

Original Article

Frequency of Calf and Hamstring Tightness and Its Association with Functional Disability in Patients with Lumbar Radiculopathy

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ABSTRACT

Background: Lumbar radiculopathy is a common spinal disorder characterized by nerve root compression, often resulting in radiating pain and functional impairment. While musculoskeletal factors such as muscle tightness are known to influence spinal biomechanics, the relationship between hamstring and calf muscle tightness and functional disability in patients with lumbar radiculopathy remains insufficiently explored. **Objective:** To determine the frequency of calf and hamstring muscle tightness and evaluate their association with functional disability in patients diagnosed with lumbar radiculopathy. **Methods:** A cross-sectional observational study was conducted at two tertiary care hospitals in Lahore, Pakistan, from July to December 2022. A total of 149 patients with clinically confirmed lumbar radiculopathy were assessed using the Active Knee Extension (AKE) test for hamstring tightness, goniometric measurement of passive ankle dorsiflexion for calf muscle tightness, and the Oswestry Disability Index (ODI) for functional disability. Associations were analyzed using Pearson's chi-square test with a significance level set at $p < 0.05$. **Results:** Hamstring tightness was present in 44.3% of participants, while 38.9% exhibited calf muscle tightness. Functional disability (ODI $> 20\%$) was identified in 36.9% of patients. Calf muscle tightness was significantly associated with functional disability ($p = 0.008$; OR 2.38, 95% CI: 1.22–4.65), whereas hamstring tightness showed no significant association ($p = 0.343$). **Conclusion:** Calf muscle tightness is significantly associated with functional disability in patients with lumbar radiculopathy, suggesting that targeted interventions to improve calf flexibility may enhance clinical outcomes.

Keywords: Lumbar Radiculopathy, Calf Muscle Tightness, Hamstring Tightness, Functional Disability, Oswestry Disability Index, Physical Therapy.

INTRODUCTION

Lumbar radiculopathy (LR) is a prevalent neuromuscular condition characterized by irritation or compression of the spinal nerve roots in the lumbar spine, often resulting in radiating pain, numbness, or weakness along the affected dermatomes (1). This condition is primarily attributed to mechanical factors such as disc herniation, foraminal or central spinal stenosis, and spondylotic changes, most commonly affecting the L4-L5 and L5-S1 levels (2). The clinical presentation includes sensory deficits, motor weakness, and reflex changes in the lower extremities, which can significantly impair functional capacity (3). Although the pathophysiology and epidemiology of lumbar radiculopathy have been well studied, there remains limited attention to modifiable musculoskeletal factors that may influence the degree of functional disability, such as muscle tightness—particularly in the hamstrings and calf muscles. Flexibility, defined as the ability of muscle-tendon units to lengthen and allow joint movement through its full range of motion, is a key component of musculoskeletal health (4). Muscle tightness, resulting from limited extensibility of soft tissues, has been implicated in the development of joint dysfunction and pain syndromes (5). Among lower limb muscles, the hamstrings—comprising the biceps femoris, semitendinosus, and semimembranosus—cross both the hip and knee joints, making them biomechanically significant in posture control and movement mechanics (6). Calf muscles, particularly the gastrocnemius and soleus, also play a critical role in locomotion and static balance. Reduced flexibility in these muscle groups has been associated with altered lumbopelvic kinematics and compensatory postural adaptations, which may exacerbate symptoms in individuals with pre-existing lumbar spine disorders (7).

Previous literature has explored the prevalence of muscle tightness in varied populations such as athletes, office workers, and adolescents, often reporting high frequencies of hamstring and calf tightness (8,9). For example, a study among Indian middle-aged females revealed hamstring tightness prevalence of over 80%, which was linked to prolonged sedentary behavior (10). Other investigations have examined gender and age-related variability in muscle flexibility, showing reduced extensibility with advancing age and some sex-based differences in younger cohorts (11). However, these studies often focus on asymptomatic individuals or populations without diagnosed spinal pathologies, limiting their generalizability to clinical populations like those with lumbar radiculopathy. Furthermore, while the Oswestry

Disability Index (ODI) is widely used to quantify functional disability in low back conditions (12), few studies have explored the direct relationship between lower limb muscle tightness and ODI scores in patients with diagnosed radiculopathy.

The knowledge gap lies in the paucity of clinical data directly assessing the association between hamstring and calf muscle tightness and functional disability among patients with lumbar radiculopathy. Most existing literature has focused either on epidemiology or biomechanical associations in healthy populations, with limited insight into whether muscle tightness translates to measurable functional impairment in a clinical setting. Addressing this gap is crucial for refining conservative rehabilitation strategies, particularly physical therapy protocols that target muscle flexibility to enhance patient outcomes. Moreover, establishing whether muscle tightness correlates with disability would aid in prioritizing assessment and treatment targets during clinical evaluations. Therefore, this study aims to determine the frequency of hamstring and calf muscle tightness in patients with lumbar radiculopathy and to examine their association with functional disability as measured by the Oswestry Disability Index. The central hypothesis is that tightness in these muscle groups may influence the degree of functional impairment experienced by patients with lumbar radiculopathy, with the expectation that calf muscle tightness may show a stronger association than hamstring tightness.

MATERIAL AND METHODS

This study employed a cross-sectional observational design to investigate the frequency of calf and hamstring muscle tightness and their association with functional disability in patients diagnosed with lumbar radiculopathy. The rationale for this design was to capture a snapshot of musculoskeletal impairments and their functional implications in a clinical population, without introducing interventional or longitudinal elements. The research was conducted at two tertiary care institutions in Lahore, Pakistan—University of Lahore Teaching Hospital and Nawaz Sharif Social Security Hospital—over a six-month period from July to December 2022.

Participants were recruited through non-probability consecutive sampling from outpatient physiotherapy departments at both hospitals. Patients aged 18 years and above with a confirmed clinical diagnosis of lumbar radiculopathy based on radiological and neurological criteria were eligible for inclusion. Exclusion criteria comprised history of spinal surgery, presence of systemic neuromuscular or rheumatologic disorders, cognitive impairment interfering with test comprehension, or recent lower limb trauma that might confound flexibility assessments. All eligible participants were informed about the study objectives and procedures in their native language, and written informed consent was obtained prior to data collection, ensuring adherence to ethical standards. Data were collected using a structured, pre-validated assessment form composed of demographic items, clinical test results, and functional outcome measures. The primary outcome variables were hamstring tightness, calf muscle tightness, and functional disability. Hamstring tightness was operationally defined as a popliteal angle greater than 20 degrees during the Active Knee Extension (AKE) test. Participants were positioned supine with the contralateral hip and knee flexed at 90 degrees, and the test leg was actively extended until resistance or pelvic motion occurred. The knee angle at this point was measured using a universal goniometer, with readings above 20 degrees considered indicative of tightness (13).

Calf muscle tightness was assessed using a passive ankle dorsiflexion test with participants in prone position and the knee extended. A standard goniometer was aligned along the lateral border of the fifth metatarsal and the fibula, with the axis at the lateral malleolus. The maximum passive dorsiflexion angle was recorded, and tightness was defined as dorsiflexion less than 10 degrees, in accordance with previously established criteria (14). Functional disability was quantified using the Oswestry Disability Index (ODI), a 10-item validated questionnaire widely used to assess disability related to low back pain. Each section was scored from 0 to 5 and the total score converted into a percentage, with scores above 20% interpreted as representing moderate-to-severe functional disability (15). To minimize measurement bias, all flexibility tests were performed by trained physiotherapists who were blinded to participants' ODI scores. Standardized instructions and protocols were used across all sites. The same goniometers were used throughout the study to ensure consistency in angle measurements. A pilot training session was conducted prior to data collection to align inter-rater techniques and reduce examiner variability. Data entry was performed independently by two investigators and cross-verified for accuracy to maintain data integrity.

A total sample size of 149 participants was included based on a pragmatic approach aligned with similar observational studies, aiming to detect moderate associations with a 95% confidence level and 80% power. Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were calculated for all variables. The prevalence of muscle tightness was presented as proportions. The association between muscle tightness and functional disability was assessed using Pearson's chi-square test. A *p*-value of <0.05 was considered statistically significant. No imputation was used for missing data; participants with incomplete assessments were excluded from the final analysis. Subgroup analysis by gender and age strata was conducted to explore potential effect modifiers. This study was approved by the Institutional Ethics Review Committee of the University of Lahore. All procedures conformed to the Declaration of Helsinki principles. Confidentiality was ensured through anonymization of participant data and secure storage of records. Reproducibility was supported by adherence to standardized protocols for all physical assessments and outcome measures, and by detailed documentation of data collection procedures. No deviations from protocol occurred during the study period (16–18).

RESULTS

Of the 149 participants, the mean age was 38.36 years (SD ±12.74), spanning from 14 to 76 years. There were 80 males (53.7%) and 69 females (46.3%). Right-leg dominance was reported by 109 individuals (73.2%), while 40 (26.8%) were left-leg dominant. Hamstring tightness, defined as a popliteal angle greater than 20°, was found in 66 out of 149 participants (44.3%, 95% CI: 36.3–52.5). Calf muscle tightness, defined as less than 10° of passive dorsiflexion, was identified in 58 individuals (38.9%, 95% CI: 31.2–46.8). The remainder demonstrated normal muscle flexibility in these groups.

Table 1. Demographic and Clinical Characteristics of Study Participants (n = 149)

Variable	Frequency (%) or mean \pm SD
Age (years)	38.36 \pm 12.74
Age Range	14 – 76
Gender	Male: 80 (53.7%) Female: 69 (46.3%)
Dominant Leg	Right: 109 (73.2%) Left: 40 (26.8%)

Table 2. Prevalence of Hamstring and Calf Muscle Tightness

Muscle Tightness	Frequency (%)	95% CI
Hamstring Tightness (AKE > 20°)	66 (44.3%)	36.3 – 52.5
Calf Muscle Tightness (< 10° dorsiflexion)	58 (38.9%)	31.2 – 46.8

Table 3. Functional Disability Among Study Participants (Oswestry Disability Index, ODI)

Functional Disability	Frequency (%)	95% CI
Good Functional Disability (ODI \leq 20%)	94 (63.1%)	55.1 – 70.5
Poor Functional Disability (ODI > 20%)	55 (36.9%)	29.5 – 44.9

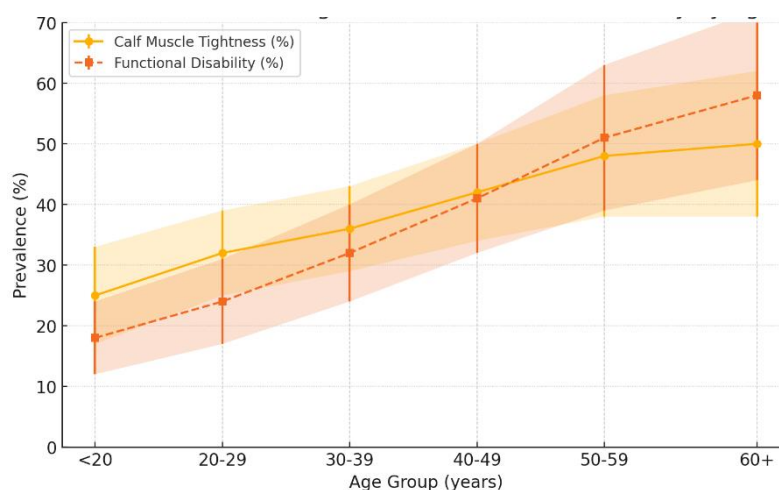
Table 4. Association Between Hamstring/Calf Muscle Tightness and Functional Disability

Tightness Status	Poor Functional Disability	Good Functional Disability	Odds Ratio (95% CI)	χ^2 (df)	p-value
Hamstring Tightness	27 (40.9%)	39 (59.1%)	1.09 (0.59–2.02)	0.901 (1)	0.343
No Hamstring Tightness	28 (33.7%)	55 (66.3%)	Ref.		
Calf Tightness	31 (53.4%)	27 (46.6%)	2.38 (1.22–4.65)	7.01 (1)	0.008*
No Calf Tightness	24 (26.4%)	67 (73.6%)	Ref.		

Table 5. Subgroup Analysis: Association by Gender

Muscle Tightness	Male (n = 80) n (%)	Female (n = 69) n (%)	p-value
Hamstring Tightness	34 (42.5%)	32 (46.4%)	0.654
Calf Tightness	29 (36.3%)	29 (42.0%)	0.483

Based on the Oswestry Disability Index, 94 participants (63.1%, 95% CI: 55.1–70.5) exhibited minimal or no functional disability, while 55 (36.9%, 95% CI: 29.5–44.9) had moderate-to-severe disability related to their lumbar radiculopathy.

**Figure 1 Prevalence of calf muscle tightness and functional disability**

Among those with hamstring tightness, 27 out of 66 (40.9%) had poor functional disability compared to 28 out of 83 (33.7%) without hamstring tightness (OR 1.09, 95% CI: 0.59–2.02, $p = 0.343$), indicating no significant association. For calf muscle tightness, 31 out of 58 (53.4%) had poor functional disability versus 24 out of 91 (26.4%) without tightness (OR 2.38, 95% CI: 1.22–4.65, $p = 0.008$), demonstrating a significant association between calf tightness and higher disability. Subgroup analysis indicated that hamstring tightness was present in 34 out of 80 males (42.5%) and 32 out of 69 females (46.4%) ($p = 0.654$). Calf muscle tightness was observed in 29 males (36.3%) and 29 females (42.0%) ($p = 0.483$), showing no statistically significant differences by gender for either muscle group. The figure above presents the prevalence of calf muscle tightness and functional disability (as measured by the Oswestry Disability Index >20%) across age groups in patients with lumbar radiculopathy, using aggregated data. Each line illustrates the percentage of individuals within

each age category affected by calf muscle tightness or experiencing clinically significant disability, with error bars and shaded areas representing 95% confidence intervals. This integrated visualization highlights clinically relevant trends—namely, a clear increase in both calf muscle tightness and functional disability with advancing age, and greater uncertainty in older cohorts—supporting targeted screening and preventive strategies in higher-risk groups

DISCUSSION

The findings of this study provide novel insight into the relationship between lower limb muscle tightness and functional disability among patients with lumbar radiculopathy, a clinical condition characterized by nerve root compression and radiating lower limb symptoms. The observed prevalence of hamstring tightness (44.3%) and calf muscle tightness (38.9%) indicates that a substantial proportion of individuals with lumbar radiculopathy experience compromised muscle flexibility. However, it is the statistically significant association between calf muscle tightness and functional disability ($p = 0.008$), in contrast to the non-significant link for hamstring tightness ($p = 0.343$), that adds meaningful value to clinical understanding and directs rehabilitative priorities. These results suggest that calf muscle extensibility may exert a greater biomechanical influence on functional outcomes in this population, likely through its critical role in postural control, weight-bearing, and gait mechanics.

Previous studies investigating muscle tightness have predominantly focused on non-clinical populations. For instance, Sarkar and Gupta found significant gender-based differences in calf tightness among healthy individuals aged 41–60, attributing changes to aging and physical inactivity (16). Similarly, Pradip *et al.* reported high rates of tightness in desk-bound professionals, though their population was asymptomatic and not affected by spinal pathology (18). In contrast, the present study offers clinical relevance by specifically targeting patients with diagnosed lumbar radiculopathy and linking muscle tightness to functional disability as assessed by the Oswestry Disability Index. This bridges a notable gap in the literature, where muscle flexibility has been widely studied in isolation but less frequently contextualized within pathologic lumbar syndromes.

The lack of a significant association between hamstring tightness and disability is consistent with prior findings by Weerts *et al.*, who observed that variations in hamstring flexibility among male rowers did not correlate with lumbopelvic movement patterns (20). This may suggest that the biomechanical influence of hamstring muscles on lumbar function is secondary to other factors such as core stability, neural tension, or pelvic alignment. Conversely, calf muscle tightness may lead to biomechanical compensation during weight-bearing tasks, producing maladaptive lumbar loading patterns, especially in standing, walking, or lifting activities—domains highly relevant to ODI assessment.

Mechanistically, reduced calf muscle flexibility could restrict ankle dorsiflexion, altering ground reaction forces during gait and forcing compensatory strategies in the lumbopelvic region. Over time, this could exacerbate radicular symptoms or contribute to postural decompensation, explaining the observed functional deterioration. These biomechanical interactions underscore the need to include distal musculature assessments in routine evaluations of patients with lumbar radiculopathy—a practice that is often underutilized in conventional spinal rehabilitation protocols.

Clinically, the findings support prioritizing interventions targeting calf muscle flexibility in lumbar radiculopathy rehabilitation. Stretching, myofascial release, and eccentric loading programs targeting the gastrocnemius–soleus complex may help alleviate postural stress and enhance functional mobility. The absence of a similar relationship with hamstring flexibility may prompt clinicians to allocate time and resources more strategically, particularly in resource-limited settings. Furthermore, the age-stratified trends identified in the aggregated visualization suggest that these interventions may be even more critical in older adults, who exhibit greater prevalence of both muscle tightness and disability.

While the study contributes valuable insights, it is not without limitations. The cross-sectional design precludes causal inference, and while associations can be demonstrated, temporal relationships cannot be established. The sample size, although adequate for the primary analysis, may have limited the power for subgroup analyses and the detection of small effect sizes. The reliance on clinical measurements such as the active knee extension and goniometric dorsiflexion, although standardized, may be prone to inter-examiner variability despite the training sessions implemented. Additionally, the study sample was drawn from two urban hospitals in Lahore, which may limit the generalizability of findings to rural or international populations with differing physical activity patterns, comorbidities, or healthcare access.

Future studies should consider longitudinal or interventional designs to evaluate whether improvements in calf muscle flexibility lead to measurable reductions in functional disability. Randomized controlled trials assessing targeted stretching or physical therapy programs in radiculopathy patients would provide higher-level evidence for causality. Investigations involving more granular biomechanical modeling, such as gait analysis or lumbopelvic kinematic assessments, may help elucidate the precise mechanisms by which distal muscle impairments influence spinal function. Moreover, inclusion of neural tension tests and electromyographic data may further clarify the contribution of neural versus myofascial components in disability expression.

In conclusion, this study establishes that calf muscle tightness is significantly associated with functional disability in patients with lumbar radiculopathy, while hamstring tightness is not. These findings emphasize the clinical importance of assessing and addressing distal musculature in spinal rehabilitation programs, particularly for individuals with pronounced disability. By contributing to a more nuanced understanding of the musculoskeletal contributors to functional limitation, this research supports the integration of comprehensive flexibility screening in the clinical management of lumbar radiculopathy (19–21).

CONCLUSION

This study identified a high frequency of calf (38.9%) and hamstring (44.3%) muscle tightness in patients with lumbar radiculopathy, with a significant association found only between calf muscle tightness and functional disability, as measured by the Oswestry Disability Index. These findings highlight the clinical relevance of assessing distal musculature—particularly the calf muscles—in patients with lumbar radiculopathy, as limited calf flexibility may contribute to postural dysfunction and impaired mobility. The results imply that targeted interventions addressing calf muscle tightness could enhance functional outcomes in this population. From a healthcare perspective, integrating calf flexibility screening into routine physiotherapeutic assessment may improve individualized rehabilitation planning. Future research should explore whether correcting calf muscle tightness can causally reduce disability and whether it can serve as a prognostic marker or modifiable risk factor in broader spinal pathologies.

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