—Short Communication—

Development and Verification of Educational Material for Plain Radiographic Diagnosis of Bone Metastasis: A Preliminary Report

Yasuyuki Kitagawa, Takashi Yamaoka, Mari Yokouchi,
Toshihiko Ito, Yoshihiro Mizuno, Yoshihiro Sudo,
Yong Kim, Ryu Tsunoda and Shinro Takai

Department of Orthopaedic Surgery, Nippon Medical School Hospital, Tokyo, Japan

Our previous studies showed that early diagnosis of painful bone metastasis is difficult and requires improvement in the diagnostic accuracy of plain radiography during an initial patient consultation. In this preliminary study, we evaluate the usefulness of educational material used to improve diagnosis of bone metastasis with plain radiography. This study included imaging data from 129 consecutive patients who visited our orthopedic clinic during the period January 2011 through December 2014. First, we prepared a test to measure the reading ability of orthopedic practitioners, after which the educational material was created. Then, the effectiveness of the educational material was verified by having orthopedic trainees take a pre-test and post-test. The test contained plain radiographic data from 12 patients with lesions and 6 without lesions. The educational material included plain radiographic data from 30 patients with typical findings of bone metastasis, as well as diagnostic magnetic resonance images or computed tomography scans, accompanied by a lecture. The accuracy and sensitivity of diagnosis significantly improved after the lecture; however, specificity decreased. Although the educational material was effective for improving the ability of orthopedic trainees to read plain radiographs of bone metastasis, some aspects of the program need to be improved and revised.
(J Nippon Med Sch 2019; 86: 307–309)

Key words: educational material, plain radiography, bone metastasis, test, practitioner

Introduction

In 2012 the incidence of cancer in Japan was about 2.5 times that in 1985. The incidence of bone metastasis is also increasing, and development of methods of diagnosing it is an urgent issue for orthopedic practitioners[1]. We previously reported that early diagnosis of painful bone metastasis is difficult and requires improvement in the diagnostic accuracy of plain radiography during an initial patient consultation[2,3]. However, no existing educational materials focus on improving interpretation of plain radiography of bone metastasis. We prepared a test to evaluate the reading ability of orthopedic practitioners and developed educational material aimed at improving reading of plain radiographs, specifically for diagnosing bone metastasis. The effectiveness of the educational material was verified by pre- and post-testing of orthopedic trainees.

Materials and Methods

This retrospective study was approved by our institutional review board and conducted in accordance with the Declaration of Helsinki.

Subjects

A consecutive series of 129 patients was selected by retrospective review of our institutional database of all patients with bone metastasis who visited our clinic for symptoms related to first incidence of bone metastasis during the period January 2011 through December 2014.

First, using a plain radiographic data set of bone metastasis that had been created in our previous study, we developed a simple test with a high discrimination index for physician reading ability of plain radiographic findings of bone metastasis[3]. In the present study, the discrimination index of patient data in the original plain radiographic data set was calculated by using the results of a blind evaluation in the previous study[3]. Data with a

Correspondence to Yasuyuki Kitagawa, MD, Department of Orthopaedic Surgery, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8603, Japan
E-mail: kitayasu@nms.ac.jp
https://doi.org/10.1272/jnms.JNMS.2019_86-506
Journal Website (https://www.nms.ac.jp/sh/jmanms/)

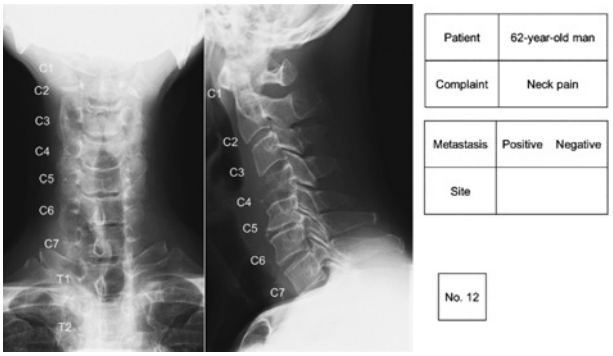

Fig. 1 Screenshot of test slide. The test was created with Microsoft PowerPoint, and each slide contains plain radiographic data and a clinical summary for 1 patient.

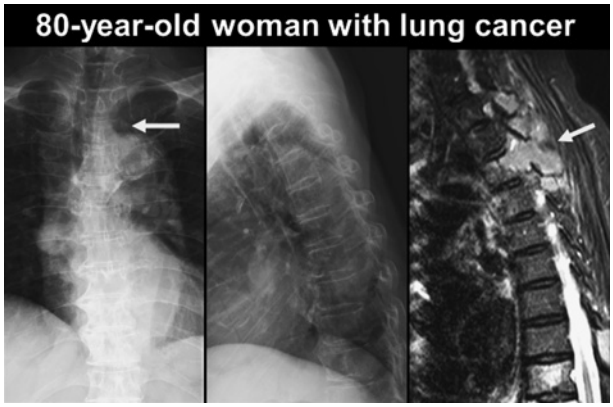

Fig. 2 Screenshot of lecture material. Plain radiographic data, a clinical summary, and magnetic resonance imaging or computed tomography scans that support a diagnosis of bone metastasis are shown side by side on a screen (arrows).

discrimination index of 0.2 or higher were extracted[4]. The discrimination index was calculated by using a simplified formula in which with the number of the highest 27% of doctors, based on their score result, and the number of the lowest 27% of doctors are represented as n_1 and n_2, respectively. The numbers of doctors who answered correctly among the highest 27% and lowest 27% of doctors are represented as a and b, respectively[5], as follows:

Discrimination index = $a / n_1 - b / n_2$

Second, from plain radiographic data files of bone metastasis of 129 patients with bone metastasis, 30 plain radiographic data sets with findings typical of bone metastasis were randomly extracted, excluding data that were used in the test. The educational material was created from plain radiographs, clinical data, and magnetic resonance imaging (MRI) or computed tomography (CT) findings, which supported a diagnosis of bone metastasis.

Third, the effectiveness of the educational material was verified by having 6 orthopedic trainees take a pre-test and post-test. During the lecture that used the educational material, trainees were shown plain radiographs of each case of bone metastasis, and a random participant was asked to identify the site of bone metastasis. Then, the lecturer displayed the correct answer on the images and showed the MRI or CT scans that supported the diagnosis, next to the plain radiographs. During testing, examinees individually evaluated the data and classified the case as "bone metastasis or bone metastasis highly suspected" or "other" within 1 minute, for each case. If "bone metastasis or bone metastasis highly suspected" was selected, the lesion site was also identified. Incorrect identification of the lesion site was regarded as an incorrect answer.

Statistical Analysis

The diagnostic results of the pre- and post-tests were compared with the Wilcoxon signed-rank test. A two-sided p-value of <0.05 was considered significant.

Results

The present test used plain radiographic data from 18 patients: 12 with depicted lesions and 6 without depicted lesions. The theoretical discrimination index of the present test (mean 0.49, range 0.33 to 0.83) was significantly higher than that of a previous test (mean 0.18, range −0.50 to 0.83). The present test mainly consisted of anteroposterior and lateral plain radiographs and a clinical summary (age, sex, and chief complaint) (**Fig. 1**).

The educational material mainly included anteroposterior and lateral plain radiographs, brief clinical information (age, sex, and primary lesion site), and MRI or CT scans, which were shown side by side on a screen (**Fig. 2**). The site of metastasis was the spine in 13 patients and other sites in 17. Twenty-five patients had osteolytic lesions, 4 had osteoblastic lesions, and 1 had a mixed lesion.

The examinees included 2 medical doctors, each with 14 months of post-residency experience in orthopedic surgery, and 4 other medical doctors, each with 2 months of post-residency experience in orthopedic surgery. The diagnostic results of the pre-test and post-test are shown in **Figure 3A-C**. The accuracy and sensitivity of diagnosis significantly improved after the lecture using the educational materials; however, specificity decreased in half the examinees.

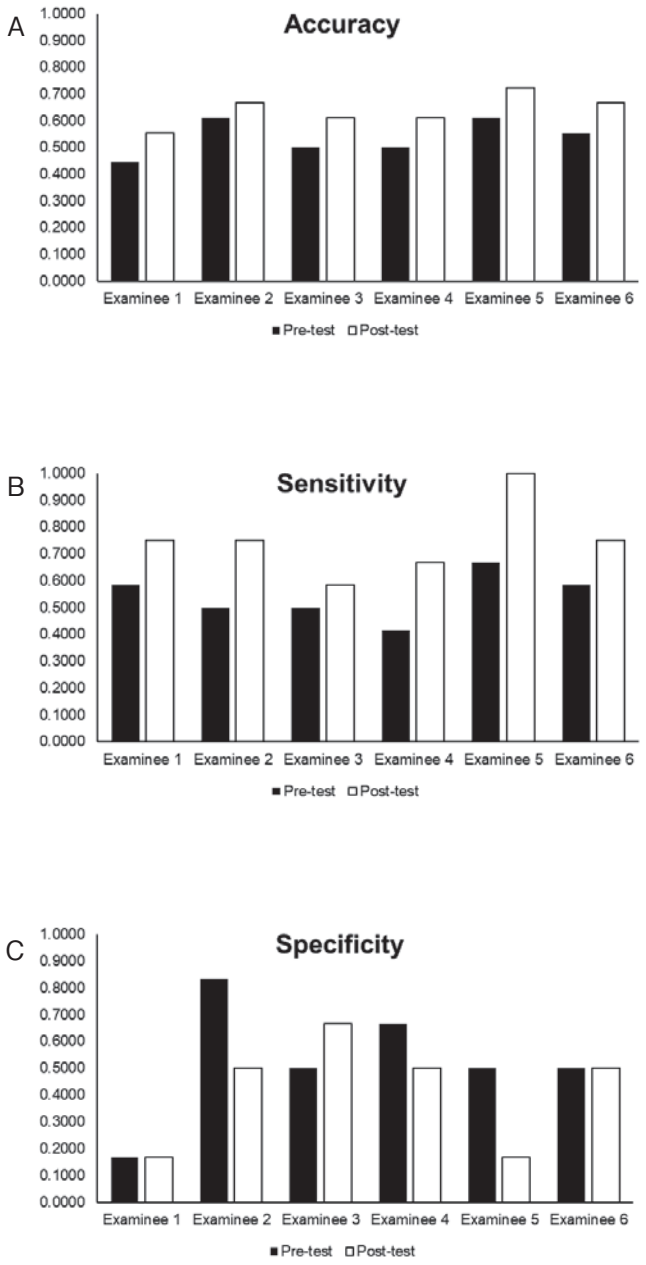

Fig. 3 Diagnostic accuracy (A) and sensitivity (B) significantly improved after the lecture using the educational materials; however, specificity (C) decreased in half the examinees.

Discussion

The present results suggest that the present educational materials improved the ability of orthopedic practitioners to use plain radiographs to diagnose bone metastasis. Viewing various plain radiographs seemed to be effective in improving their ability to identify bone metastases.

The post-test results showed improved diagnostic accuracy and sensitivity in all orthopedic examinees; however, specificity decreased in some examinees. This decreased specificity may have been caused by hyperawareness of bone intensity and contours, after viewing many different images of bone metastasis. A previous study reported that the sensitivity of post-test results increased when the proportion of abnormal cases in the educational material was high and that specificity increased when the proportion of abnormal cases was low[6]. To limit the decline in the post-test results of our educational material, it may be necessary to display plain radiographs of normal bone and non-bone metastatic disease that must be differentiated from bone metastasis. After increasing the proportion of cases of non-bone metastasis cases, as mentioned above, the usefulness of the educational material should be re-evaluated in a new group of examinees. In addition, use of a reading checklist, guidebook, e-learning system, or an eye-tracking feedback approach might enhance the educational value of the lecture[7]. Program developers must create an environment that improves the ability of orthopedic practitioners to read plain radiographic findings when diagnosing bone metastasis.

Conflict of Interest: None declared; no external funding was received for this study.

References

1. Hori M, Matsuda T, Shibata A, Katanoda K, Sobue T, Nishimoto H, Japan Cancer Surveillance Research Group: Cancer incidence and incidence rates in Japan in 2009: a study of 32 population-based cancer registries for the Monitoring of Cancer Incidence in Japan (MCIJ) project. Jpn J Clin Oncol 2015; 45: 884–891.
2. Kitagawa Y, Ito T, Mizuno Y, Sudo Y, Kim Y, Tsunoda R, Miyamoto M, Takai S: Challenges in diagnosis of bone metastasis in patients without history of malignancy at first visit. J Nippon Med Sch 2018; 85: 271–278.
3. Kitagawa Y, Yamaoka T, Yokouchi M, Ito T, Mizuno Y, Sudo Y, Kim Y, Tsunoda R, Takai S: Diagnostic value of plain radiography for symptomatic bone metastasis at first visit. J Nippon Med Sch 2018; 85: 315–321.
4. Sim SM, Rasiah RI: Relationship between item difficulty and discrimination indices in true/false-type multiple choice questions of a para-clinical multidisciplinary paper. Ann Acad Med Singapore 2006; 35: 67–71.
5. Tavakol M, Dennick R: Post-examination analysis of objective tests. Med Teach 2011; 33: 447–458.
6. Pusic MV, Andrews JS, Kessler DO, Teng DC, Pecaric MR, Ruzal-Shapiro C, Boutis K: Prevalence of abnormal cases in an image bank affects the learning of radiograph interpretation. Med Educ 2012; 46: 289–298.
7. McLaughlin L, McConnell J, McFadden S, Bond R, Hughes C: Methods employed for chest radiograph interpretation education for radiographers: a systematic review of the literature. Radiography (Lond) 2017; 23: 350–357.

(Received, November 18, 2018)
(Accepted, May 22, 2019)
(J-STAGE Advance Publication, June 15, 2019)