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## Bone Scintigraphy in Three Patients with Cough Related Stress Fractures of Ribs

*Kazuyoshi Suga\**, *Kazuya Nishigauchi\**, *Tsuyoshi Arita\**, *Takashi Nakanishi\**,  
*Hiromoto Utsumi\*\** and *Norimasa Yamada\*\**

\*Department of Radiology, Yamaguchi University School of Medicine, Ube, Yamaguchi 755, Japan

\*\*Department of Radiology, Yamaguchi University Hospital, Ube, Yamaguchi 755, Japan  
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**Abstract** The  $^{99m}\text{Tc}$ -HMDP bone scintigraphic findings in three cases of unusual cough related stress fractures of ribs are presented. In all three patients, bone scintigraphy clearly disclosed the fracture sites as abnormal concentrations of activity. Bone scintigraphy was available for early detection and diagnosis in one patient. All of the lesions were located in the axillary line, even in the two cases with multiple lesions (one of whom had bilateral lesions), and there were abnormal accumulation sites in the adjacent above and below ribs. These bone scintigraphic findings seem to be characteristic of cough related stress fractures of ribs.

*Key Words* : Bone scintigraphy,  $^{99m}\text{Tc}$ -HMDP, Stress fracture, Rib

### Introduction

So-called stress fracture or fatigue fracture occur with a peculiar mechanism<sup>1-5</sup>. These fractures are generally not fractures in the usual sense of loss of structural continuity, and occur with seemingly normal bone form and structure. They are induced by unaccustomed stress and/or chronic and repetitive external pressure to the bones under conditions in which the stress or pressure is not sufficient to break the normal bone structure and is tolerated by the elasticity and flexibility of the bone.

March foot and march fracture of the lower extremities are well known fractures induced by these mechanism<sup>1,2</sup>. Cough-related stress fracture of the ribs is another stress fracture induced by repeated cough or intense cough, but is relatively infrequent in the average radiological practice<sup>4</sup>.

Although the availability of bone scintigra-

phy for early detection and diagnosis so-called stress fracture has been reported several times<sup>6-10</sup>, the bone scintigraphic findings in cough related stress fractures of the ribs has been described in only a few reports<sup>11</sup>. We recently experienced three cases of cough-related stress fractures of the ribs and performed bone scintigraphy. The characteristic bone scintigraphic features in these patients and its contribution to early diagnosis is described.

### Materials and Methods

Bone scintigraphy was performed in three patients with cough-related stress fractures of the ribs. All of the patients complained of severe or chronic coughing with chest pain and had a respiratory infection, i.e. diffuse panbronchiolitis in one patient and bronchopneumonia in two patients, and reported no trauma. Serum phosphorus, calcium and

alkaline phosphatase (ALP) levels were normal in previous and current examinations. Although histological examination was not performed, the diagnosis was confirmed from clinical course and radiographic findings of the healing phase of the fractures<sup>6)</sup>.

Bone scintigraphy was performed 3 hours after the I.V. injection of 740 MBq (20 mCi) <sup>99m</sup>Tc-hydroxymethylene diphosphonate (<sup>99m</sup>Tc-HMDP), with a low energy all-purpose parallel hole collimator and a 20% window centered at 140 keV, using a Toshiba model GCA-901-A. Whole body images and spot images of the chest with anterior, posterior and an additional lateral view were obtained in all three patients.

### Case reports

#### Case 1

A 30-year-old male, who had received therapy for diffuse panbronchiolitis (DPB) over the last 10 years, was admitted to our hospi-

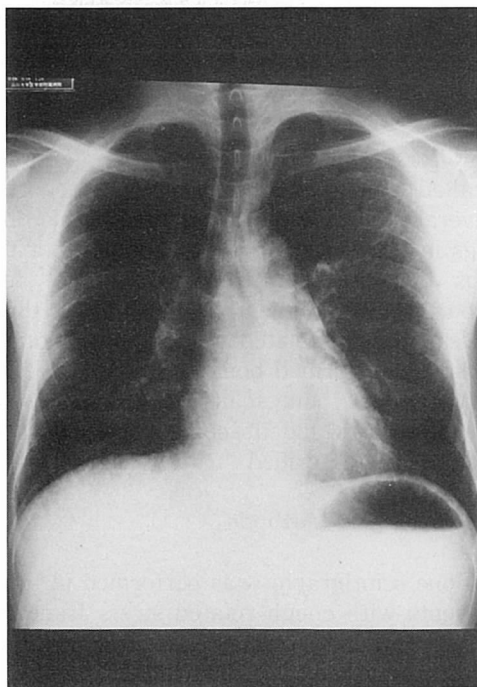


Fig. 1-A: Initial chest radiology (Case 1) showing diffuse small opacities due to panbronchiolitis. No abnormalities can be seen in any of the ribs.

tal on 12 March 1992 for acute onset of severe right lower anterolateral chest pain. He complained a chronic, but not severe cough for an extended period. Physical examination revealed tenderness in the right anterolateral regions of the lower ribs. Chest radiographs showed only diffuse small nodular opacities due to panbronchiolitis (Fig. 1-A), unchanged since 1 month, and failed to reveal any definitive osseous abnormality, even on additional plain films of the ribs. We suspected a cough-related stress rib fracture from the clinical course and performed bone scintigraphy, which revealed a focal pathological increased accumulation over the right VIII rib, located in the posterior axillary line on the lateral view (Fig. 1-B). With a diagnosis a cough-related rib fracture, he was administered a cough suppressant and the ribs were fixed with a *corcet*. The pain gradually subsided and chest radiography obtained six weeks later showed faint callus formation corresponding to the abnormal accumulation site of the right rib.

#### Case 2

A 60-year-old male, who had complained of severe cough and sputum for 10 days, was transferred from another hospital to ours because of continuous severe bilateral ante-

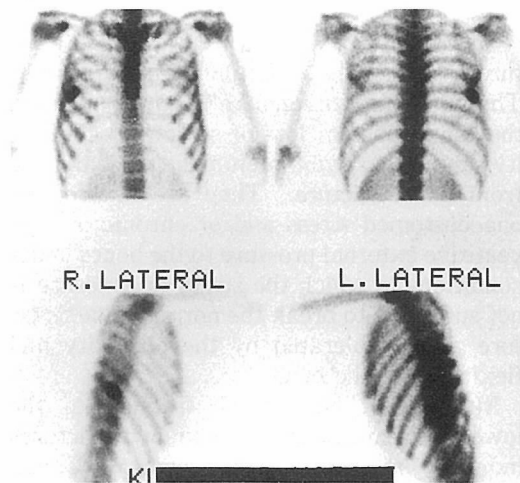


Fig. 1-B: Bone scintigraphy performed 4 days later showing intense accumulation at the VIIIth rib. Lateral views revealed that the lesion was located at the posterior axillary line.

rior chest pains inspite of the administration of antibiotics. Initial studies revealed a white blood cell count  $9170/\text{mm}^3$  and sedimentation rate of  $56\text{mm/hr}$ . Initial chest radiography, performed on 29 December, 1990, showed an infiltrate suggestive of bronchopneumonia of the middle lobe, however, no abnormality was detected in the ribs (Fig. 2-A). A cough suppressant and antibiotics were administered and his symptoms resolved. Follow-up chest radiography 4 weeks later showed improvement of the lung infiltrate. Four months later, he was again referred to our hospital for the colonic polypectomy, which revealed a  $2 \times 2\text{cm}$  polyp (carcinoma in adenoma). The callus formation was noted in the right IV, V, VI and left IV ribs no chest

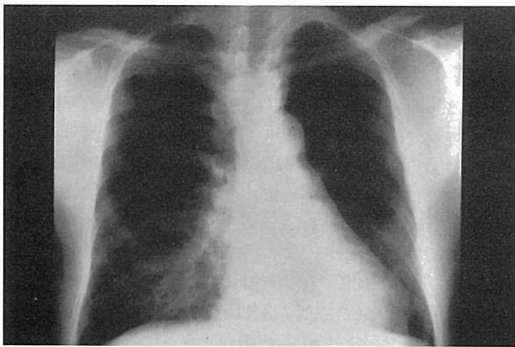


Fig. 2-A: Initial chest radiography (Case 2) showing an infiltrate in the middle lobe. No abnormalities can be seen in any of the ribs.

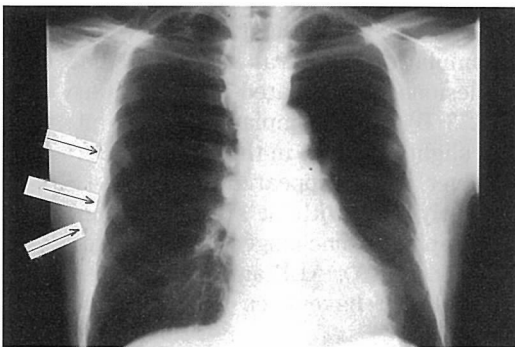


Fig. 2-B: Follow up chest radiography 4 weeks later showed callus formations of the right IV, V, VI and left ribs (→) with residual infiltrate in the middle lobe.

radiography at that time (Fig. 2-B). Chest computed tomography also revealed only callus formation corresponding to those lesions with no soft-tissue mass lesions or bony destructive changes suggestive of metastatic bone tumors (Fig. 2-C). Bone scintigraphy was performed to exclude other bone lesions suggestive of metastatic bone tumors, however, the only abnormal accumulations corresponded to the rib lesions described above. Lateral views revealed that the lesions were located around the axillary line (Fig. 2-D). One year later, he has no symptoms and the chest radiography is un-

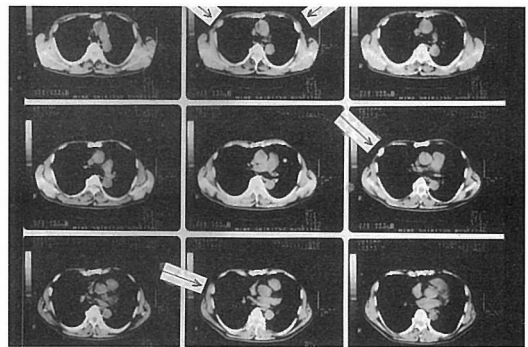


Fig. 2-C: Chest CT also revealed only callus formations corresponding to the plain film lesions without soft-tissue masses or bony destructive changes(→).

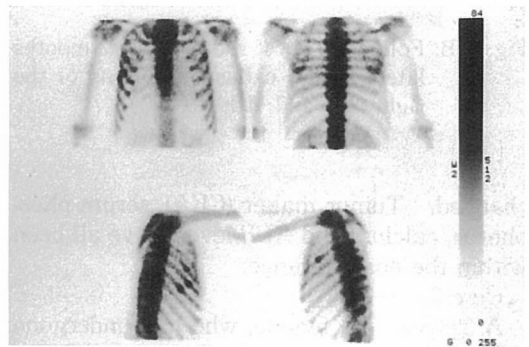


Fig. 2-D: Bone scintigraphy showing abnormal accumulation corresponding only to the lesions seen on chest radiography. Lateral views revealed that the lesions were located in the axillary line. There were also abnormal accumulations in the adjacent above and below ribs.

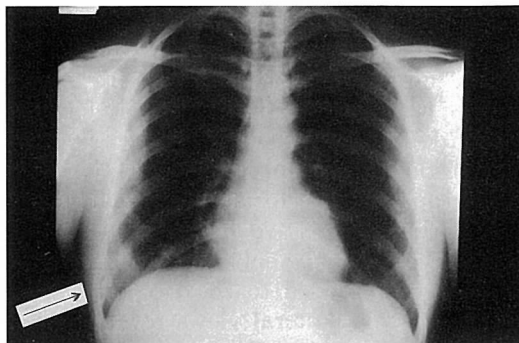


Fig. 3-A: Initial chest radiography (Case 3) showing an infiltrate in the right S<sup>8</sup> (→). No abnormalities can be seen in the ribs.

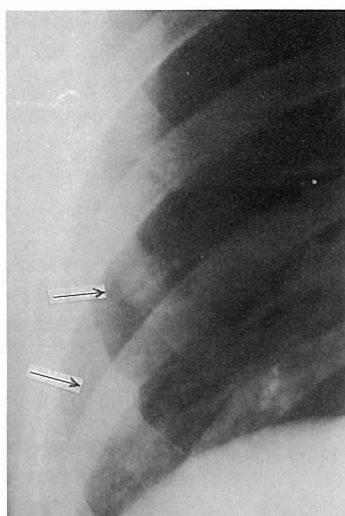


Fig. 3-B: Follow up chest radiography 2 months later showed callus formations of the right Vth and VIth ribs (→).

changed. Tumor maker (CEA), serum phosphorus, calcium and ALP levels have all been within the normal range.

#### Case 3

A 39-year-old female, who had undergone total hysterectomy for uterine cancer (Stage I<sub>a</sub>), noted sputum, fever cough and also progressive right anterolateral chest pain and coughing had been persistent 10 days was referred to our hospital on 30 April, 1991. Initial chest radiography showed an infiltrate in the right lower lobe (S<sup>8</sup>) consistent with bronchopneumonia, however, no definitive

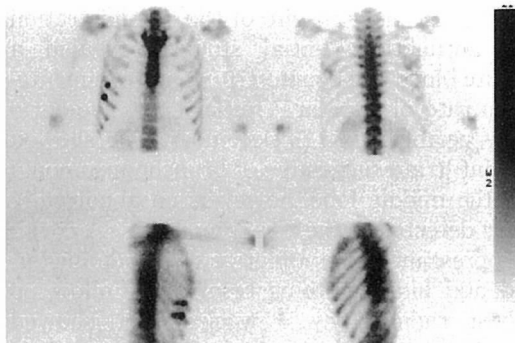


Fig. 3-C: Bone scintigraphy showing an abnormal accumulation only at the right the 5th and 6th rib. Laterla views revealed that the lesions were located in the axillary line. Abnormal accumulations were noted in the adjacent above and below ribs.

abnormalities of the ribs were noted (Fig. 3-A). Antibiotics and a cough suppressant were administered, and her symptoms and infiltrate on the chest radiography resolved two weeks later. Follow-up chest radiography performed on 2 July showed callus formations at the 5th and 6th ribs (Fig. 3-B). Plain tomography of the rib lesions also revealed callus formations but no bony destructive change. Although these findings were consistent with changes after bone fractures, the possibility of metastatic bone lesions was considered because of her history of malignancy and whole-body scintigraphy was performed. Abnormal accumulation was only seen corresponding to the rib lesions described above, without any other abnormal accumulation. Lateral views revealed that the lesions were located in the axillary line (Fig. 3-B). She complained of an intermittent slight dull pain in the chest until August, however, it disappeared thereafter. She is currently well without symptoms and chest radiography is unchanged. Tumor markers (SCC and CEA), ALP and serum phosphorus and calcium have been within the normal range.

#### Discussion

Cases 2 and 3 had a history of malignant

tumors, although both were removed at an early stage tumor by surgery and endoscopy. It was therefore necessary to differentiate metastatic rib tumors rib fractures. However, the following clinical findings suggested the diagnosis of cough-related stress fracture. The chest pain and rib abnormalities on the chest radiography appeared with onset of respiratory infections with persistent or severe coughing. Only callus formation characteristic of post-fractural change without irregular destruction nor osteolytic changes were noted in the ribs<sup>6</sup>. The rib lesions appeared at the same time, and bone scintigraphy failed to detect any other lesions. Moreover, resolution of the chest pain and unchanged follow-up chest radiography without new lesions confirmed the diagnosis.

Wilson et al<sup>4</sup>) reported that stress fractures of the ribs occurred in 14 (almost 6 percent) of 250 total cases of stress fractures at various sites. Initial chest radiography in 10 of these 14 cases revealed fracture lines, however rib abnormalities were not found in the other 4 cases. Their incidence paralleled the large number of hospital admissions for upper respiratory infection during the winter months, and chest radiography in 13 of the 14 cases revealed infiltrates due to respiratory infections. All our cases also exhibited pulmonary infiltrates due to respiratory infections.

All of the fracture sites in the present cases were located at the axillary line in the middle ribs and two cases had multiple lesions. However, previous reports have shown a low incidence of multiple sites and a high frequency in the lower ribs<sup>4</sup>). Only one case report with bilateral lesions similar to Case 2 was found in the previous literature<sup>11</sup>). A high frequency at the axillary line was reported by Oren et al<sup>11</sup>) and the possibility that the muscular insertions act predominantly at the axillary portion of the longest ribs during violent coughing may be related to this phenomenon.

The bone scintigraphic findings of cough-related stress fracture have been described in only two cases by Oren et al<sup>11</sup>). They detected the lesion on bone scintigraphy and failed to find any osseous abnormality of the

ribs on initial chest radiography, as in all of the present cases. In incomplete fractures, so-called stress fractures, neither, bone deformity of the bone nor a fracture line is generally observed, especially in the early stage, and later osteosclerosis and callus formation subsequently appears<sup>4</sup>). In the present cases, all of the initial chest radiographies showed only lung infiltrate due to respiratory disease, but failed to reveal any definitive osseous abnormality of the ribs. Follow-up chest radiographs later revealed callus formation at the fracture sites.

The ability of bone scintigraphy for early detection and diagnosis of so-called stress fractures at various sites has been reported many times<sup>6-10</sup>), because the phosphate scanning agent provides early sensitive accumulation in lesions which plain radiography cannot resolve. It has been reported that bone resorption and remodeling begin 48-72 hours after an episode of excessive stress, accumulation of technetium-labeled phosphate compounds increase, and bone image becomes positive as early as 24 hours after the onset of fracture<sup>6,8</sup>). In the same way, bone scintigraphy is considered to be useful for early detection of a stress rib fracture as an intense accumulation similar to that observed in Case 1.

On the other hand, in Cases 2 and 3 with a history of a malignant tumor, we used bone scintigraphy to document the presence or absence of lesions of bones other than the rib lesions observed on chest radiography to differentiate fractures from metastatic lesions. Metastatic bone tumors must be considered when sites other than the ribs have lesions. However, bone scintigraphy did not reveal other bony lesions in our cases and the diagnosis of cough-related fractures was confirmed with radiographic findings of the healing phase of fractures.

Bone scintigraphy clearly identified the fracture sites as abnormal accumulations on all of the present patients. This indicates that bone scintigraphy is sensitive enough to detect the physiological alterations found in stress fractures of the ribs. All of the lesions were located at the axillary line, even when multiple lesions were present as in Case 2 and 3. The lesions were also located at the axil-

lary line on the two case reported by Oren et al<sup>11)</sup>. Moreover, there were abnormal accumulations in the adjacent above and below ribs in our patients (Cases 2 and 3). These bone scintigraphic findings seem to be characteristic of cough-related stress fractures of the ribs. The importance of use of bone scintigraphy is emphasized in patients whose continued symptoms and signs suggest abnormalities of the ribs despite initially negative radiographic findings.

#### References

- 1) Draffner, R.H.: Current concepts. *Skeletal Radiol.*, **2**: 221-229, 1978.
- 2) Watson-juones R.: *Fractures and joint injuries. Vol.1.*, Williams & Wilkins, Baltimore, 1952, p.343-350.
- 3) Fink-benett, D.M. and Benson, M.T.: Unusual exercise-stress fractures. Two case reports. *Clin. Nucl. Med.*, **9**: 430-434, 1984.
- 4) Wilson, E.S. and Katz, F.M.: Stress fractures; An analysis of 250 consecutive cases. *Radiol.*, **92**: 481-486, 1969.
- 5) Levin, D.C., Blazina, M.E. and Levine, E.: Fatigue fractures of the shaft of the femur; stimulation of malignant tumor. *Radiol.*, **89**: 883-885, 1967.
- 6) Geslien, G.E., Thrall, J.H., Espinosa, J.L. and Older, R.A.: Early detection of stress fractures using <sup>99m</sup>Tc-Polyphosphate. *Radiol.*, **121**: 683-687, 1976.
- 7) Holder, L.E. and Matthews, L.S.: The nuclear physician and sports medicine, *Nucl. Med. Annual*. Raven Press, New York, 1984, p.81-140.
- 8) Genant, H.K., Bautovich, G.J., Siongh, M.: Bone-seeking radionulide; an in vivo study of factors affecting skeletal uptake. *Radiol.*, **113**: 373-382, 1974.
- 9) Holder, L.E.: Clinical radionuclide bone imaging. *Radiol.*, **176**: 607-614, 1990.
- 10) Rupani, H.D., Holder, L.E., Espinola, D.A.: Three-phase radionuclide bone imaging in sports medicine. *Radiol.*, **156**: 187-196, 1985.
- 11) Oren, V., Kozenitzky, A., Babiacki, A., Stern, A.: Unusual cough related stress injuries. *Eur. J. Nucl. Med.*, **14**: 108-111, 1988.