The effect of quadriceps force to the balance between quadriceps and patellar tendon

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Introduction. Several parameters have been proposed regarding elucidation of mechanical stability of the knee joint(1), (2). One of the parameters is the ratio of the patellar tendon force ($F_{pt}$) to the quadriceps tendon force ($F_q$). Tension of the quadriceps causes knee extension through the quadriceps tendon, patella and patellar tendon. The tension of the patellar tendon is caused by the tension of the quadriceps. The patellar tendon is slackened in the relaxed knee extension position, however there are no research describing this slackening process. The present study was carried out to clarify the influence of the tension of the patellar tendon on the ratio ($F_{pt}/F_q$).

Materials and methods. Nine healthy human subjects (6 male and 3 female) with no history of knee injuries participated in this study. Each right knee was imaged with the subject kept in supine position using a 3T MRI. We acquired 3D MR images of sagittal plane in the relaxed position. Multi slice cine MR images of sagittal plane were acquired in an extension position while asking the subject to contract and relax the quadriceps simultaneously. We corrected the motion of slice direction, using image registration with the 3D MR images. Insertion sites of the patellar tendon, at the patella, and the tibial tuberosity were defined using the 3D MR images. We calculated the insertion sites based on the coordinate system set for each bone while the patellar tendon was in tension. The length of the patellar tendon at rest was measured along the loosen patellar tendon. When the subject contracted the quadriceps, the patellar tendon was straighten and the length was measured taking the distance between two insertion sites. The moment arms of the quadriceps ($ma_q$) and the patellar ligament ($ma_{pt}$) were measured taking the perpendicular distances from the patellofemoral contact point to the respective tendons (Fig. 1). The $F_{pt}/F_q$ was indicated by $ma_q/ma_{pt}$.

Result and discussion. The patellar tendon was lengthened during the contracted state of the quadriceps and it was relaxed when the quadriceps was relaxed. Fig. 2 shows the relationship between the $F_{pt}/F_q$ when the patellar tendon was in relax and in tension. The $F_{pt}/F_q$ increased when the quadriceps was tensed. The $F_{pt}/F_q$ should be evalutated when the patellar tendon is in tension because the tension of the quadriceps transfers through the patellar tendon. The tension of the patellar tendon has not been considered in previous studies(1), (2) however, the $F_{pt}/F_q$ was about 6% large when the patellar tendon was in tension.

References.