The Boundary of the Vastus Medialis Oblique and the Vastus Medialis Longus

TAKEYA ONO, PhD, PT1), CHERYL RIEGGER-KRUGH, ScD, PT2), NANCEY A BOOKSTEIN, EdD, PT3), MICHELE EISEMANN SHIMIZU, PhD, PT1), SHUSAKU KANAI, MS, PT1), AKIRA OTSUKA, PhD, PT1)

1)Department of Physical Therapy, Hiroshima Prefectural College of Health Sciences: 1-1 Gakuen Machi, Mihara City, Hiroshima 723-0053, Japan. TEL 81+848-60-1210 E-mail: ono@hpc.ac.jp
2)University of Colorado Health Sciences Center, Physical Therapy Program

Abstract. There are no well-defined or documented boundaries for either the vastus medialis oblique or for the vastus medialis longus. The purpose of this study was to examine anatomically the boundaries of the vastus medialis longus and the vastus medialis oblique. In an embalmed adult cadaver, two vastus medialis muscles were examined by direct visual observation. Our observations indicate that the boundary of the vastus medialis oblique and the vastus medialis longus appears to be the line from the adductor hiatus to the medial rim of the patella. This finding indicates that the vastus medialis oblique and vastus medialis longus may have different functions in the vastus medialis.

Key words: Vastus medialis oblique, Vastus medialis longus, Anatomy

INTRODUCTION

The quadriceps femoris muscle is composed of four distinctive portions, the rectus femoris, vastus intermedius, vastus lateralis and vastus medialis (VM). The VM muscle has two portions, known as the vastus medialis oblique (VMO) and the vastus medialis longus (VML)1). The function of the VMO has been reported as to pull the patella medially during knee extension, while that of the VML has been reported as to extend the knee2, 3).

Lieb1) stated that in one out of six cadaver specimens, there was a definite separation between these two portions defined by a separate nerve trunk. However, Thiranagama4) reported many nerve branches distributed in sequential order from one area of the femoral nerve to the proximal and then distal portions of the VM. Also, Weinstabl2) stated that the VML and VMO could be differentiated by means of a nerve branch that runs between the two parts of the muscle. The areolar fascial plane was described by Lieb and Perry1) as a fibrofatty plane between the distal and proximal portions of the VM and was shown in a photograph by Weinstabl2). Lieb1), Weinstabl2) and Bose3) reported a separation of the VMO from the VML by muscle fiber alignment in the VM. However, Hubbard5) stated that it was difficult to distinguish the VMO from VML clearly by the muscle fiber alignment.

Some have also maintained that the VMO and the VML are not separate structures anatomically6). The purpose of this study was to determine whether a boundary exists between the VMO and VML, and if so, how the boundary can be defined.
MATERIAL AND METHODS

Both legs of a middle-aged male cadaver with a common physique were examined. The specimen had no evidence of knee surgery. First, we examined the spino-malleolus distance (SMD), the trochanto-malleolus distance (TMD), and the joint angles of the hip and knee. Careful dissection was performed to expose the thigh and leg from the level of the anterior superior iliac spine to the level of the tibial tubercle, and the thigh was dissected to the depth of the quadriceps muscle. The VM muscles from the embalmed adult cadaver were examined by direct visual observation during and following dissection. Areas of examination included: the areolar fascial plane, nerve distribution, and muscle fiber direction. Muscle fiber angles of the two portions of VM were measured using standard goniometric techniques, with the long axis of the femur utilized as the reference point for the measurement. The long axis of the femur was determined to be the line from the anterior superior iliac spine to the apex of the patella. Fiber angle measurements were taken from both the proximal and distal portions of the VM. The fiber angle measurements from the proximal fibers of the VM were taken from those fibers lying closest to the shaft of the femur. The distal portion of the VM fiber angle measurements were taken from the most distal portion of the muscle.

RESULTS

SMD and TMD were 94 cm and 46 cm bilaterally, respectively. As to the state of the joints, the hip showed slight external rotation and abduction bilaterally, the right knee was at 30 degrees flexion, and the left knee was at 15 degrees flexion.

The areolar fascial plane as reported and shown by Weinstabl\(^2\) was not definitive. However, a structure similar to an areolar fascial plane contained a nerve and a blood vessel, as shown in Fig. 1. Interestingly, the right VM had two structures similar to an areolar fascial plane. The first was superficial, and the second was deep and exposed when the superficial muscle fibers were removed, as shown in Fig. 2.

The femoral nerve ran along the medial rim of the VM, and it distributed branches to the VM from the proximal to the distal portion in an orderly manner. Cursory observations showed the femoral nerve extended to the proximal portion of the VM and the distal portion of the VM separately, as shown in Fig. 3.

Muscle fiber direction was observed as a gradual change from distal to proximal bilaterally. The distal portion of the muscle direction was more horizontal, whereas the proximal portion of the muscle direction was more vertical. The angles of the distal portion of the VM fibers to the right and the left of the shaft of the femur were both 40
degrees, and the angles of the proximal portion of the VM fibers were 30 degrees and 15 degrees, respectively. In addition, the fiber directions of the three portions, as the distal portion of the VM, the vasto-adductor lamina, and the adductor magnus, were the same. Furthermore, the fiber directions of the three portions of the proximal portion of the VM, adductor canal and adductor longus were the same. Also, these two fiber directions abruptly changed at the adductor hiatus (Fig. 4).

**DISCUSSION**

Anterior knee pain has been linked to insufficiency in the VMO portion of the VM. Anterior knee pain related to dysfunction of the patellofemoral joint has been reported to be one of the most common knee problems seen in orthopedic practice. One cause of the patellofemoral pain syndrome is VMO muscle insufficiency. If the VMO can be strengthened selectively, this might lead to a good outcome, without the necessity of surgery. In order for this type of intervention to occur, the VMO needs to be identified as distinct from the rest of the VM. Conservative interventions could include muscle stimulation, biofeedback training, etc., all of which require accurate identification of the muscle to be focused on.

Presence of an areolar fascial plane in the area of the boundary between the distal and the proximal portion of the VM was reported as being inconsistently present by Lieb and Weinstabl. Their results, as well as ours, indicate that an areolar fascial plane is not the definitive criterion for the division of the distal and the proximal portion of the VM.

Separate nerves for the distal and the proximal portion of the VM were reported by Lieb, while Thiranagama reported the same nerve innervating the distal and proximal portion of the VM. We could distinguish between the proximal and the distal portion of the VM by nerve distribution. The presence of this nerve distribution indicates that the portions of the proximal and the distal VM might have different timings of muscle contraction from voluntary or peripheral nerve stimulation.

The division of the distal portion of the VM from the proximal portion of the VM by a muscle fiber alignment was reported by Lieb, Weinstabl, and Bose, while Hubbard reported that this distinction did not exist. In our study, the muscle fiber direction was clearly different between the proximal and the distal portion of the VM. Also, the relationship between the distal and the proximal portions of the VM and the adductor muscles was interesting. The boundary of the distal and the proximal portion of the VM appeared to be the line from the adductor hiatus to the medial rim of the patella, that is, if we are to define the boundary of the vastus medialis oblique and the vastus medialis oblique.
longus. In the future, we would like to confirm this finding in more specimens.

The differences of the fiber directions suggest a difference of function in each portion of the VM. In non-human primates, the origin of the VM is confined to the femur\(^3\). While in humans, some of the distal portion of the VM originates from the adductor magnus, and some of the proximal portion of the VM originates from the adductor longus. The explanation for these differences would be the human adaptation to bipedal gait within the theory of evolution\(^3\).

**REFERENCES**


