Anatomical Assessment of the Vastus Medialis Oblique Muscle in Patients With Osteoarthritis of the Knee

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Abstract: Minimally invasive total knee arthroplasty requires subluxation of patella laterally without eversion. The anatomy of the vastus medialis oblique muscle (VMO), which affects the surgical exposure of minimally invasive total knee arthroplasty, was investigated. There was no significant difference between men and women with respect to any parameter. The average fiber angle relative to the rectus femoris muscle was 52.9° on anteroposterior view and 49.7° on lateral view. The average insertion height and the distal portion of VMO belly were 17.3% and 38.4% of the patella length from the upper pole of patella, respectively. Female patients had lower VMO attachment and VMO belly, and a significant sex difference was demonstrated. All patients had attachments beneath the upper pole of the patella. **Key words:** knee, arthroplasty, quadriceps muscle, anatomy, tomography, spiral computed.

Total knee arthroplasty (TKA) has been the criterion standard, and various surgical approaches have been described such as the subvastus, midvastus, and lateral parapatellar [1-5]. The medial parapatellar approach has been the most frequently used method, and the results of TKA using this approach are satisfactory. On the other hand, minimally invasive surgery (MIS) using minimidvastus, minisubvastus, or quadriceps-sparing approach instead of the conventional medial parapatellar approach has recently been developed [6-12]. This surgical exposure of MIS involves lateral subluxation without everting the patella; and thus, anatomical comprehension of the vastus medialis (VM), especially the VM oblique muscle (VMO), is indispensable for appropriate surgical exposure. The anatomy of this muscle has been described by cadaveric studies, such as alignment of muscle fiber and neurovascular anatomy [13-21], whereas VMO position relative to the patella has not been well described, although it has an impact on the surgical exposure in MIS-TKA.

With development of computer technology, multidetector computed tomography (MDCT) has facilitated the 3-dimensional (3D) visualization of the muscle with contrast [22-25]. This study describes anatomical variations of the VM using MDCT. In particular, VMO position relative to the patella and the fiber alignment was examined in patients who underwent TKA.

Material and Methods

We examined the bilateral knee joints of 30 Japanese patients (60 joints) who underwent or were scheduled for TKA. This study population included 10 men and 20 women. Patient ages

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ranged from 60 to 85 years, and the average age was 74.2 ± 5.1 years. All patients demonstrated osteoarthritis. All CT images were obtained with 4-MDCT or 16-MDCT scanner (Asteion Multi and Aquillion 16, Toshiba Medical Systems, Tokyo Japan) before surgery using 0.5 or 0.75 second per rotation and 0.5- mm collimation with 120 kV and 100 to 250 mA. Computed tomographic images were obtained with or without intravenous injection of the contrast medium to examine deformity of the knee joint or preoperative deep venous thrombosis. The CT images for multiplanar reconstruction (MPR) and 3D–volume rendering (3D-VR) were reconstructed with 0.5-mm slice thickness and 0.5-mm slice increment. These thin-slice CT data sets were transferred to 3D workstations (Virtualplace liberty, AZE Inc, Tokyo, Japan, and ZIO M900, ZIOSOFT, Tokyo, Japan). All MPR and 3D-VR images were obtained with these 3D workstations. The most distal sites of insertion to the patellae and muscle belly of the VMO were determined on MPR images. *Distal portion of insertion* was defined as the site where the medial side of VMO attached to the joint capsule with sharp edge (Fig. 1A). *Distal portion of the muscle belly* was determined as the site where the muscle belly of VMO disappeared (Fig. 1B). These sites were marked on MPR images, and the accuracy was confirmed by projecting these points on VR images (Fig. 1A and B). The distal height of VMO insertion was calculated as the percentage of the length between the uppermost point of the patella and the insertion site relative to total patella length on a sagittal MPR image through the center of the patella. The most distal portion of the VMO belly was also calculated in the same manner. The VMO fiber angle was measured from the most distal portion of the muscle belly relative to the long axis of the rectus femoris muscle in the AP view on VR images following a previously described goniometric technique using cadavers [13,15-17] (Fig. 2).

Descriptive statistics were generated for data on age, sex, height, weight, bony mass index (BMI), and femorotibial angle (FTA) as alignment. A linear regression analysis was performed between measurement data from the MDCT images, including fiber angle, height of insertion, and most distal portion of VMO, and patients' parameters. Average of the fiber angle, height of insertion, and most distal portion of VMO were statistically analyzed by Student *t* test. Probability less than 0.05 was considered significant, although the probability of a type I or type II error exists because of the small number of samples. Intrarater reliability test was carried out for all joints on consecutive days by the same researcher through the use of 1-way repeated measures analysis. Pearson correlation was also demonstrated between measurements regarding the fiber angle, height of insertion, and most distal portion of VMO.

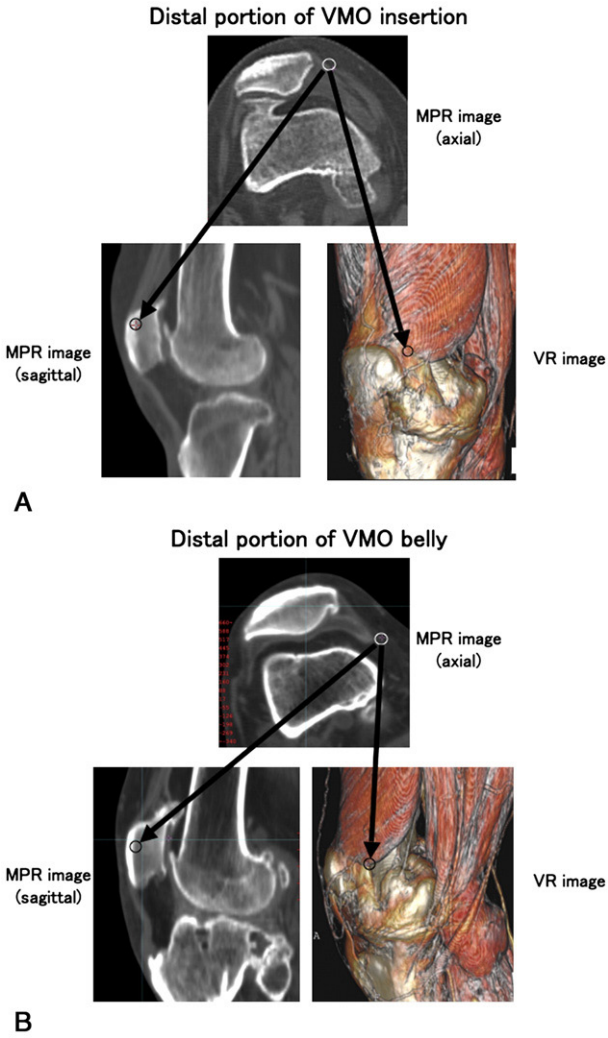

Fig. 1. Measurement of the distal site of insertion and muscle belly of VMO. A, *Distal portion of insertion* was defined as the height of the slice in which the VMO attached to the joint capsule. The insertion height was calculated as the percentage of the length between the uppermost point of the patella and the insertion site relative to the total patella length on a sagittal MPR image through the center of the patella. B, Measurement of distal portion of VMO belly.

Results

Data from the present study, including age, sex, height, weight, BMI, and FTA are summarized in Table 1. There was no significant difference