Examination of pattern of RI accumulation in thyroid cartilage on bone scintigraphy

Hiroko Kurooka · Joji Kawabe · Chikako Tsumoto
Takehiro Hayashi · Ai Oe · Jin Kotani
Shigeaki Higashiyama · Etsushi Kawamura
Hideo Yamane · Susumu Shiomi

Received: 8 April 2008 / Accepted: 30 July 2008
© The Japanese Society of Nuclear Medicine 2009

Abstract
Objective In bone scintigraphy, abnormal RI accumulation in ossified thyroid cartilage is often noted. However, because similar accumulation is also seen in tumor-involved cartilage, distinction between these two lesions is sometimes difficult. We examined the differences in RI accumulation by ossification of the thyroid cartilage and cartilage invasion with anterior, posterior, and oblique views of bone scintigraphy in this study.
Methods This study included 120 patients (104 men, 16 women; mean age 67.8 ± 9.6 years; range 48–90 years) with laryngeal or lower pharyngeal carcinoma. The patients had exhibited abnormal accumulation of RI on thyroid cartilage on bone scintigraphy between February 1999 and March 2007. We evaluated accumulation of thyroid cartilage in the anterior, posterior, and oblique views on bone scintigraphy. The presence/absence of tumor invasion of the thyroid cartilage was checked by comparing the findings of enhanced computed tomography and magnetic resonance imaging (MRI) as well as evaluating operative records. RI accumulation in thyroid cartilage was divided into four types (diffuse accumulation, intense diffuse accumulation, slight inhomogeneous accumulation, and intense inhomogeneous accumulation).
Results Tumor invasion of thyroid cartilage was noted in 2 of the 42 patients with diffuse accumulation, 1 of the 18 patients with intense diffuse accumulation, 1 of the 38 patients with slight inhomogeneous accumulation, and 17 of 22 patients with intense inhomogeneous accumulation. Because the degree of tumor invasion was highest in cases in which bone scintigraphy revealed intense inhomogeneous accumulation of RI in the thyroid cartilage, we judged this pattern of RI accumulation to be an indicator of tumor invasion. When diagnosis was based on this criterion, positive predictive value, negative predictive value, and accuracy were 77%, 96%, and 93%, respectively (P < 0.0001, Chi-square test).
Conclusions The findings of this study suggest that ossification of thyroid cartilage can be distinguished from tumor-involved thyroid cartilage on the basis of the pattern of abnormal RI accumulation in the thyroid cartilage in patients with head/neck cancer.

Keywords Bone scintigraphy · Ossification of the thyroid cartilage · Cartilage invasion

Introduction

Tc-99m-labeled phosphate compound bone scintigraphy has been widely performed for the detection and evaluation of bone metastasis because of its high sensitivity and ease of evaluation of the entire skeletal system [1]. However, because detection of lesions by bone
Scintigraphy makes use of the tendency of radionuclides to accumulate in areas with active bone turnover, it does not enable specific detection of bone metastasis. Bone scans are indicated for patients with metastatic bone disease, primary bone tumors, hematologic malignancies, and some non-neoplastic diseases [2]. When bone scintigrams are evaluated, the examiner often faces difficulty in determining whether abnormal RI accumulation represents bone metastasis. Elderly individuals often exhibit RI accumulation in ossified thyroid cartilage [3]. When discriminating between bone metastasis and bone invasion, it is necessary to take the degree of RI accumulation into account. In practice, this judgment is often difficult owing to the fact that RI accumulation is sometimes also observed in cases of ossification of the thyroid cartilage. This study was undertaken to classify RI accumulation of thyroid cartilage in bone scintigraphy of patients with laryngeal or lower pharyngeal carcinoma, which is known to often invade thyroid cartilage, and to examine whether distinction between ossification and tumor invasion of cartilage is possible on the basis of differences in the pattern of RI accumulation.

Methods

Patients

This study included 120 patients (104 men, 16 women; mean age 67.8 ± 9.6 years; range 48–90 years) with laryngeal or lower pharyngeal carcinoma. The patients had exhibited abnormal RI accumulation in thyroid cartilage on bone scintigraphy between February 1999 and March 2007. By treatment status, 63 patients were pre-therapy and 57 were post-therapy, including 44 with radiation therapy, 5 with radiation therapy and chemotherapy, and 8 with radiation therapy and surgery (laser surgery, etc., other than laryngectomy).

Bone scintigraphy

Tc-99m-hydroxymethylene diphosphonate (HMDP) bone scintigraphy was performed 3 h following the intravenous injection of 740 MBq Tc-99m-HMDP. We evaluated accumulation of thyroid cartilage in the anterior, posterior, and oblique spot images of bone scintigraphy. On anterior images, the lower cervical spine sometimes overlaps with the annular and thyroid cartilage and thus exhibits reinforced RI accumulation in some cases. To distinguish between the cervical spine and the annular and thyroid cartilage and between the bodies of vertebrae and vertebral arches/spinous processes, we also evaluated oblique images.

Analysis

The presence/absence of tumor invasion of the thyroid cartilage was checked by comparing the findings of enhanced computed tomography (CT) and magnetic resonance imaging (MRI) as well as evaluating the operative records. RI accumulation in thyroid cartilage was divided into four types: diffuse accumulation (Fig. 1a), intense diffuse accumulation (Fig. 1b), slight inhomogeneous accumulation (Fig. 1c), and intense inhomogeneous accumulation (Fig. 1d). Classification was done visually by three nuclear medicine physicians. Each of the physicians involved in reading of the images had more than 5 years of experience in this. Three physicians evaluated each image together. Judgment was made in a blind fashion. Statistical analysis was performed using the Chi-square test, with findings of \( P < 0.05 \) considered to be significant.

Results

Tumor invasion of thyroid cartilage was noted in 21 (17.5%) of the 120 patients using bone scintigraphy. By pattern of RI accumulation, tumor invasion was noted in 2 (4.8%) of the 42 patients with diffuse accumulation, 1 (5.6%) of the 18 patients with intense diffuse accumulation, 1 (2.6%) of the 38 patients with slight inhomogeneous accumulation, and 17 (77.3%) of 22 patients with intense inhomogeneous accumulation (Table 1).

The CT findings of the patients exhibiting intense inhomogeneous accumulation on bone scintigrams (Fig. 2) were compared with those of the patients exhibiting diffuse accumulation (Fig. 3).

Because the degree of tumor invasion was highest in cases in which CT revealed intense inhomogeneous accumulation of RI in the thyroid cartilage, we judged this pattern of RI accumulation to be an indicator of tumor invasion. When the diagnosis was based on this criterion, positive predictive value, negative predictive value, and accuracy were 77%, 96%, and 93%, respectively (\( P < 0.0001 \), Chi-square test; Table 2).

<table>
<thead>
<tr>
<th>Types of accumulation pattern</th>
<th>n</th>
<th>Tumor invasion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intense diffuse accumulation</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Diffuse accumulation</td>
<td>42</td>
<td>2</td>
</tr>
<tr>
<td>Slight inhomogeneous accumulation</td>
<td>38</td>
<td>1</td>
</tr>
<tr>
<td>Intense inhomogeneous accumulation</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>21</td>
</tr>
</tbody>
</table>