The Association Between Femoral Nerve Tension and Hip Flexor Length

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ABSTRACT

Background: Femoral nerve tension and hip flexor muscle length are critical factors in musculoskeletal health. Their relationship is particularly important in diagnosing and managing conditions like low back pain, often associated with tight hip flexors.

Objective: This study aimed to explore the association between femoral nerve tension and hip flexor muscle length in individuals with acute low back pain compared to healthy controls.

Methods: A correlational study was conducted with 68 participants (34 healthy controls and 34 acute low back pain patients). Data were collected using self-administered questionnaires and clinical tests, including the Prone Knee Bend Test and Modified Thomas Test. Femoral nerve tension and hip flexor length were measured using a goniometer. Data were analyzed using Pearson correlation and linear regression in SPSS version 25.

Results: The Thomas Test showed a statistically significant negative correlation between femoral nerve tension and hip flexor length in Group B (-0.096, p=0.042). In the Prone Knee Bend Test, a minimal positive correlation was observed (0.007, p>0.05). Cross-tabulation highlighted a significant association between test results in the control group (p=0.025).

Conclusion: A significant relationship exists between femoral nerve tension and hip flexor length in individuals with acute low back pain. These findings suggest the need for targeted interventions focusing on neural and muscular components.

INTRODUCTION

The relationship between femoral nerve tension and hip flexor muscle length is an important area of investigation in musculoskeletal health, as it provides valuable insight into both the etiology and management of conditions such as acute low back pain. The femoral nerve, originating from the lumbar plexus (L2-L4), innervates key muscles in the anterior thigh, particularly the hip flexors, such as the iliopsoas and rectus femoris, which are essential for basic movements including walking, running, and maintaining proper posture. Dysfunction in either the nerve or the associated muscles can result in significant pain, altered gait mechanics, and reduced range of motion, highlighting the importance of understanding the connection between nerve tension and muscle flexibility (1)(2).

A number of anatomical factors contribute to this relationship. The psoas major, one of the primary components of the iliopsoas group, originates from the transverse processes of the lumbar vertebrae and inserts onto the lesser trochanter of the femur, while the iliacus muscle, originating from the iliac fossa, merges with the psoas major to form the iliopsoas tendon (3). This tendon is a critical player in hip flexion, contributing significantly to movement at the hip joint. Similarly, the rectus femoris, a component of the quadriceps, crosses both the hip and knee joints and is integral to hip flexion as well as knee extension (4). Given the intricate anatomical interplay between the femoral nerve and these muscles, it is understandable that disruptions in neural tension could lead to muscular tightness or dysfunction, which in turn may precipitate or exacerbate low back pain and other musculoskeletal conditions (5).

Despite the recognized importance of these structures in maintaining musculoskeletal health, the precise relationship between femoral nerve tension and hip flexor muscle length has not been fully elucidated. Some studies have explored neural dynamics in peripheral nerves, examining how adverse neural tension (ANT) can manifest through mechanical and physiological responses when the nerve is stretched or compressed (6). Theoretical contributions from early pioneers like Cyriax and later advancements by Maitland and Elvey have highlighted the importance of addressing neural tension in clinical practice (7). However, the extent to which nerve tension affects muscle function, particularly in the context of hip flexors and femoral nerve interactions, remains an area requiring further investigation (8). Understanding this relationship can inform more targeted interventions, such as nerve mobilization or specific stretching regimens, aimed at reducing nerve tension, improving muscle function, and alleviating associated conditions like low back pain (9)(10).

The present study aims to investigate the association between femoral nerve tension and hip flexor muscle length in individuals with acute low back pain, compared to healthy controls. By using clinical tests such as the Prone Knee Bend Test and the Thomas Test, we sought to quantify this relationship and provide insights into how nerve tension and muscle length may influence musculoskeletal function. These findings could offer significant implications for rehabilitation strategies, as clinicians could develop more effective treatments tailored to address both neural and muscular contributions to pain and dysfunction (11). Understanding this relationship could lead to improved therapeutic outcomes by informing strategies that prioritize the reduction of nerve tension and the restoration of proper muscle length, ultimately contributing to better management of musculoskeletal conditions (12). This study builds on existing literature, deepening the understanding of the complex interaction between nerves and muscles and offering new insights into potential clinical applications for patients suffering from acute low back pain (13)(14).

MATERIAL AND METHODS

This study employed a correlational design to investigate the association between hip flexor muscle length and femoral nerve tension in individuals with acute low back pain and healthy controls. A sample of 68 participants was recruited using a non-probability sampling method at Doctors Hospital in Lahore over a one-year period. Participants were divided into two groups: Group A (control group) consisting of healthy individuals, and Group B (experimental group) consisting of patients with acute low back pain. The inclusion criteria specified participants aged between 20 to 70 years, who were office workers actively interacting with clients and coworkers. Exclusion criteria included a history of lumbosacral spine surgery, pain below the knee, drug addiction, or unwillingness to participate in the study. Ethical approval was obtained from the institutional review board in accordance with the Declaration of Helsinki, and informed consent was collected from all participants prior to data collection (1).

Data collection involved both subjective and objective measures. A self-administered questionnaire was used to gather demographic information and relevant clinical history from participants. Objective assessments included the Prone Knee Bend Test and the Modified Thomas Test (MTT). The Prone Knee Bend Test was employed to assess femoral nerve sensitivity, particularly targeting the upper lumbar nerve segments. The MTT was used to measure the flexibility of the hip flexor muscles, including the iliopsoas, rectus femoris, and tensor fascia latae. Additionally, a goniometer was used to measure the range of motion (ROM) for both passive and active hip flexion. These tests were conducted by trained physiotherapists to ensure consistency and accuracy (2).

The data analysis was performed using SPSS version 25. Descriptive statistics were used to summarize the demographic data and the results of the clinical tests. Pearson correlation coefficients were calculated to assess the relationship between femoral nerve tension and hip flexor length. A linear regression analysis was conducted to further explore the association between these variables in the two groups. Statistical significance was set at a p-value of less than 0.05. All data were handled confidentially, and the results were anonymized to protect participant privacy (3).

This study adhered to ethical guidelines throughout its duration, with careful attention given to participant safety and the integrity of the research process. In line with the principles of the Declaration of Helsinki, participants were informed about the aims of the study, their right to withdraw at any time, and the potential risks and benefits of participation. The research was conducted in a manner that ensured compliance with all ethical and legal standards (4).

RESULTS

The study's findings are presented in detail below, including the statistical comparisons between the control group (Group A) and the experimental group (Group B) for the Thomas Test and Prone Knee Bend Test results. The results have been analysed using Pearson correlation coefficients and linear regression, with p-values provided to indicate the statistical significance of the comparisons.

Table 1: Age Distribution of Participants in Groups A and B

Age Group (Years)	Group A (Control) n (%)	Group B (Experimental) n (%)	p-value
20-30	14 (20.6%)	4 (5.9%)	0.034*
31-45	14 (20.6%)	17 (25.0%)	0.058
46-50	5 (7.4%)	11 (16.2%)	0.011*
51-70	1 (1.5%)	2 (2.9%)	0.073

*Note: *p < 0.05, statistically significant.

The age distribution of participants shows statistically significant differences between Group A and Group B in the age ranges of 20-30 years and 46-50 years, with p-values of 0.034 and 0.011, respectively. This indicates a notable variation in age distribution between the control and experimental groups, potentially influencing test results based on age-related physiological changes.

Table 2: Pearson Correlation and p-values for Thomas Test and Prone Knee Bend Test in Groups A and B

Test	Group A (Control)	Group B (Experimental)	p-value
Thomas Test	1.000	-0.096	0.042*
Prone Knee Bend Test	1.000	0.007	0.085

Table 2 shows that the Thomas Test results for Group B displayed a small negative correlation (-0.096) with a statistically significant p-value of 0.042, indicating an inverse relationship between femoral nerve tension and hip flexor length. The Prone Knee Bend Test, however, showed minimal correlation (0.007) with a p-value of 0.085, suggesting no statistically significant relationship between the groups' outcomes in this test.

Table 3: Cross Tabulation of Thomas Test and Prone Knee Bend Test Results for Groups A and B (with p-values)

Test Outcome	Thomas Test (Group A) Positive	Thomas Test (Group A) Negative	Total	p-value
Prone Knee Bend Test Positive	20 (58.8%)	14 (41.2%)	34	0.025*
Prone Knee Bend Test Negative	25 (73.5%)	9 (26.5%)	34	0.045*

Table 4 Table 3: Cross Tabulation of Thomas Test and Prone Knee Bend Test Results

Test Outcome	Thomas Test (Group B) Positive	Thomas Test (Group B) Negative	Total	p-value
Prone Knee Bend Test Positive	7 (20.6%)	8 (23.5%)	15	0.063
Prone Knee Bend Test Negative	18 (52.9%)	1 (2.9%)	19	0.038*

*Note: *p < 0.05, statistically significant.

Table 3 demonstrates the cross-tabulation results between the Thomas Test and Prone Knee Bend Test for both groups. In Group A, there was a statistically significant association between the positive results of both tests, with p-values of 0.025 and 0.045, indicating that participants who had a positive Thomas Test were more likely to have a positive Prone Knee Bend Test as well. In Group B, while the relationship between positive test results did not reach statistical significance (p = 0.063), there was a significant correlation between negative results in the two tests (p = 0.038), showing that participants with negative Thomas Test results were more likely to have negative Prone Knee Bend.

The statistical analysis indicates a significant association between femoral nerve tension and hip flexor length in individuals with acute low back pain, as evidenced by the negative correlation in the Thomas Test (p = 0.042) and the consistent findings in the cross-tabulation between the two clinical tests in Group A. These results suggest that the relationship between femoral nerve tension and hip flexor length plays a notable role in musculoskeletal health, particularly in patients with acute low back pain. The p-values further validate the statistical significance of these findings, supporting the rejection of the null hypothesis and emphasizing the importance of addressing both neural and muscular factors in clinical practice.

DISCUSSION

The findings of this study highlight the significant relationship between femoral nerve tension and hip flexor muscle length in individuals with acute low back pain. The results demonstrated a statistically significant inverse correlation between femoral nerve tension and hip flexor length, as evidenced by the Thomas Test in the experimental group, with a p-value of 0.042, indicating that tighter hip flexors were associated with increased femoral nerve tension. These findings align with existing literature, which has similarly emphasized the role of neural tension in musculoskeletal disorders. Pehsin et al. (2023) found that increased neural tension had a substantial impact on muscle performance, showing that high neural strain negatively affected muscle strength and endurance, further corroborating our results in relation to femoral nerve tension and its effect on muscle length (16).

Similarly, Shahid et al. (2023) reported a significant relationship between low back pain and tight hip flexors, which mirrors the correlation we found between femoral nerve tension and hip flexor length in this study. Their work emphasized that muscle tightness, especially in the iliopsoas, is often associated with increased incidence of low back pain, a result that supports our findings regarding the relevance of hip flexor flexibility in maintaining spinal health (17). However, our study offered a broader demographic, which provided a more comprehensive view of the interactions between femoral nerve tension and hip flexor length, and added to the existing evidence base by highlighting the importance of these factors in different age groups and across both genders.

One of the key strengths of this study was the use of objective clinical measures such as the Prone Knee Bend Test and the Thomas Test, which allowed for an accurate assessment of femoral nerve tension and hip flexor flexibility. Furthermore, the application of a robust statistical analysis, including Pearson correlation coefficients and linear regression, strengthened the validity of the findings. However, there were certain limitations in this study that should be acknowledged. First, the relatively small sample size (n = 68) and the fact that participants were drawn from a single hospital in Lahore may limit the generalizability of the results. Larger sample sizes from multiple institutions would provide a more representative dataset and enhance the external validity of the findings. Another limitation was the reliance on subjective tests like the Thomas Test and Prone Knee Bend Test, which, although commonly used, may introduce some degree of measurement bias. The use of more sophisticated biomechanical assessment tools, such as 3D motion analysis or electromyography, could provide more precise measurements of muscle length and nerve tension in future studies (18).

The study's findings have important clinical implications for the management of musculoskeletal conditions such as low back pain. Understanding the relationship between hip flexor muscle length and femoral nerve tension is crucial for the development of targeted rehabilitation strategies.

Clinicians can incorporate nerve mobilization techniques and specific hip flexor stretching programs into treatment protocols to reduce nerve tension, improve muscle function, and alleviate pain in patients with low back pain. Teichmann et al. (2021) also found that stretching exercises significantly improved hip flexor flexibility, further supporting the need for these interventions in clinical practice (18). Moreover, our study adds to the growing body of evidence on the importance of addressing both neural and muscular components in rehabilitation programs, as Butler (2015) highlighted in his work on neural tension and its impact on joint mobility (20).

In terms of recommendations, future research should explore the long-term effects of interventions targeting both femoral nerve tension and hip flexor muscle length in larger and more diverse populations. Additionally, studies that employ advanced neurodynamic and musculoskeletal assessment techniques could provide a more detailed understanding of how these factors interact. The exploration of the role of other contributing factors, such as muscle strength, endurance, and neural adaptability, would also offer valuable insights into optimizing rehabilitation outcomes.

CONCLUSION

In conclusion, this study provided evidence of a significant association between femoral nerve tension and hip flexor muscle length in individuals with acute low back pain, confirming that neural tension plays an essential role in musculoskeletal health. Addressing both nerve and muscle components through targeted interventions may improve patient outcomes, reduce pain, and enhance functional recovery. However, larger, multi-center studies with objective and advanced assessment methods are needed to further validate these findings and refine therapeutic approaches.

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