Articularis genus muscle may retract the synovial suprapatellar bursa proximally during end-range of knee extension

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INTRODUCTION: The articularis genus muscle (AG) originates from the anterior surface of the distal femur and inserts into the proximal aspects of the suprapatellar bursa. The AG, vastus medialis (VM), and the medial half of vastus intermedius muscles (VI) are supplied by the same deep medial branch of the femoral nerve[1]. The AG retracts the synovial suprapatellar bursa proximally during knee extension with adjacent VI and VM muscles[1]. However, the functional role of the AG remains controversial because the AG is too small to retract the bursa. Some patients with knee osteoarthritis (OA) suffered from the loss of knee extension. In the imaging study, the skeletal muscle atrophy is caused by the disuse[2]. Thus, we hypothesized that the severe atrophy of the AG related with the loss of knee extension may be ascribed to the disuse of the AG. In other words, the AG may have a role in end-range of knee extension if the atrophy was found in relation to loss of knee extension. Therefore, this study investigated the effect of loss of knee extension on the muscle atrophy of AG.

METHODS: Forty-one patients with knee OA who were scheduled for total knee arthroplasty at our hospital were retrospectively obtained in this study. The loss of knee extension was measured with gonio-meter by experienced physical therapists. Subjects were classified into 3 groups based on the loss of passive knee extension angle as follows: control group (without loss of knee extension), mild loss of knee extension group (-5 to -10 degrees in knee extension), and severe loss of knee extension group (-15 to more degrees in knee extension). The cross-sectional area (CSA) of AG, quadriceps femoris muscle (QF), VI, and VM were measured using computed tomography image, at 50% of the femur and 15% proximal to the patellar, based on the muscle attenuation assessed with Hounsfield units (HU) as follows: total area (TA; -29 to 100 HU), skeletal muscle area (SMA; 0 to 100HU), normal density muscle area (NDMA; 35 to 100HU), low density muscle area (LDMA; 0 to 34 HU), and very low density muscle area (VLDMA; -29 to -1HU) as shown in ***Figure***. The ANOVA or Kruskall-wallis followed by the post hoc test were conducted to compare the CSA among groups.

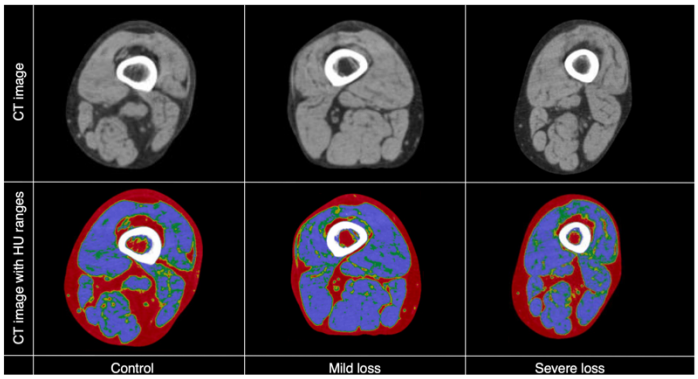

Figure CT images with HU ranges at 15% proximal to the patellar. *Red*: -190 to -30HU, *Yellow*: -29 to -1HU, *Green*: 0 to 34HU, *Blue*: 35 to 100HU, *White*: 101-1000HU.

RESULTS: Finally, 17 patients were classified into control group, 17 into mild loss group, and 7 into severe loss group. ***Table*** shows the CSA of AG, VI and VM muscles. There were no significant differences in CSA of QF, VI and VM among groups, respectively ($P > 0.098$). However, significant differences in CSA of AG among groups were found. Post hoc test revealed that the SMA and LDMA of AG in severe loss group were significantly less than control and mild loss groups ($P < 0.002$). TA and NDMA of AG in severe group were significantly less than that in control group ($P < 0.044$). There were no significant differences in VLDMA of AG among groups ($P > 0.084$).

DISCUSSION: The purpose of this study was to investigate the effect of loss of knee extension on muscle atrophy of AG. This study revealed that the AG in the severe loss of knee extension significantly atrophied than that in mild and control groups, while there were no significant differences in CSA of QF, VI, and VM among groups. Specific atrophy of the AG found in severe loss of knee extension group suggested the disuse of the AG. Therefore, the AG may have a functional role especially in end-range of knee extension.

SIGNIFICANCE/CLINICAL RELEVANCE: The insufficiency of AG may lead to anterior knee pain[3]. Special attention to the atrophy of AG should be paid for the patients with loss of knee extension.

REFERENCES: 1. Grob et al., JBJS. 2017. 2. Miokovic et al., J *Appl Physiol.* 2011. 3. Woodley et al., JBJS 2012.

Table CSA of AG, QF, VI, and VM in each group in relation to HU.

Parameter (cm2)	Control group, N = 17 (without knee extension loss)	Mild loss of knee extension group, N = 17 (-5 to -10 degrees in knee extension)	Severe loss of knee extension group, N = 7 (-15 or more degrees in knee extension)	P value
Articuralis genus muscle				
Total Area (-29 to 100HU)	0.89 ± 0.41	0.71 ± 0.21	0.43 ± 0.17	0.005
Skeletal muscle are (0 to 100HU)	0.40 ± 0.22	0.36 ± 0.17	0.11 ± 0.04	<0.001
Normal density muscle area (35 to 100HU)	0.09 ± 0.09	0.10 ± 0.10	0.03 ± 0.02	0.049
Low density muscle area (0 to 34HU))	0.31 ± 0.20	0.26 ± 0.12	0.08 ± 0.04	<0.001
Very low density muscle area (-29 to -1HU)	0.50 ± 0.23	0.34 ± 0.15	0.33 ± 0.17	0.046
Quadriceps femoris muscle				
Total Area (-29 to 100HU)	31.47 ± 5.80	35.74 ± 8.83	36.02 ± 7.98	0.205
Skeletal muscle are (0 to 100HU)	30.42 ± 5.99	34.44 ± 8.96	33.70 ± 8.14	0.301
Normal density muscle area (35 to 100HU)	25.53 ± 6.92	27.19 ± 9.69	24.90 ± 10.24	0.476
Low density muscle area (0 to 34HU))	6.89 ± 1.88	7.25 ± 3.38	8.80 ± 5.36	0.950
Very low density muscle area (-29 to -1HU)	1.05 ± 0.43	1.29 ± 0.95	2.31 ± 2.66	0.737
Vastus intermedius and medialis muscles				
Total Area (-29 to 100HU)	14.45 ± 3.11	16.73 ± 4.95	18.40 ± 4.81	0.098
Skeletal muscle are (0 to 100HU)	14.15 ± 3.25	16.38 ± 4.99	17.79 ± 4.74	0.131
Normal density muscle area (35 to 100HU)	11.01 ± 3.80	12.94 ± 5.15	13.63 ± 5.19	0.342
Low density muscle area (0 to 34HU))	3.14 ± 1.03	3.45 ± .1.54	4.16 ± 2.06	0.604
Very low density muscle area (-29 to -1HU)	0.30 ± 0.26	0.35 ± 0.46	0.61 ± 0.52	0.182