

Impact of Symptom Duration on Periarticular Muscle Atrophy and Fatty Degeneration in Patients with Unilateral Hip Osteoarthritis: An AI-Based Imaging Analysis

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INTRODUCTION: Hip osteoarthritis have been reported to exhibit muscle atrophy and fatty degeneration, both of which influence postoperative functional outcomes [1]. Traditionally, three-dimensional assessments of periarticular muscles around the hip and thigh have relied on manual segmentation. However, recent advances in artificial intelligence (AI) based imaging techniques allow automated three-dimensional quantification of muscle volume and fatty infiltration for each individual hip muscle [1-3]. While preoperative assessments of muscle atrophy and fatty degeneration have been conducted in patients with hip osteoarthritis, the relationship between the duration of pain and the extent of muscle atrophy and fatty degeneration in specific periarticular muscles remains unclear. Clarifying the relationship between pain duration and the degree of muscle atrophy and fatty degeneration in individual muscles may enable identification of target muscles for preoperative rehabilitation, using the duration of symptoms as a clinical guide. Therefore, the present study aimed to investigate the association between the duration of hip pain and the degree of muscle atrophy and fatty degeneration in individual muscles around the hip joint in patients with unilateral hip osteoarthritis using AI-based imaging technique.

METHODS: This study included 61 patients (11 men and 50 women) who underwent primary total hip arthroplasty (THA) for unilateral hip osteoarthritis at our institution between April 2020 and December 2021. The mean age at the time of surgery was 70.0 years (51-85 years), and the mean body mass index (BMI) was 24.6 kg/m² (18.7 -34.2 kg/m²). The interval from pain onset to surgery was recorded, and patients were stratified into short-term (<3 years, n=32) and long-term (≥3 years, n=29) groups. Preoperative computed tomography (CT) images was analyzed with AI-based software (Fig.1: [1, 3]) to quantify muscle volume (affected vs. contralateral side, %) and fatty degeneration by calculating the reduction of Hounsfield units (HU). The evaluated muscles included the psoas major, iliacus, gluteus maximus, gluteus medius, gluteus minimus, obturator externus, obturator internus, pectineus, piriformis, sartorius, adductor muscles, tensor fasciae latae, gracilis, semimembranosus, semitendinosus, biceps femoris, rectus femoris, vastus lateralis/intermedius, and vastus medialis. Comparisons of muscle atrophy and fatty degeneration between the groups were conducted using the Mann-Whitney U test. A p-value of <0.05 was considered statistically significant.

RESULTS SECTION: The mean pain duration was 3.2 years. Overall, the mean muscle atrophy on the affected side was 87.6%, and the average reduction in muscle density was 6.9 HU. Compared with the short-term group, the long-term group exhibited greater muscle atrophy (84.6% vs 90.2%) and fatty regeneration (-7.9 HU vs. -5.9HU). Significant muscle atrophy in the long-term group was observed in the iliacus, gluteus maximus, sartorius, adductor muscles, semimembranosus, semitendinosus, and vastus medialis (p < 0.05, Table.1). Significant fatty degeneration was detected in the iliacus, gluteus medius, gluteus minimus, obturator externus, pectineus, sartorius, and adductor muscles (p < 0.05, Table.1).

DISCUSSION: In this study, patients with unilateral hip osteoarthritis who experienced a longer interval between pain onset and surgery exhibited a mean reduction of 5.6% in muscle volume and a mean decrease of 2 HU in muscle density of the periarticular muscles compared with those with a shorter interval. Notably, the iliacus, sartorius, and adductor muscles demonstrated significant atrophy and fatty degeneration in the long-term group, indicating that prolonged symptom duration adversely affects both muscle mass and quality. However, the impact of symptom duration was not uniform across all hip muscles, as only certain muscles appeared particularly susceptible to these changes. Previous studies have shown that atrophy and fatty degeneration of the gluteal muscles are associated with early postoperative physical function after total hip arthroplasty, but no prior studies have evaluated the relationship between muscle degeneration and the time elapsed since pain onset. The present findings suggest that the degree of atrophy and fatty infiltration varies among individual muscles depending on symptom duration, and that the specific muscles requiring targeted rehabilitation may differ according to the length of time since pain onset.

SIGNIFICANCE/CLINICAL RELEVANCE: Longer pain duration before surgery is associated with greater atrophy and fatty degeneration in key periarticular muscles. Recognizing these changes may help guide individualized preoperative rehabilitation strategies to optimize recovery after total hip arthroplasty.

REFERENCES: [1] Iwasa M et al. IJCARS. 2025 [2] Ogawa T et al. JOS. 2020 [3] Iwasa M et al. IJCARS. 2023

IMAGES AND TABLES:

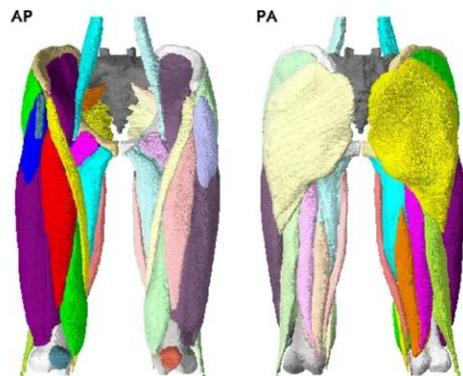


Fig.1 Three-dimensional models reconstructed from computed tomography images

Table.1 The muscle atrophy and fatty degenerations in each muscle around hip and thigh

	Muscle atrophy (%)				Fatty degeneration (HU)			
	Short-term group	Long-term group	Total	P value	Short-term group	Long-term group	Total	P value
psoas_majior	82.7	75.4	79.2	0.106	-4.7	-7.2	-5.9	0.078
iliacus	90.5	77.3	84.2	< 0.05*	-5.9	-9.2	-7.5	< 0.05*
gluteus_maximus	86.0	79.3	82.8	< 0.05*	-10.2	-13.9	-12.0	0.053
gluteus_medius	87.3	83.1	85.3	0.091	-9.1	-13.1	-11.0	< 0.05*
gluteus_minimus	93.6	92.4	93.0	0.965	-12.2	-17.1	-14.5	< 0.05*
obturator_externus	98.9	94.7	96.9	0.236	-9.2	-13.6	-11.3	< 0.05*
obturator_internus	91.1	86.3	88.8	0.179	-6.8	-7.2	-7.0	0.828
pectineus	95.2	89.6	92.5	0.109	-4.7	-7.8	-6.1	< 0.05*
piriformis	87.4	79.6	83.7	0.076	-6.1	-8.2	-7.1	0.078
sartorius	99.7	92.1	96.1	< 0.05*	-1.2	-3.5	-2.3	< 0.05*
adductor_muscles	83.1	74.2	78.9	< 0.05*	-7.1	-10.5	-8.7	< 0.05*
tensor_fasciae_latae	100.3	99.6	99.9	0.885	-6.7	-7.8	-7.2	0.644
gracilis	89.9	83.4	86.8	0.236	-3.4	-4.7	-4.0	0.488
semimembranosus	90.0	81.4	85.9	< 0.05*	-6.2	-6.5	-6.4	0.817
semitendinosus	91.8	91.9	91.9	< 0.05*	-2.9	-3.7	-3.3	0.209
biceps_femoris	88.6	86.3	87.5	0.535	-3.8	-4.2	-4.0	0.795
rectus_femoris	83.4	78.7	81.2	0.153	-2.5	-3.2	-2.8	0.242
vastus_lateralis_intermedius	89.2	84.7	87.0	0.097	-5.2	-4.8	-5.0	0.634
vastus_medialis	85.4	78.1	81.9	< 0.05*	-4.7	-4.4	-4.6	0.333
Total	90.2	84.6	87.6		-5.9	-7.9	-6.9	

Data are presented as means
*Statistically significant difference
P values were calculated with Mann-Whitney U-test