Int. J. Morphol.,
43(4):1382-1387, 2025.

Anatomical Investigation of the Obturator and Saphenous Nerves as Potential Contributors to Exercise-Induced Knee Pain

Investigación Anatómica de los Nervios Obturador y Safeno como Posibles Contribuyentes al Dolor de Rodilla Inducido por el Ejercicio

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JEON, A.; BACK, S.-G. & LEE, J.-H. Anatomical investigation of the obturator and saphenous nerves as potential contributors to exercise-induced knee pain. *Int. J. Morphol., 43(4)*:1382-1387, 2025.

SUMMARY: This study aims to perform a comprehensive anatomical analysis of the spatial relationship between the saphenous and obturator nerves in the context of the vastoadductor membrane. Furthermore, it seeks to offer an initial evaluation of the potential benefits of manual compression of the femoral triangle for individuals experiencing knee pain during activities such as lunges and squats. Twenty-nine lower limbs from both embalmed and fresh Korean cadavers were dissected to investigate the anatomical course of the obturator nerve. And, participants were recruited from university-level physical education students who reported experiencing knee pain during exercises such as squats and lunges. The incidence of neural structures passing through the vastoadductor membrane was 41.3 %. Notably, communicating branches between the obturator nerve and the saphenous nerve were identified in 75.8 % of cases. Furthermore, in participants who reported knee pain, repeated application and release of manual pressure to areas of palpable tension around the femoral triangle resulted in the alleviation of local tension, which was accompanied by a reduction or resolution of knee pain. Increased awareness of these neural pathways can aid in more accurate diagnosis and targeted treatment strategies for exercise-induced knee pain.

KEY WORDS Anatomy; Obturator nerve; Saphenous nerve; Entrapment; Knee pain.

INTRODUCTION

The prevalence of symptomatic knee osteoarthritis among individuals aged 45 years and older has been estimated at approximately 16.7 % in the United States. In 2010, hospital discharge data indicated an average of 155,000 knee arthroplasties per quarter performed due to osteoarthritis-related degeneration. Despite the generally favorable functional and clinical outcomes associated with total knee arthroplasty, persistent postoperative pain remains a significant concern, with up to 44 % of patients reporting ongoing discomfort even after objectively successful surgical intervention (Tran *et al*., 2018). Given its anatomical course and sensory distribution, the saphenous nerve is frequently identified as a relevant factor in both postoperative knee pain and non-specific knee discomfort (Abd-Elsayed *et al*., 2024; Li *et al*., 2025).

Although numerous clinical studies have investigated techniques for saphenous nerve block, anatomical research has primarily focused on the saphenous nerve and its infrapatellar branch (Patterson *et al*., 2019; Im *et al*., 2020). In addition, anatomical investigations of the saphenous nerve in the context of graft harvesting have been well-documented (Niimi *et al*., 2019). However, studies examined the branching pattern of the saphenous nerve from the femoral nerve, its potential passage through the adductor canal, and its precise anatomical relationships remain limited and insufficiently explored.

The adductor canal also referred to as the subsartorial or Hunter's canal, is an aponeurotic tunnel located in the middle third of the thigh. It serves as a conduit for key neurovascular structures, including branches of the femoral artery, vein, and nerve. Anatomically, the canal extends from the apex of the femoral triangle to the adductor hiatus (Mettu *et al*., 2025). Although several anatomical studies have described the course of the saphenous nerve within the adductor canal, along with its relationship to the infrapatellar branch, investigations specifically addressing the anatomical

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Received: 2025-05-04 Accepted: 2025-06-03

relationship between the saphenous nerve and the obturator nerve remain scarce in the existed literature (Anagnostopoulou *et al*., 2016; Laurant *et al*., 2016).

Knee pain frequently arises during exercises such as squats or lunges, and previous studies have suggested that its onset may be influenced by factors such as the degree of knee flexion and the orientation of the ankle during movement (Huang *et al*., 2014; Pereira *et al*., 2022). As the saphenous nerve, which is known to contribute to the sensation of knee pain, courses distally from the apex of the femoral triangle, it plays a role in the sensory innervation of the medial aspect of the knee. Consequently, individuals who experience knee pain during physical activity may present with abnormal findings upon palpation of the femoral triangle, such as increased firmness or localized tenderness, which may indicate neural irritation or entrapment.

The saphenous nerve is a distal sensory branch of the femoral nerve that descends medially toward the knee, while the obturator nerve emerges deep to the adductor longus and innervates the medial compartment muscles of the thigh, in addition to supplying cutaneous sensation to a portion of the medial thigh. Given their origins from the lumbar spinal cord and their distinct yet adjacent anatomical courses, further investigation into the spatial relationship and trajectories of these nerves following their exit from the spinal cord may provide valuable insights into the somatic contributions to medial knee pain. Such studies would be of significant importance in advancing the anatomical understanding necessary for diagnosing and managing exercise-induced or idiopathic knee discomfort.

The aim of this study is to conduct a detailed anatomical investigation of the spatial relationship between the saphenous and obturator nerves in relation to the vastoadductor membrane. Based on these findings, the study also seeks to provide a preliminary assessment of the potential effects of manual compression of the femoral triangle in individuals experiencing knee pain during exercises such as lunges and squats.

MATERIAL AND METHOD

Cadaveric Dissection. Twenty-nine lower limbs from both embalmed and fresh Korean cadavers (9 males, 6 females; mean age: 76.3 years; age range: 36–90 years) were dissected to investigate the anatomical course of the obturator nerve. Among these, none of the cadavers exhibited evidence of prior surgical intervention or traumatic injury in the pelvic or thigh regions. Following reflection of the skin flaps on the anterior and medial aspects of the thigh, the pectineus muscle was identified and its origin carefully incised to expose the underlying obturator nerve. Their distribution patterns were classified in relation to the saphenous nerve and the vastoadductor membrane. Furthermore, in order to investigate the course patterns of the saphenous and obturator nerves, their trajectories were examined in relation to the vastoadductor membrane, and their anatomical characteristics were systematically analyzed (Figs. 1 to 4).

Participants. Participants were selected from among university students in physical education programs who experienced knee pain during exercises such as squats or lunges. Individual exercise methods and intensity levels were not assessed; instead, participants were selected based on the presence of knee pain specifically during thigh muscle–focused exercises. Voluntary exercise sessions were conducted for students across the first to third academic years, each cohort consisting of approximately 30 individuals. A total of 13 individuals who reported such knee discomfort were included in the study. The participants' pain levels were assessed using the Visual Analog Scale (VAS), with scores ranging from 1 to 10, where 1 represented the least pain and 10 indicated the most severe pain. In those reporting discomfort, manual palpation of the femoral triangle was performed. If pain was elicited upon compression, repeated manual pressure was applied—pressing and releasing for 5 seconds each, repeated 10 to 20 times—to assess the immediate effect on symptom relief.

Ethical Considerations. All cadaveric specimens were legally donated to the University College of Medicine, with informed consent provided by donors or their families. The study protocol was reviewed and approved by the Institutional Review Board and was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

In 37.9 % of cases, the obturator nerve was observed to pass through the vastoadductor membrane and subsequently merge with the saphenous nerve (Fig. 1). In contrast, in 3.4 % of cases, the obturator nerve did not traverse the vastoadductor membrane and showed no convergence with the saphenous nerve (Fig. 2). Additionally, in 34.5 % of cases, the obturator nerve merged with the saphenous nerve without passing through the vastoadductor membrane (Fig. 3), while 24.1 % of cases exhibited neither passage through the membrane nor convergence with the saphenous nerve (Fig. 4). When analyzed irrespective of its relationship with the saphenous nerve, the obturator nerve passed through the vastoadductor membrane in 41.3 % of cases, whereas in 58.0 % of cases, it did not. Regardless of membrane passage, convergence of the obturator nerve with the saphenous nerve occurred in 72.4 % of all cases, while no convergence was observed in 27.5 % (Table I).

Among the students who reported knee pain during exercise, 13 individuals were selected for further evaluation. Each participant was placed in a supine position, and the femoral triangle of the affected limb was palpated. Manual compression was applied to the identified tender area for approximately 5 seconds, repeated 10 to 20 times with intermittent release. In most cases, a gradual reduction in localized tenderness was observed during the course of repeated compression. Once tenderness subsided, adjacent areas within the femoral triangle were palpated to assess for any remaining sensitivity. Following this procedure, participants were asked to stand and report on the status of their knee pain. All 13 individuals reported complete resolution of knee pain immediately after the intervention. Initially, eight participants reported a pain score of VAS 2, while five participants reported VAS 3. Following the application of manual pressure to the femoral triangle, ten participants reported complete relief with a VAS score of 0, and three participants indicated that their pain had nearly resolved, describing it as being close to VAS 0.

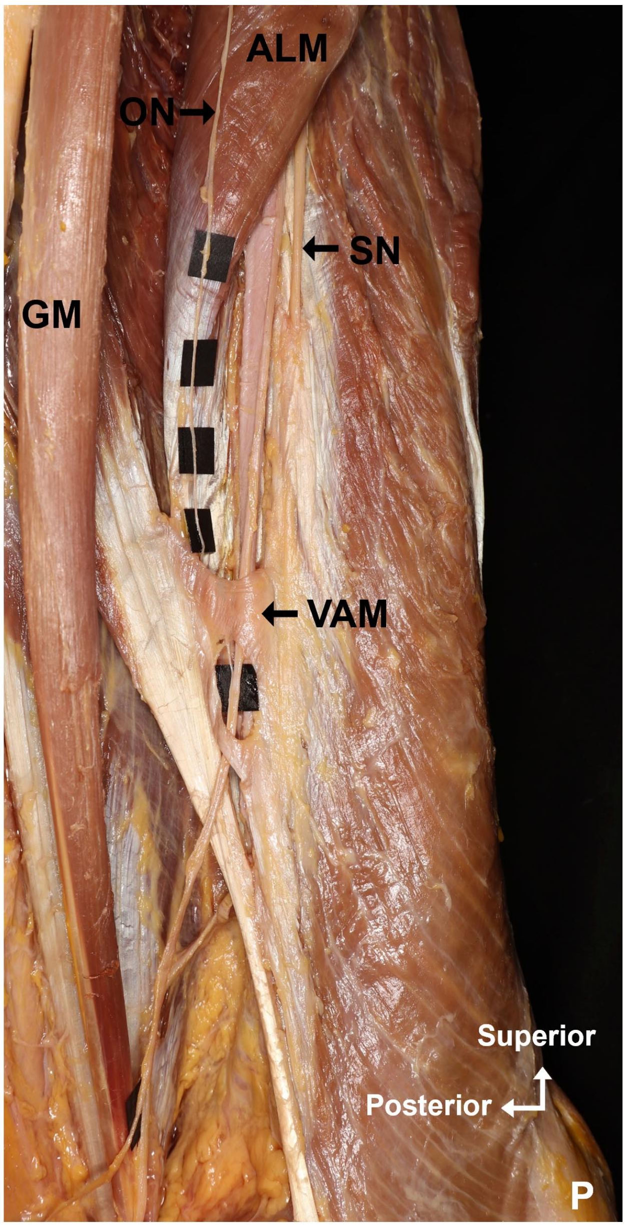

Fig. 1. Anatomical dissection demonstrating the obturator nerve (ON) passing through the vastoadductor membrane (VAM) and subsequently forming a communicating branch with the saphenous nerve (SN). ALM, adductor longus muscle; GM, gracilis muscle; P, patella.

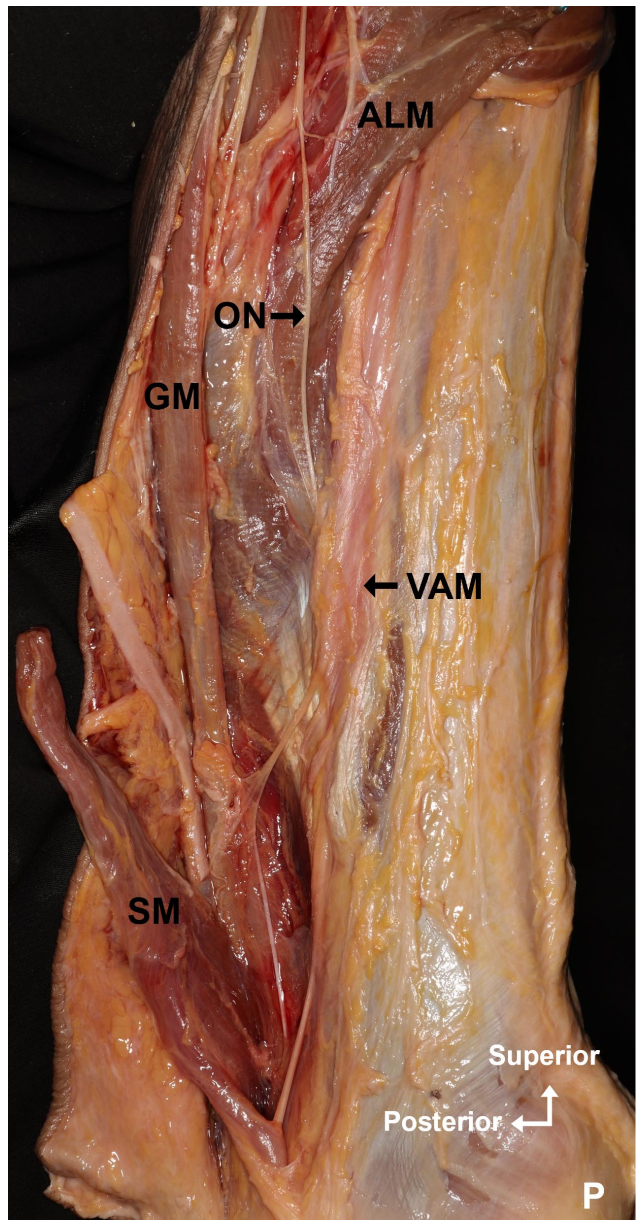

Fig. 2. Anatomical dissection showing the obturator nerve (ON) passing through the vastoadductor membrane (VAM) without forming a communicating branch with the saphenous nerve (SN). ALM, adductor longus muscle; SM, sartorius muscle; P, patella.

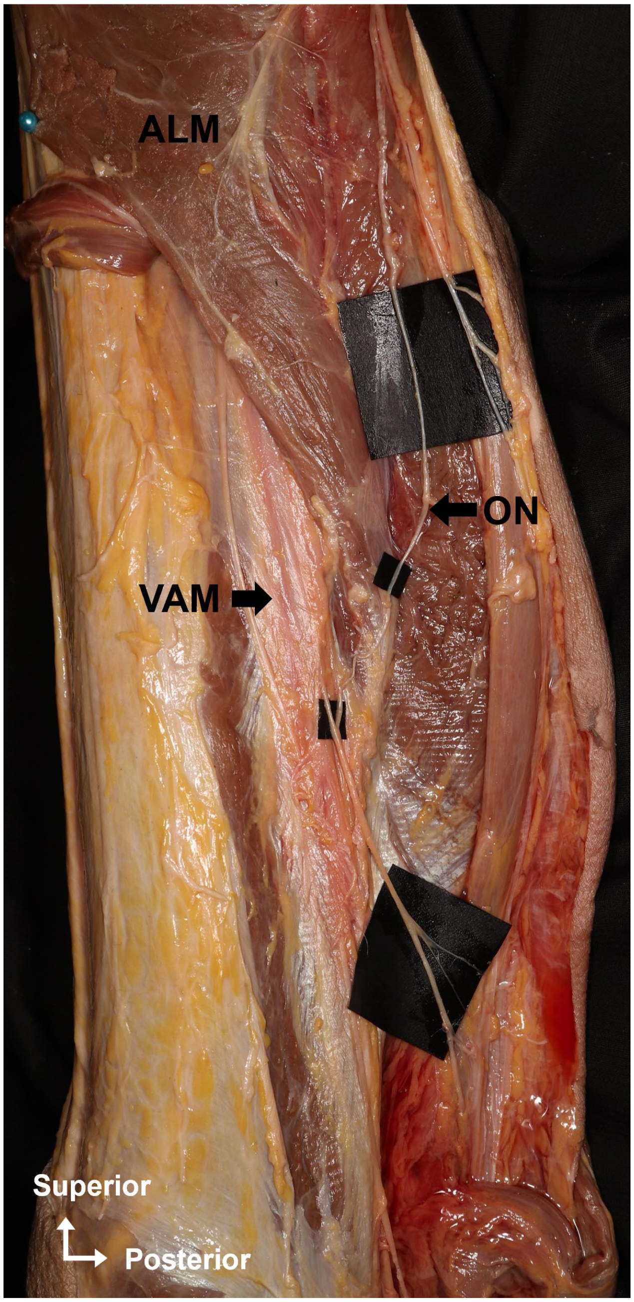

Fig. 3. Anatomical dissection demonstrating the obturator nerve (ON) not passing through the vastoadductor membrane (VAM), yet forming a communicating branch with the saphenous nerve (SN). AL, adductor longus; ALM, adductor longus muscle.

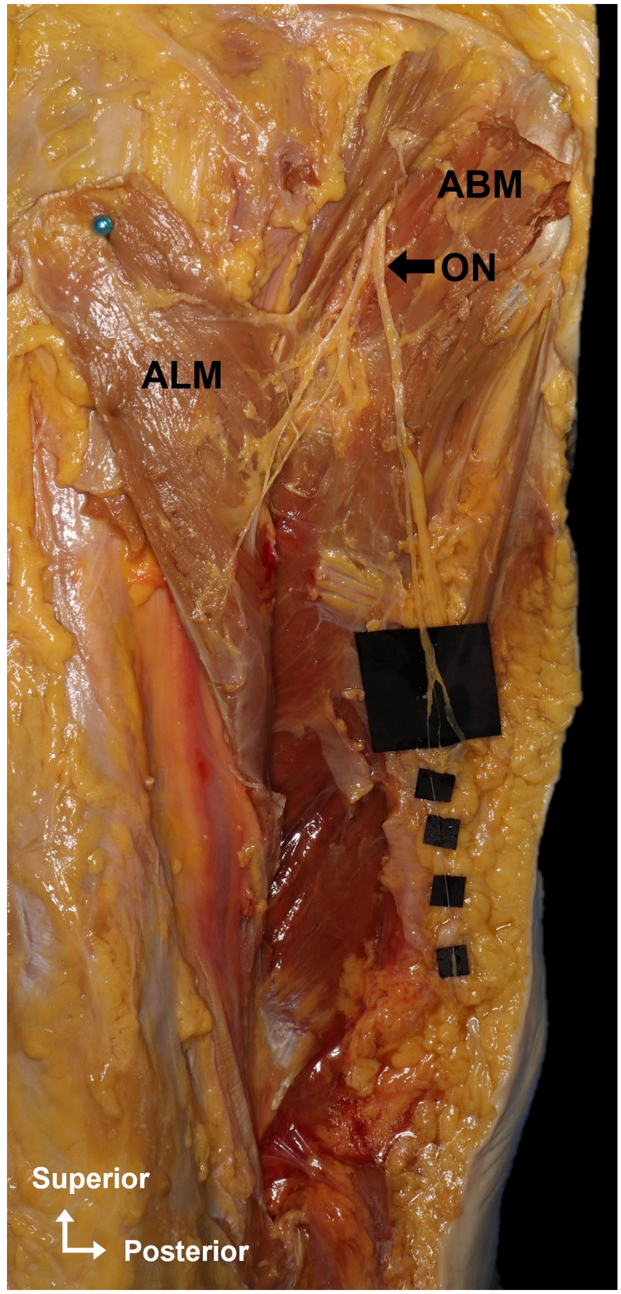

Fig. 4. Anatomical dissection showing the obturator nerve (ON) not passing through the vastoadductor membrane and not forming a communicating branch with the saphenous nerve. AL, adductor longus; AB, adductor brevis; ALM, adductor longus muscle; ABM, adductor brevis muscle.

Table I. Anatomical pathways of the obturator and saphenous nerves.

	Type	N	%
A	Through + Anastomosis	11	37.9
B	Through + Non-anastomosis	1	3.4
C	Non-through + Anastomosis	10	34.5
D	Non-through + Non-anastomosis	7	24.1
	Total	29	100.0

Through: The obturator nerve passes through the vastoadductor membrane, Non-through: The obturator nerve does not pass through the vastoadductor membrane, Anastomosis: The obturator nerve and the saphenous nerve merge, Non-anastomosis: The obturator nerve and the saphenous nerve do not merge. N: number.

DISCUSSION

According to a study published in 2019 (Staples *et al*., 2019), the cutaneous branch of the obturator nerve was reported to travel toward the medial malleolus at the ankle, while the saphenous branch of the femoral nerve courses anteriorly relative to the great saphenous vein. Additionally, Mercer *et al*. (2011), conducted an anatomical investigation into the course of the saphenous nerve, and Laurent *et al*. (2016), also examined the anatomical relationships of these nerves in the context of adductor canal block. Other studies (Hasabo *et al*., 2022) have investigated the efficacy of adductor canal block and femoral nerve block in the context of knee arthroplasty; however, considering the possibility of communicating branches between the two nerves, a broader range of interpretations regarding clinical outcomes could have been explored. None of these studies addressed the presence of communicating branches between the obturator and saphenous nerves or whether either nerve passes through the vastoadductor membrane. It is hoped that the findings of this study, demonstrating the existence of communicating branches between the obturator and saphenous nerves, will contribute to improved clinical assessment and treatment strategies for patients.

In this study, it was observed that in 73.0 % of cases, the obturator nerve converged with the saphenous nerve. Although these findings are limited to the Korean population, it may be hypothesized that in approximately 73 % of individuals, contraction of the adductor muscles during exercise could exert pressure on the obturator nerve, potentially leading to knee pain. Given that one of the anatomical boundaries of the femoral triangle is formed by the adductor muscles, it is plausible that localized tension perceived on the medial side during palpation of the femoral triangle may reflect adductor muscle tightness, contributing to obturator nerve compression and subsequent knee discomfort. Previous studies investigating exercise-induced knee pain have primarily focused on patellofemoral pain syndrome or osteoarthritis (Huang *et al*., 2014; Pereira *et al*., 2022; Li *et al*., 2024). However, one may question whether closer anatomical consideration of the femoral triangle as a potential site of symptom modulation could have yielded alternative interpretations or therapeutic approaches.

The etiology of knee pain is multifactorial, encompassing degenerative joint diseases such as osteoarthritis, patellofemoral pain syndrome, acromegaly, tumors, and muscular imbalances. Furthermore, a recent study by Lygrisse *et al*. (2025), emphasized the importance of considering spinal pathology when evaluating patients with knee pain. According to their findings, lumbar spine pathology, particularly at the L3–L4 level, was identified as the most common source, followed by spinal stenosis and intervertebral disc herniation. In the present study, the subjects were young university students, and treatment was applied immediately upon the onset of any discomfort. This prompt intervention likely contributed to the rapid resolution of pain, highlighting the potential benefits of early therapeutic strategies.

The vastoadductor membrane extended from the medial margin of the vastus medialis muscle to the lateral margin of the adductor magnus muscle and its distal tendon, approximately aligned with the coronal plane. In most specimens, the membrane exhibited a rhomboid configuration, being broader proximally and tapering distally. The orientation of the majority of its fibers was oblique, coursing in a superomedial direction. In some specimens, the proximal fibers displayed a more horizontal alignment, while the distal fibers maintained an oblique trajectory in the same superomedial direction (Tubbs *et al*., 2007). According to his study, a branch of the saphenous nerve was found to traverse the membrane in 31.0 % of cases, while the main branch did not penetrate the membrane. Additionally, in two cases, a branch of the obturator nerve was reported to pass through the membrane. In the present study, the incidence of neural structures passing through the membrane was 41.3 %. Notably, communicating branches between the obturator nerve and the femoral nerve were identified in 75.8 % of cases—an anatomical finding unique to this investigation. These results may provide valuable insight when evaluating patients with lower limb pain of potential neural origin.

Based on the results of this study, it is suggested that knee pain may be attributed to obturator nerve entrapment caused by the strengthening of the adductor muscles, or to saphenous nerve entrapment resulting from increased pressure on the vastoadductor membrane due to hypertrophy of the thigh muscles. As a non-invasive therapeutic approach, applying manual pressure to areas of tension identified through palpation of the femoral triangle may prove to be effective.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the valuable contribution of the students who participated in this research and extend their deepest respect and appreciation to the body donors whose selfless gifts made this study possible.

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RESUMEN: Este estudio tuvo como objetivo realizar un análisis anatómico exhaustivo de la relación espacial entre los nervios safeno y obturador en el contexto de la membrana vastoaductora. Además, busca ofrecer una evaluación inicial de los posibles beneficios de la compresión manual del trígono femoral para personas que experimentan dolor de rodilla durante actividades como zancadas y sentadillas. Se diseccionaron veintinueve miembros inferiores de cadáveres coreanos, tanto embalsamados como frescos, para investigar el recorrido anatómico del nervio obturador. Los participantes fueron estudiantes universitarios de educación física que reportaron experimentar dolor de rodilla durante ejercicios como sentadillas y zancadas. La incidencia de estructuras neurales que atraviesan la membrana vastoaductora fue del 41,3 %. Cabe destacar que se identificaron ramas comunicantes entre el nervio obturador y el nervio safeno en el 75,8 % de los casos. Además, en los participantes que reportaron dolor de rodilla, la aplicación y liberación repetidas de presión manual en áreas de tensión palpable alrededor del trígono femoral resultó en el alivio de la tensión local, lo que se acompañó de una reducción o desaparición del dolor de rodilla. Un mayor conocimiento de estas vías neurales puede contribuir a un diagnóstico más preciso y a estrategias de tratamiento específicas para el dolor de rodilla inducido por el ejercicio.

PALABRAS CLAVE: Anatomía; Nervio obturador; Nervio safeno; Atrapamiento; Dolor de rodilla.

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