

Development of Semi-quantitative Radiographic Evaluation for Cervical Spondylosis

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INTRODUCTION: Cervical spondylosis is a common age-related spinal condition and most commonly presents as neck pain, which is one of the most common symptoms related to musculoskeletal disorders and its lifetime prevalence is approximately 48.5% (14.2-71.0%) [1]. Cervical spine radiograph is a common and first-choice screening tool for cervical spondylosis, whose radiographic features include osteophyte (OP), disc height narrowing (DHN), vertebral sclerosis (VS) and spondylolisthesis (SL). The Kellgren Lawrence (KL) classification is a widely used semi-quantitative method for evaluating musculoskeletal radiographs including knee, hip, and spine [2]. However, KL classification comprehensively evaluates the extent of spondylosis and is difficult to evaluate the individual radiographic features of spondylosis with. We have established a novel elemental grading system based on the KL classification that can individually score according to the extent of OP, DHN, VS and SL and reported that its evaluation of lumbar radiograph would more accurately reflect the LBP of the subject compared to KL classification [3]. The purpose of this study was to develop an elemental grading system for an evaluation of cervical spine radiographs.

METHODS: 320 participants (119 men, 201 women, mean age 71.6 ± 10.2 years old) of medical examination in a typical Japanese mountain village (Ohdai-cho, Mie prefecture, Japan) were the subjects of this study. This study was conducted with the approval of the Institutional Committee for the Ethics of Human Research, and all participants provided written informed consent before enrollment in the study.

Clinical interview: Subjects completed an interviewer-administered questionnaire that included information on age, gender and the presence of neck pain. Subjects were divided into two groups as neck pain- or neck pain+.

Radiographic assessment: Lateral cervical spine radiographs from C2/C3 to C6/C7 of each subject were obtained in the standing position during the medical examination. Radiographic features related to cervical spondylosis, including OP, DHN, VS, and SL, were separately graded and classified into three groups: grade 0, normal; grade 1, mild change; and grade 2, severe change (Fig 1). Specifically, OP was classified as grade 0, normal; grade 1, minimal anterior vertebral osteophytosis; and grade 2, definite vertebral osteophytosis. DHN was classified as grade 0, normal; grade 1, mild (less than 1/2 of estimated disc height) DHN; and grade 2, severe (equal to or more than 1/2 of estimated disc height) DHN. VS was classified into grade 0, normal; grade 1, mild and small (less than 1/2 of anteroposterior diameter) sclerosis; and grade 2, severe or large (equal to or more than 1/2 of anteroposterior diameter) sclerosis. SL was classified into grade 0, normal; grade 1, Meyerding [4] grade I; and grade 2, Meyerding grade II or worse. The sum of the grades of each radiographic feature at each intervertebral level was designated as the intervertebral grade (IG). Lateral cervical radiographs were also evaluated using the KL classification according to a previous report [2, 5]. The average grades of each radiographic feature (OP, DHN, VS and SL), IG and KL of the whole cervical spine (from C2/C3 to C6/C7) was defined as 'wOP', 'wDHN', 'wVS', 'wSL', 'wIG' and 'wKL'. Inter-observer reliability between two board-certified orthopedic surgeons (JY and NT) was examined using radiographs of 33 (10% of the subjects) randomly selected participants as well as intra-observer reliability examination (JY-JY).

Statistical analysis: Intra-, inter-observer reliability and reproducibility was evaluated by Kappa coefficient. Mann-Whitney analysis was used for radiographic grades between the neck pain- and neck pain+ groups. Chi-square test was performed to evaluate the percentage of the radiographic features.

RESULTS SECTION: The intra-observer reliability coefficients of OP, DHN, VS, SL, IG, and KL were ranging from 0.80 to 0.90, which indicated a strong reliability. The inter-observer Kappa coefficients also showed strong reliability for OP, DHN and VS evaluation (0.82-0.87) and evaluation of cervical spondylosis (IG: 0.74, KL: 0.81, respectively).

Distribution of grade 1 and 2 in OP, DHN and VS were observed the most frequently in C5/C6 level followed by C4/C5 and C6/C7 level while significantly higher SL grade than expected was found in C4/C5.

94 subjects (29.4%) reported their neck pain. Age, gender ratio, height, weight and BMI were not significantly different between the neck pain- and neck pain+ groups. Whole cervical analysis showed significantly higher grades of wOP, wDHN, wVS, wIG and wKL in men were significantly higher than in women ($P < 0.05$). The subjects with neck pain showed significantly higher wVS ($P < 0.05$) than those without neck pain while wOP, wDHN, wSL, wIG or wKL showed no significant differences between the neck pain- and neck pain+ groups (Fig.2).

DISCUSSION: In this study, approximately 30% elderly inhabitants in the Japanese mountain village demonstrated their neck pain. Radiographic degenerative changes of cervical spine, except for SL, were significantly frequent in men as well as that of lumbar spine [3]. This elemental grading system showed significantly higher VS grades in the neck pain+ group than in the neck pain- group. In the previous study, logistic regression analysis showed that VS in the lumbar spine evaluated by elemental grading system was significantly associated with low back pain, implying the association of VS with severe lumbar spondylosis [3]. This study also showed most of VS grades were accompanied with grade 2 OP and grade 2 DHN. The KL classification did not show any significant difference. Therefore, elemental grading system would contribute to the more accurate evaluation of severity of cervical spondylosis and understanding of the patients' neck pain.

SIGNIFICANCE/CLINICAL RELEVANCE: We have developed an elemental grading system for radiographic cervical spondylosis that can individually evaluate each degenerative feature. Vertebral sclerosis reflects the neck pain of the subjects.

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