), which vary globally and can interact with degenerative cascades and symptom severity [9,10]. Moreover, coronal nerve root sleeve angulation (NRSA) has the potential to be a reflection of traction or distortion at the root entry zone but there is paucity in clinical utility evidence.

The Occupational needs and lifestyle patterns Occupational needs and lifestyle patterns are diverse, with Sikkim being ethnically diverse (Bhutia, Lepcha, Limboo, Nepali, etc.). They could potentially affect the spinal loading and sagittal alignment, but only a limited amount of population specific data is available. We thus undertook an analytical research of the adult population with ULLRP in a tertiary hospital in Gangtok to: (1) describe clinical profile; (2) outline radiological morphology and spinopelvic alignment; and (3) determine correlation with the demographic, lifestyle and occupation in the ethnic population. The hypotheses we made were that exam-MRI concordance would be the best in IVDP; that SI and thehel syndrome would exhibit different provocation patterns; and that specific radiological indications would have better diagnostic values compared with conventional indicators.

MATERIALS AND METHODS

Study Design and Setting

Prospective analytical study conducted in the Department of Orthopaedics, Central Referral Hospital, Sikkim Manipal Institute of Medical Sciences, Gangtok (May 2023–December 2024).

Participants

Inclusion: Adults (>18 years) with unilateral lower limb radiating pain, able to stand unaided, and providing written informed consent.

Exclusion: Bilateral radiculopathy; non-ambulatory status; spinal deformity (scoliosis, spondylolisthesis, sacralization/lumbarization); prior lumbosacral surgery; osteoporotic compression fracture; trauma, tumor, or malignancy/radiation/chemotherapy; hip or pelvic pathology; peripheral vascular disease; and contraindications to imaging.

Clinical assessment

A structured proforma captured age, sex, ethnicity, occupation, diet, smoking/alcohol status, side of pain, height/weight, and leg VAS. Bilateral exam included SLR, sitting SLR (Aird's), slump, FABER, FAIR (piriformis), and femoral stretch tests using standard techniques. Motor function was screened functionally (single-leg sit-to-stand, heel walk, single-leg heel-rise) and graded (0–5) if impaired. Great toe extensor and hip abductor strength were tested manually. Sensation was assessed by pinprick across L2–S2 dermatomes and graded (0–2). Based on synthesis of symptoms and signs, patients were clinically categorized as likely IVDP, SI joint dysfunction, or piriformis syndrome prior to imaging.

Radiology

Radiographs: Standing lateral lumbosacral radiographs provided PI, PT, SS, and LL (L1 superior endplate to L5 superior endplate). **MRI:** 1.5T (T1/T2 sagittal and axial, 4-mm slices). Experienced neuroradiologists, aware of clinical summaries, recorded disc bulge or herniation and nerve root compression using ASNR nomenclature. NRSA was measured on T1 coronal images for the symptomatic and contralateral side.

Outcomes

Primary: clinical profile; radiological morphology and alignment parameters. Secondary: association of ethnicity, lifestyle, occupation, and diet with diagnostic categories.

Statistical analysis

Continuous data were summarized as mean±SD or range; categorical data as counts/percentages. Group comparisons used

ANOVA for continuous variables and chi-square for categorical variables. Significance was set at $p<0.05$. Analyses were performed on the complete dataset of 75 participants.

Ethics

Institutional oversight adhered to the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants.

RESULTS

Cohort Profile

Seventy-five adults (mean age 44.5±12.5 years, range 22–77; 56% female) presented with ULLRP. Most were Nepali (74.7%), with others from Bihari (9.3%), Limboo (6.7%), Bhutia (4.0%), Bengali (2.7%), Lepcha (1.3%), and Punjabi (1.3%) communities. Mean BMI was 24.2±2.8 kg/m²; 62.2% were in the normal BMI range and 35.1% were overweight. Field/standing occupations constituted 34.7%, desk/sitting 30.7%, homemakers 29.3%, and students 5.3%. A non-vegetarian diet predominated (81.3%); 28% reported smoking and 40% alcohol intake. Radiculopathy was right-sided in 52%. The mean leg VAS was 6.7±1.4.

Clinical Examination

SLR was restricted on the affected limb (mean 52.6°±19.0 vs 72.5°±12.3 unaffected). Sitting SLR was positive in two-thirds overall and bilateral in 4%. The slump test was positive in 70.7%. FABER was positive in 18.7% (predominantly left-sided), and FAIR was positive in 8%. Femoral stretch was rarely positive (5.3%, right-sided only). Motor deficits occurred in 21.3%—most commonly involving L5 plantar/dorsiflexors—and sensory deficits in 60%, chiefly combinations across L4–S1 dermatomes.

Imaging

On standing lateral radiographs, mean PI was 45.7°±7.5, PT 13.7°±3.6, SS 35.9°±6.0, and LL 43.0°±9.3. MRI demonstrated disc pathology at L4–L5 (42.7%) and L5–S1 (40.0%); morphology was diffuse (25.3%) or central/paracentral (32%), with small proportions of extrusion (5.3%) and central-left mixed patterns. NRSA was larger on the affected side (28.2°±14.7, range 15.7–59.0) than the unaffected side (26.1°±12.7, range 15.3–44.9).

Diagnostic Categories and Correlations

IVDP constituted 76% of diagnoses (L4–L5 36%; L5–S1 36%), SI joint dysfunction 16%, and piriformis syndrome 8%. Age, BMI, sex, ethnicity, smoking, alcohol, occupation, and diet differed descriptively but not significantly across diagnoses.

Exam correlations were robust: sitting SLR and slump were significantly more often positive in IVDP (82.5% each) than in SI dysfunction (≈50%) or piriformis (0%) ($p=0.001$ and <0.001). Piriformis stress test positivity was exclusive to piriformis syndrome (100%, $p<0.001$). FABER positivity clustered in SI dysfunction ($p<0.001$). Femoral stretch did not differ significantly.

Radiologic correlates showed LL differed across diagnoses ($p=0.045$), being lowest in SI dysfunction. NRSA—both affected and unaffected sides—strongly differentiated IVDP from SI and piriformis (both $p<0.001$), with higher angles in IVDP.

Table 1. Demographic and Lifestyle Profile of the Cohort (N=75).

Variable	Category	n (%) or mean±SD
Age (years)		44.5±12.5 (22–77)
Sex	Female 42 (56.0%); Male 33 (44.0%)	
BMI (kg/m²)	24.2±2.8; Normal 46 (62.2%), Overweight 26 (35.1%), ≥30: 2 (2.7%)	
Ethnicity	Nepali 56 (74.7%), Bihari 7 (9.3%), Limboo 5 (6.7%), Bhutia 3 (4.0%), Bengali 2 (2.7%), Lepcha 1 (1.3%), Punjabi 1 (1.3%)	
Occupation	Field/Standing 26 (34.7%), Desk/Sitting 23 (30.7%), Housewife 22 (29.3%), Student 4 (5.3%)	
Diet	Non-vegetarian 61 (81.3%), Vegetarian 14 (18.7%)	
Lifestyle	Smoking 21 (28.0%), Alcohol 30 (40.0%)	
Side of pain	Right 39 (52.0%), Left 36 (48.0%)	
VAS (leg)	6.7±1.4	

Table 2. Clinical Tests across Diagnostic Categories.

Test	IVDP (n=57)	SI dysfunction (n=12)	Piriformis (n=6)	p-value
Sitting SLR positive	47 (82.5%)	6 (50.0%)	0 (0%)	0.001
Slump positive	47 (82.5%)	6 (50.0%)	0 (0%)	<0.001
Piriformis stress positive	0 (0%)	0 (0%)	6 (100%)	<0.001
FABER positive	1 (1.8%)	9 (75.0%)	1 (16.7%)	<0.001
Femoral stretch positive	4 (7.0%)	0 (0%)	0 (0%)	0.513

Table 3. Spinopelvic Parameters and NRSA by Diagnosis (Mean±SD).

Parameter	IVDP	SI dysfunction	Piriformis	p-value
PI (°)	45.7±7.9	46.2±5.8	44.4±8.0	0.899
PT (°)	13.7±4.0	13.6±1.5	13.5±2.5	0.986
SS (°)	35.7±6.2	36.0±6.2	37.4±5.2	0.810
LL (°)	44.2±8.4	36.9±12.2	43.5±7.6	0.045
NRSA affected (°)	32.7±9.4	16.8±18.3	7.0±17.0	<0.001
NRSA unaffected (°)	30.7±8.0	15.9±17.1	6.9±16.8	<0.001

Table 4. MRI Distribution of Disc Pathology.

Level / Morphology	n (%)
No disc abnormality	10 (13.3%)
Level	
L3–L4	3 (4.0%)
L4–L5	**32 (42.7%)**
L5–S1	**30 (40.0%)**
Morphology	
Diffuse	19 (25.3%)
Central	14 (18.7%)
Right paracentral	12 (16.0%)
Left paracentral	12 (16.0%)
Extrusion (any)	4 (5.3%)
Mixed/other	5 (6.7%)

Figure 1. Standing Lateral Lumbosacral Radiograph with Annotated Spinopelvic Parameters (Pi, Pt, Ss, Ll).

Figure 1. Standing lateral lumbosacral radiograph with annotated spinopelvic parameters (PI, PT, SS, LL).

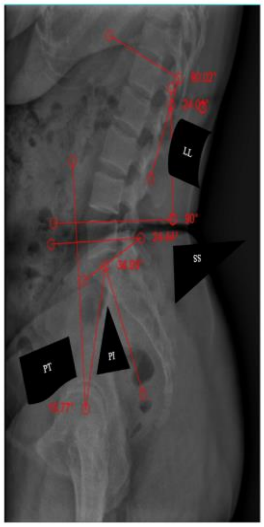
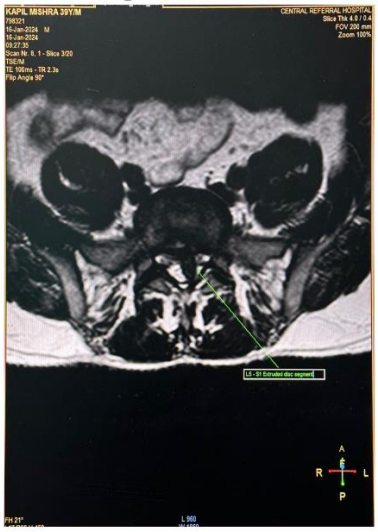


Figure 2. Axial T2-Weighted Mri At L5–S1 Showing an Extruded Disc Fragment Impinging in the Lateral Recess.

Figure 2. Axial T2-weighted MRI at L5–S1 showing an extruded disc fragment impinging in the lateral recess.



DISCUSSION

This analytical cohort provides contemporary evidence that, while IVDP remains the predominant cause of unilateral radicular symptoms, SI joint dysfunction and piriformis syndrome together account for nearly one-quarter of cases and may be mistaken for discogenic sciatica without careful examination. The diagnostic pattern we observed aligns with established literature: SLR-type maneuvers (including the seated variant and slump) preferentially correlate with MRI-confirmed root compression, functioning as sensitive but incompletely specific screening tools [6,7]. In contrast, FABER positivity clustered in SI pathology—consistent with provocation testing paradigms for SI-mediated pain [4]—and piriformis stress testing was exclusive to deep gluteal syndrome, echoing prior syntheses that emphasize clinical clusters for this diagnosis [5].

Our radiological findings situate IVDP chiefly at L4–L5 and L5–S1, mirroring epidemiology from high-income and Asian settings [1–3]. Importantly, although gross spinopelvic parameters (PI, PT, SS) did not differ across diagnoses, LL was significantly reduced in SI dysfunction. This suggests that sagittal alignment may reflect compensatory mechanics distinct from discogenic disease. Prior work has tied PI–LL mismatch and diminished LL to low-back symptoms and disability [9,10]; our data add that SI-mediated pain may preferentially present with lordotic attenuation even when PI and SS are comparable.

A novel observation is the discriminative behavior of NRSA. In IVDP, NRSA was substantially larger—on both symptomatic and asymptomatic sides—than in SI or piriformis syndromes. Conceptually, increased coronal root sleeve angulation may reflect root tethering or path-of-least-resistance deviation due to lateral recess compromise. Although NRSA measurement is not yet standardized, our results support its potential as a supportive biomarker that complements axial and sagittal MRI sequences when clinicoradiologic discordance exists. Further reliability studies are warranted.

Ethnic, occupational, and lifestyle descriptors did not demonstrate statistically significant associations. Nevertheless, the predominance of field/standing work and non-vegetarian diet, along with moderate rates of smoking and alcohol use, contextualize regional exposures that may shape load, conditioning, and pain behavior. Larger population cohorts would clarify whether biomechanical exposures (e.g., terraced farming, portering) modify sagittal balance or disc degeneration trajectories in Himalayan populations.

Our study has limitations. First, as a single-center analysis, external validity is constrained. Second, neuroradiologists were not fully blinded to clinical data, which may introduce incorporation bias; however, we used ASNR nomenclature to standardize reporting. Third, while we recorded functional motor tests before manual grading to improve ecological validity, subtle deficits could be missed. Fourth, we did not quantify psychosocial variables or central sensitization, which can modulate pain reports and test positivity. Finally, NRSA protocols require inter-rater reliability assessment and threshold derivation in future work.

The clinical conclusions of these findings are as follows: In ULLRP anecdotally, sitting SLR and slump together with FABER and piriformis

provocation should be combined to triage to IVDP, SI, or piriformis pathways. Apply MRI, not only to rule in the disc pathology and beware of asymptomatic abnormality [8], but to question lateral recess/foraminal compromise whilst bearing in mind LL and NRSA. This synthesis may increase accuracy level, minimize false diagnosis and guide conservative or interventional therapies.

CONCLUSION

Complex clinical testing with specific imaging is associated with high diagnostic precision in patients who have unilateral lower limb pain radiating at the radicula. IVDP through L45S1 to L5 remains predominant but SI joint dysfunction and the piriformis syndrome are significant mimics and will have different provocation patterns. Lumbar lordosis and nerve root sleeve angulation are some of the radiological markers that have complementary discriminative value to traditional disc morphology and global pelvic parameters. The way these metrics are introduced into the daily evaluation may facilitate better decision-making, lessen misclassification, and allow individualized management in specific and practical organization as Sikkim does.

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