



Original Article

Inter-rater reliability between two examiners with different professional roles in the evaluation of fat infiltration in the lumbar paraspinal muscles using magnetic resonance imaging

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Abstract. [Purpose] To clarify the inter-rater reliability of the evaluation criteria for paraspinal muscle fat infiltration on magnetic resonance images between two examiners with different professional roles in interdisciplinary physical therapy teams. [Participants and Methods] In this retrospective study, we reviewed the clinical data of 225 patients with degenerative lumbar diseases who underwent posterior lumbar surgery at our hospital. A physical therapist and a spinal surgeon visually quantified fat infiltration of the multifidus muscles at the level of L4/5 on the preoperative magnetic resonance images of the patients using Kjaer's criteria (Grade 0: 0–10%, Grade 1: 10–50%, and Grade 2: >50%). We used the kappa coefficient to assess inter-rater reliability. [Results] The participants included 142 males and 83 females (mean age, 64.7 years; range, 21–89 years). The number of patients with grades 0/1/2 were 50/160/15, respectively, for examiner 1; and 59/155/11, respectively, for examiner 2. The kappa coefficient was 0.69, indicating a substantial agreement. [Conclusion] Our study, which is the first to assess the inter-rater reliability of Kjaer's criteria between examiners with different medical occupations, revealed that these criteria could be a reliable tool for evaluating fat infiltration in the multifidus muscles and sharing information between interdisciplinary physical therapy teams.

Key words: Fat infiltration, Inter-observer variability, Paraspinal muscles

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INTRODUCTION

As part of the aging process, both males and females experience a decrease of 20% to 40% of their maximal muscle strength by the time they are in their 70s and 80s¹⁾. In recent years, musculoskeletal muscle evaluation has evolved from the quantitative evaluation of muscle strength and muscle volume to include qualitative assessments, such as fat infiltration of muscle tissue. Muscle strength and fat infiltration of muscles play an important role in individuals performing activities of daily living (ADL) and when following hobbies, and these parameters are frequently evaluated in clinical physical therapy settings. According to the Asian Working Group of Sarcopenia²⁾, sarcopenia is the age-related loss of muscle mass as well as characterized by low muscle strength and/or low physical performance, which results in decreased muscle cross-sectional area and increased fat infiltration of the muscles^{3, 4)}. Fat infiltration of the lumbar erector spinae muscle has been reported to be substantially associated with aging⁵⁾. Multifidus fat infiltration is involved in low back pain⁶⁾ and lumbar dysfunction⁷⁾

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and may contribute to a decrease in both the ADL and quality of life of patients. Therefore, it is important to evaluate the degree of fat infiltration of the lumbar paraspinal muscles. The fat infiltration rate is not reflected in the body mass index⁸⁾ but needs to be examined at a medical institution. Ultrasound⁹⁾, computer tomography¹⁰⁾, magnetic resonance imaging (MRI)^{6, 7)}, and magnetic resonance spectroscopy^{6, 11)} have been used to evaluate the fat infiltration of the erector spinae muscles. Kjaer et al.¹²⁾ described a method of grading the fat infiltration using MRI, which is commonly used in clinical settings^{7, 13)}. This grading method is a simplified visual evaluation and is considered to be useful not only for medical doctors but also for physiotherapists who want to evaluate the fat infiltration of paraspinal muscles. However, the inter-rater reliability of Kjaer's criteria in the evaluation of the fat infiltration of paraspinal muscles between examiners of different medical occupations within the field of physical therapy has not been examined to date. If the evaluation of fat infiltration of paraspinal muscles using the criteria has good inter-rater reliability between a physiotherapist and a spinal surgeon, the evaluation by a physiotherapist may contribute to the improvement of quality in the preoperative evaluation of physical function and postoperative rehabilitation for patients undergoing spinal surgeries.

Therefore, the purpose of this study was to investigate the inter-rater reliability of these criteria between a spinal surgeon and a physiotherapist in assessing fat infiltration of the multifidus muscle in patients with lumbar degenerative diseases. To the best of our knowledge, this is the first study to investigate the reliability of these criteria in such a multidisciplinary setting.

PARTICIPANTS AND METHODS

We retrospectively reviewed the clinical data of adult (≥ 18 years) patients who had undergone posterior lumbar spinal surgery (conventional open decompression and/or fusion procedures) for degenerative lumbar diseases (spinal canal stenosis and/or lumbar disc hernia) from July 2013 to June 2017 at the orthopedic department of our hospital. Patients who underwent revision lumbar surgery were excluded from this study. We also excluded patients aged < 18 years and those who underwent posterior instrumentation removal and percutaneous vertebroplasty to ensure homogeneity of the study group. Based on the exclusion criteria, 225 patients were finally analyzed.

The patients' MRI performed prior to their lumbar surgeries as part of the medical diagnostic procedures was used for the purpose of this study. We used patients' axial T2-weighted MR images at the level of L4–5 to determine fat infiltration of the lumbar multifidus muscles because there have been several reports that the Kjaer's criteria (originally using T1-weighted MR images) were used for evaluation of fat infiltration with axial T2-weighted images^{13–16)}; furthermore, it has been reported that either (T1-weighted or T2-weighted) MRI sequence could be used interchangeably for this purpose¹⁷⁾. In the current analysis, preoperative MRI of all the enrolled participants was evaluated by two examiners: a physiotherapist (with seven years of clinical experience) and a spinal surgeon (with 21 years of experience as a medical doctor).

According to the criteria that Kjaer et al. proposed¹²⁾, the fat infiltration in the lumbar erector spinae muscles was visually evaluated and assigned to either of the three grades (Fig. 1):

- Grade 0 (0–10% fat infiltration)
- Grade 1 (10–50% fat infiltration), and
- Grade 2 (>50% fat infiltration).

This study was approved by the institutional review board of Saitama Medical Center, Saitama Medical University (No. 1969-II). Because of the retrospective nature of this study, the requirement for written informed consent was waived by the institutional review board. Information on opt-out was posted on the website of Saitama Medical Center, Saitama Medical University.

All data were represented as the mean \pm standard deviation (SD).

Data were analyzed with the statistical software R. To evaluate the inter-rater reliability, the kappa coefficient κ was calculated for the grading of each patient by the two examiners.

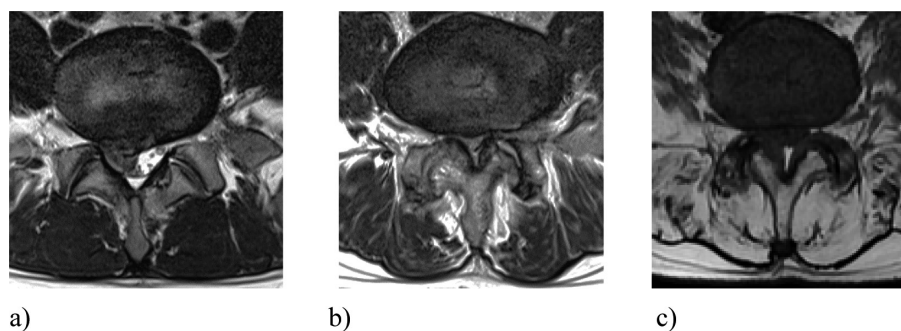


Fig. 1. The grading method of L4/5 fat infiltration on T2-weighted magnetic resonance imaging used in this study of 225 patients with degenerative lumbar spine disease: Fat infiltration rated as a) Grade 0 in the absence of fatty degeneration (0–10%); b) Grade 1 in the case of slight fat infiltration (10–50%); and c) Grade 2 in the case of severe fat infiltration (>50%).

RESULTS

The study population consisted of 142 males and 83 females with a mean age of 64.7 years (range 21–89 years; mean height 160.59 ± 9.44 cm; mean weight 63.08 ± 13.04 kg). The number of patients with grades 0, 1, and 2 for examiner one was 50, 160, and 15, respectively, and that for examiner two was 59, 155, and 11, respectively (Table 1). The age (mean \pm SD) of the patients with grades 0, 1, and 2 for examiner one was 55.05 ± 19.1 , 67.45 ± 11.7 , and 77.27 ± 4.6 years, respectively, and that for examiner two was 53.06 ± 19.4 , 67.22 ± 11.9 , and 76.33 ± 4.8 years, respectively (Table 2). The number of male/female patients with grades 0, 1, and 2 for examiner one was 49/10, 91/64, and 2/9, respectively, and that for examiner two was 43/7, 97/63, and 2/13, respectively (Table 3).

The kappa coefficient of inter-rater reliability of the grade of fat infiltration was 0.69 ($p < 0.001$), which corresponds to a substantial agreement between the raters.

DISCUSSION

Low back pain is commonly prevalent, affecting 65–85% of the world population at some point in their life¹⁸. Age, physical condition, weight, and low back pain can affect the cross-sectional area and density of the erector spinae muscles^{19, 20}. Studies reported that patients with acute or chronic low back pain had smaller erector spinae muscles than healthy participants^{21–24}. Fat infiltration of the multifidus muscles is related to low back pain⁶, and patients with low back pain showed significantly more fat infiltration of the erector spinae muscles than healthy participants^{25, 26}. It has also been suggested that fat infiltration of the paraspinal muscles is associated more with older age and female gender²⁷ and that dysfunction of the lumbar region causes pain and eventually fat infiltration^{10, 28}. As mentioned earlier, fat infiltration of the multifidus may be associated with low back pain and decreased ADL in patients. Hence, there is a need for a simple and reliable method for assessing the grade of this fat infiltration in clinical settings. Sorensen et al.²⁹ described the inter-observer reliability among radiologists in the assessment of paraspinal muscle fat infiltration in adult patients using MRI and Kjaer's criteria as substantial agreement ($\kappa = 0.58$). The results of the current study ($\kappa = 0.69$) demonstrate substantial agreement in the assessment

Table 1. The number of patients for each grade of fat infiltration determined by two examiners among 225 patients with lumbar degenerative disease

	Examiner 1 (n)	Examiner 2 (n)
Grade 0	50	59
Grade 1	160	155
Grade 2	15	11

Grades refer to Kjaer's criteria (Grade 0: 0–10%, Grade 1: 10–50%, and Grade 2: >50%).

Table 2. The age of 225 patients (mean age 64.68 ± 15.1 years) distinguished by the different grades of fat infiltration in the lumbar muscles and grouped per examiner who assessed the images

	Examiner 1	Examiner 2
Grade 0 (years)	55.05 ± 19.1	53.06 ± 19.4
Grade 1 (years)	67.45 ± 11.7	67.22 ± 11.9
Grade 2 (years)	77.27 ± 4.6	76.33 ± 4.8

Data are presented as the mean \pm standard deviation. Grades refer to Kjaer's criteria (Grade 0: 0–10%, Grade 1: 10–50%, and Grade 2: >50%).

Table 3. The number and gender of participants (total 142 males/83 females) distinguished for each grade of fat infiltration between both examiners

	Examiner 1 (n)	Examiner 2 (n)
Grade 0 (male/female)	49/10	43/7
Grade 1 (male/female)	91/64	97/63
Grade 2 (male/female)	2/9	2/13

Grades refer to Kjaer's criteria (Grade 0: 0–10%, Grade 1: 10–50%, and Grade 2: >50%).

of fat infiltration into the paraspinal muscles between a physiotherapist and a surgeon³⁰), which compares favorably with the inter-rater reliability among radiologists²⁹). Generally, spine surgeons are experienced in the evaluation of spinal MRIs in their daily clinical routine, whereas physiotherapists are not commonly exposed to evaluating spinal MRIs. Therefore, considering the differences between the expertise of physical therapists and spinal surgeons, inter-rater reliability comparable to that among radiologists is remarkable²⁹). The classification of Kjaer appears as a simple and highly reliable evaluation method for examiners of different professional backgrounds and may be very useful for sharing information between different professionals with varying roles in interdisciplinary physical therapy teams.

The limitation of this study is that, since the participants were surgical patients comprising many elderly patients with highly degenerated lumbar spines, our study population may be biased compared to a normal healthy population. The strength of this study is that it analyzed data from a relatively large number of patients.

In conclusion, Kjaer's criteria can be used by examiners of different medical occupations who achieve inter-rater reliability that is comparable to that among radiologists ($\kappa=0.69$). Kjaer's criteria may be considered a simple, reliable, and useful method for sharing information among different professionals in daily physical therapy routines.

Funding and Conflict of interest

We have no financial relationships to disclose and no conflicts of interest to declare.

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