Clinical Study

# The fatty degeneration of lumbar paraspinal muscles on computed tomography scan according to age and disc level

Shin Heon Lee, MD[a], Seung Won Park, MD, PhD[a,*], Young Baeg Kim, MD, PhD[a],
Taek Kyun Nam, MD, PhD[a], Young Seok Lee, MD[b]

[a]*Department of Neurosurgery, College of Medicine, Chung-Ang University Hospital, 102 Heukseok-ro, Dongjak-gu, Seoul, 156-755, Republic of Korea*
[b]*Department of Neurosurgery, College of Medicine, Gyeongsang National University, 79 Gangnam-ro, Jinju-si, Gyeongsangnam-do, 660-702, Republic of Korea*

**Abstract**

**BACKGROUND CONTEXT:** Spinal degeneration can occur not only in the bone and disc but also in muscles. Fatty infiltration (FI) and decreased volume have been described as characteristic changes that occur in muscle degeneration. Many studies about the lumbar paraspinal muscles have been conducted on patients with spine problems. However, the natural changes of age-dependent degeneration in the paraspinal muscles have not been studied properly.

**PURPOSE:** The purpose of this study is to investigate age- and level-dependent changes of the lumbar paraspinal muscles in the population without lumbar spinal symptoms.

**STUDY DESIGN:** This study is a retrospective case-control study.

**PATIENT SAMPLE:** A total of 887 patients who underwent computed tomography scan for abdomen and pelvis (APCT) between January 2013 and December 2013 were enrolled. After excluding 237 patients with medical history of spine surgery, low back pain, myopathy, muscular dystrophy, infectious disease, vertebral fracture, and deformity, 650 patients were finally subjected to this study.

**OUTCOME MEASURE:** The patients were divided into three age groups: young (20–39 years old), middle (40–59 years old), and old (60–89 years old). The degree of FI was checked twice for multifidus muscle (MF), erector spinae muscle (ES), and psoas muscle (PS) at each disc level from L1 to S1 on APCT by two investigators. The FI was measured as the Hounsfield unit, a mean density (MD) on CT.

**METHODS:** The age differences were compared with the data of the young group, and the level differences were compared with the data of the L1–L2 level. Student $t$ test and intraclass correlation coefficient were checked for statistical analysis.

**RESULTS:** The gender ratio was not significantly different among the groups. Comparing with the young group, the MD of MF significantly decreased at L5–S1 in the middle group (p<.05), and at L3–L4–L5–S1 in the old group (p<.05). The MD of ES was significantly decreased at all levels in the old group (p<.05) but not significant in the middle group. Comparing with the L1–L2 level, the MD of MF significantly decreased at L5–S1 in the middle group (p<.05) and at L4–L5–S1 in the old group (p<.05). The MD of ES was significantly decreased at L5–S1 in the young and middle groups (p<.05) and at L4–L5–S1 in the old group (p<.01) compared with those at L1–L2. According to the age- and level-dependent changes of MD in the MF and ES, there was a tendency of progressive increase of FI in the muscles with age, which seemed to start from L5–S1 and spread to the upper levels. The age-dependent fatty degeneration appeared wider in the ES than the MF. The level-dependent FI of the ES showed a similar pattern with the MF, but the change of the ES seemed to start earlier in age than the MF at the L5–S1. There was no significant MD change in the PS according to age and level. Intraobserver and interobserver reliabilities were both high across all of the muscles (0.86–0.94 and 0.83–0.92).

---

**CONCLUSIONS:** As a result, the degree of intramuscular fat infiltration seems to be affected by age, disc level, and muscle type. It seems to be more prominent in the extensor muscles, extending from lower to upper levels.   © 2016 Elsevier Inc. All rights reserved.

## Introduction

Age-related changes are important medical and socioeconomic concerns of modern society [1]. Spinal degeneration, one of the results of the aging process, can result in a lower quality of life in old age [2]. Studies of degenerative spinal changes to date have focused on the bone and joint of the spine [3]. However, studies on the spinal muscular biomechanics have shown that age-related changes occur not only in the skeletal system but also in the muscles [4–8]. Fatty infiltration and muscle atrophy have been described as characteristic changes that occur in muscle degeneration [9]. Many studies about the lumbar paraspinal muscles have been conducted on patients with spine problems, which were not designed to understand the muscular changes according to the aging process [10–15]. Patients with spinal symptoms may have more spinal degeneration than the non-symptomatic population. Therefore, the natural changes of age-dependent degeneration in the paraspinal muscles have not been studied properly. In the present study, we tried to investigate age-dependent changes of the lumbar paraspinal muscles at each lumbar disc level in the population without lumbar spinal symptoms.

## Materials and methods

This study was conducted on 887 patients who underwent computed tomography of the abdomen and pelvis (APCT) as a part of regular health checkup at Chung-Ang University Hospital between January 2013 and December 2013. A retrospective study was conducted on 650 patients after excluding 237 patients (63 with previous spinal surgery, 152 with medical record histories of back pain or radicular leg pain, and 22 with other conditions such as myopathy, muscular dystrophy, infectious disease, vertebral fracture, or deformity) according to their medical records. They were divided into three groups by age: young group (20–39 years old), middle group (40–59 years old), and old group (60–89 years old).

The APCT images (Brilliance iCT; Philips Healthcare, Cleveland, OH) were used to measure the mean density, as the Hounsfield units, of the paraspinal muscles. The mean density reflects the degree of intramuscular fat content because the Hounsfield unit values decreased as the fat content increased. Before each CT scan, a calibration was performed by using air as the standard. Patients underwent CT scanning on a supine position with a 120-KV and 150-mA protocol. The cross sectional images of the entire abdomen were obtained at 3-mm intervals, which included cross sectional images of paraspinal muscles of the lumbosacral area.
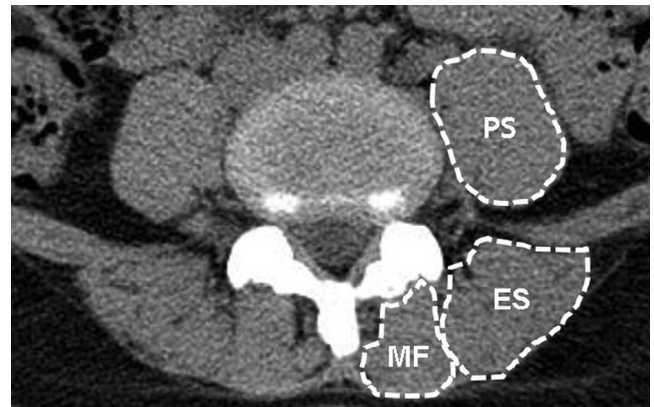


Fig. 1. Boundaries of multifidus, erector spinae, and psoas muscles on abdominopelvic computed tomography at the L4–L5 disc level.

The mean densities of the multifidus (MF), erector spinae (ES), and psoas (PS) muscles were measured at the five disc levels from L1 to S1 (Fig. 1). The ES muscle compartment was composed of the longissimus thoracis and iliocostalis lumborum muscles. The region of interest calculator of the picture archiving and communication system (Maroview version 5.4, Marotech Inc, Seoul, Korea) was used to measure the mean densities bilaterally and to calculate the mean value. Two surgeons (SHL and SWP) measured two times respectively, and the mean values were used for analysis. For checking the age-dependent changes, the mean densities of the muscles in the middle and old groups were compared with those of the young group at each disc level. For the level-dependent changes, the mean densities of the muscles at L2–L3–L4–L5–S1 levels were compared with those of the L1–L2 level in each group.

Student $t$ test was used to test for statistical significance at a level of $p < .05$. All measurements by the two doctors were performed two times with a 2-week interval to assess the reliability of the measurements. The intraobserver and interobserver intraclass correlation coefficients were calculated for the mean density measurements of the paraspinal muscles [16].

## Results

The mean ages and gender ratios (male:female) were $32.7 \pm 5.3$ and 1:0.8, $53.3 \pm 5.2$ and 1:0.8, and $77.8 \pm 8.1$ and 1:1.1 in the young, middle, and old groups, respectively. There was no statistically significant difference in the mean age and gender ratio among the three groups (Table).