Clinical analysis of bone scanning in solitary lesion

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Abstract A rational analysis procedure for solitary lesions on whole bone scanning was offered. This study was undertaken to analyze retrospectively solitary lesions which obtained final diagnose through the following aspects: (1) diagnosis of bone metastasis, (2) the incidence of bone metastasis in different tumor, (3) the most possible lesion sites indicating bone metastasis, (4) morphological analysis of solitary lesions. The results are: (1) The incidence of solitary lesions in 2465 cases on whole bone scanning is 15.3%. (2) The rate of bone metastasis is 24.8% in 282 patients with primary malignancy. The rate of bone metastasis is 6.3% in 64 patients without primary malignancy, and the total diagnostic rate of bone metastasis is 21.4% in 346 patients. (3) In patients with primary malignancy, the incidence of bone metastasis of solitary lesions is as follows respectively: bronchi cancer 36.1%(22/61); breast cancer 23.8%(20/84); prostate gland 17.2%(5/29); other urinary system cancer 22.2%(4/18); G.I. system cancer 16.9%(10/59); others 29.0%(9/31). There is no significant difference in different cancer. (4) In patients without primary malignancy, 93.7%(60/64) of solitary lesions are benign. (5) From anatomical point of view, we found the diagnostic rate of bone metastasis is as follow: 30% in spine; 34.2% in pelvis; 36.4% in skull; 10.8% in other bones. There are significant differences in four groups. It is concluded that: (1) The diagnostic rate of bone metastasis in solitary lesions is 21.4%. (2) The most possible solitary lesions indicating osseous tumor spread are at spine, pelvic and skull. (3) Special attention to "cold" and streak like lesions should be paid. (4) A clinical analysis procedure for diagnosis of solitary lesions has been summarized out here.

Keywords Bone neoplasm, Radionuclide imaging, Metastases

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1 INTRODUCTION

Application of ^{99m}Tc labelled biphosphated salt (MDP) to assess primary and metastatic bone neoplasm has been used for almost 30 years. The sensitivity of bone imaging to inflammation, trauma and neoplastic lesions is high, but the specificity in the diagnosis is not satisfactory, especially in the diagnosis of solitary lesions. In the literature, this aspect has seldom been mentioned[1-7] and thus afforded little statistics

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significance. In China, no report has ever been seen. Recent years, 346 cases of radionuclide bone imaging of solitary tumor were encountered and analyzed clinically. A rational analysis program is presented in this report.

2 MATERIALS AND METHODS

2.1 Clinical materials

From Mar. 1994 to Jan. 1999, we performed 2465 cases of bone imaging, among which solitary lesions were found in 378 cases, in which 346 cases were followed up for at least 6 months so that a final diagnosis was obtained (including primary tumor, no history tumor, trauma). In the 346 cases, 159 were male and 187 female. The age ranged from 17 to 87 years, mean 58.4.

2.2 Base on which clinical analysis were made

(1) Evidence of primary tumor: pathological examination on surgery; bone aspiration; X-CT or X-MRI; others included finding of cancer cells in the sputum; bone imaging after follow up for 6 months. If any one of the above was positive, the diagnosis of primary tumor was made.

(2) In solitary lesions on bone imaging, the diagnosis base for differentiating metastatic bone lesion and non-metastatic lesion: a)those proven by pathological examination, b) bone aspiration, c) follow-up for at least 6 months, with appearance of new lesion, proven by CT or MRI, d)solitary lesion still present after 6 months follow-up, asymptomatic and without appearance of new lesion, X and CT or X and MRI yielding negative result, then the lesion was not metastatic.

2.3 Methods

Routine bone scanning and retrospective analysis.

2.4 Statistics

Chi-square tests between groups were made. $p < 0.05$ was consider to be significant.

3 RESULTS

3.1 Incidence of solitary lesions on bone imaging

From Mar. 1994 to Jan. 1999, 2465 cases of bone imaging were done, among which 378 were solitary lesions(15.3%).

3.2 Analysis of solitary lesions on bone imaging (346 cases)

(1) Analysis of solitary lesions in 282 patients with a history of tumor.

Among the 346 patients of whom a final diagnosis could be made, 282 cases had a history of tumor. The primary tumors were breast carcinoma in 84 (24.3%); carcinoma of the prostate gland in 29 (8.4%); the bronchogenic carcinoma in 61 (17.6%); urinary system cancer in 18 (5.2%)(renal cancer 8, cancer of urinary bladder 10); G.I. system cancer in 59 (17.0%) (esophagus cancer 4, liver cancer 11, intestinal cancer 33, gastric carcinoma 11); others in 31 (9.0%) (including carcinoma of the thyroid gland 17, thymoma 2, nasopharyneal cancer 1, adrenal adenoma 1, pancreatic cancer 2, lymphoma 4, fibrocarcinoma 1, endometrial cancer1, sarcoma 2).

Table 1 The incidence of bone metastasis in solitary lesions in different primary tumor

Primary tumor	Metastasis	Non metastasis	Trauma	Incidence of metastasis
Prostate gland	5	22	2	17.2%
Lung	22	33	6	36.1%
Breast	20	55	9	23.8%
Urinary system	4	13	1	22.2%
G.I. system	10	42	7	16.9%
Others	9	19	3	29.0%
Totals	70	184	28	24.8%

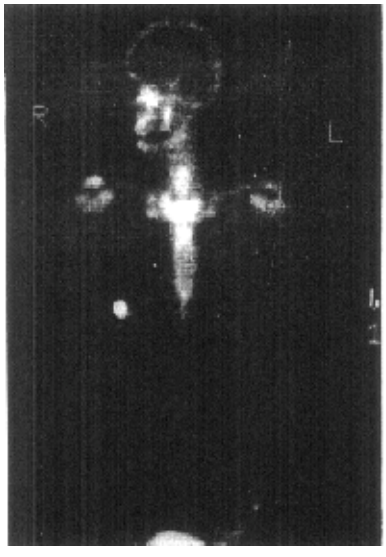


Fig.1 A hot spot in 65-yr-old woman with breast cancer shows solitary tracer uptake in the sixth rib on right side

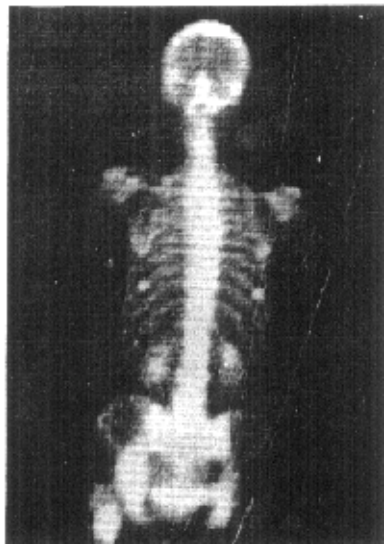


Fig.2 6 months later, the original lesion is larger, and there is widespread metastasis

In patients with a history of tumor, 212 cases were proven to be non metastasis, among which 28 cases had sustained traumatic injury. 70 cases were proven to be metastasis, the bone metastasis is 24.8% (Figs.1-3). The incidence of bone metastasis of solitary lesions in different primary tumor was given in Table 1. Make use of the statistical sampling chi-square distribution to analyze, the test results showed that: $\chi^2=7.39$, $\chi^2_{0.05(5)}=11.07$, $\chi^2 < \chi^2_{0.05(5)}$, $p>0.05$, there are no significant differences among groups.

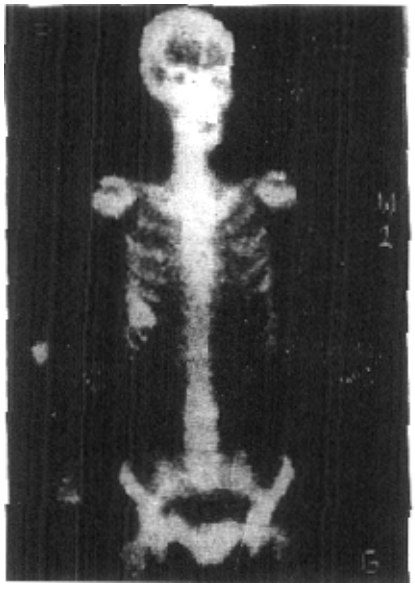


Fig.3 Anterior bone scan view shows increased radioactitivity in the sixth right rib which is chondrosarcoma confirmed by pathological examination on surgery

Fig.4 Posterior bone scan view shows increased radioactivity in blade bone on left

(2) The results of bone imaging in patients without a history of tumor.

Of the 64 cases without a history of tumor, 4 cases were proven to be metastasis; 3 cases were proven to be primary bone tumors(chordoma 1, myeloma 2); 9 cases had sustained traumatic injury; 48 cases were benign. The incidence of bone metastasis was 6.3% (Figs. 4,5).

(3) Comparison of the incidence of bone metastasis between groups with and without a history of tumor.

Of the 346 cases, 74 cases were proven to be bone metastasis, 272 cases were proven to be not bone metastasis, the total bone metastasis was 21.4%. In 282 cases with a history of tumor, 70 cases were proven to be bone metastasis, the incidence of bone metastasis was 24.8%, while in 64 cases without a history of tumor, 4 cases were proven to be bone metastasis, the incidence of bone metastasis was 6.3%. The results of chi-square test showed that: χ^2=10.7, $\chi^2_{0.05(1)}$=13.84, $\chi^2 > \chi^2_{0.05(1)}$, p <0.05, there was significance difference between groups with and without a history of tumor.

Fig.5 The same lesion which is fibrous dysplasia confirmed by CT

3.3 The relationship between lesion sites and the incidence of bone metastasis

Table 2 showed the relationship between lesion sites and the incidence of bone metastasis(346 cases).

Table 2 The relationship between lesion sites and the incidence of bone metastasis

Site	Metastasis	Non metastasis	Trauma	Incidence of metastasis
Cervical spine	1	8	1	10.0%
Thoracic spine	31	20	2	58.5%
Lumbar spine	7	47	13	10.4%
Skull	4	5	2	36.4%
Pelvis	13	21	4	34.2%
Rib	7	80	11	7.1%
Sternum	6	4	0	60.0%
Shoulder	2	9	1	16.7%
Sternoclavicular joint	0	14	0	0%
Extremities	3	27	3	9.1%
Total	74	235	37	21.4%

For statistics convenience, we divided bones into four groups: spine, pelvis, skull and others. The incidence of bone metastasis were 30.0%, 34.2%, 36.4% and 10.8% respectively. The results of chi-square test showed that: χ^2=22.13, $\chi^2_{0.05(3)}$=7.81, $\chi^2 > \chi^2_{0.05(3)}$, p <0.05. There were significant differences among four groups.

3.4 Morphological analysis of solitary lesions on bone imaging

We classified imaging results into three groups according to their characteristics: "hot", "cold", and streak like lesions as listed in Table 3.

Table 3 The relationship between morphology and the incidence of bone metastasis

Morphology	Bone metastasis	Non metastasis	Trauma	Incidence of metastasis
"hot"	51	230	34	16.2%
"cold"	12	2	3	70.6%
Streak like	11	3	0	78.6%
Total	74	235	37	21.4%

Table 3 showed the relationship between morphology and the incidence of bone metastasis. The results of chi-square test showed that: $\chi^2=56.7$, $\chi^2_{0.05(2)}=5.99$, $\chi^2 > \chi^2_{0.05(2)}$, $p<0.05$, there were a significant differences among groups .

4 DISCUSSION

When bone imaging yields only a solitary lesion, it is difficult to make a diagnosis as far as malignancy is concerned. Our aim is to present a more rational program after 346 cases of solitary lesion were retrospectively analyzed on clinical background.

Our results showed that, the incidence of solitary lesion is 15.3%, similar to those reported in the literature.[6] The incidence of metastasis is 21.4%. In tumor patients, the incidence of metastasis is 24.8%, a little higher than that reported in the literature.[2] In patients without a history of tumor, the incidence of metastasis is 6.3%. Solitary lesions without bone metastasis were benign almost with no exception. In the elderly, most cases were degeneration arthritis. But it must be pointed out that cancer and degenerative disease frequently occur together in older individuals, and 11% would be malignant.[1] There is significant difference between bone metastasis with and without a tumor history, it should receive ample attention when primary tumor is presented with solitary lesions on bone imaging. Different tumor showed no differences as far as metastasis concerned. In the 346 cases, the incidence of metastasis to the spine, pelvis, skull is higher than to the other bones, but sternoclavicular joint is 0, conforming to that reported in the literature.[5] It is postulated that axial bone containing rich red marrow, and blood metastasis often occurred in the red marrow. Metastasis is also more seen in proximal bone shaft.

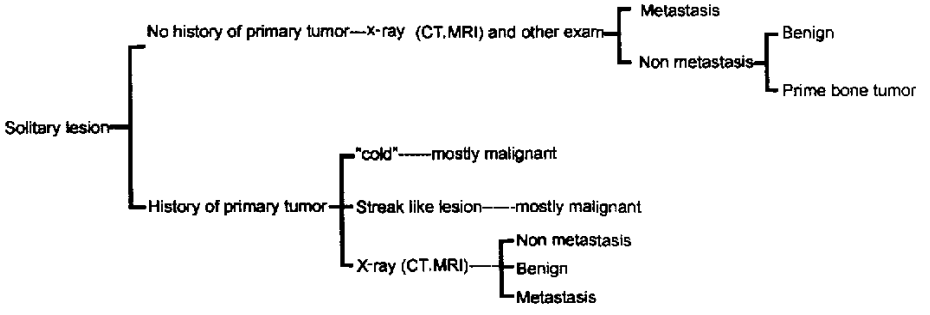
In multiple metastasis, ribs are the common sites, but in solitary lesion, it is rarely seen (7.1%). In the literature,[7] it was 6%. This low rate of metastasis may be partly related to the difficulty in differentiating for trauma and radio injury. As far as sternum concerned, Puig *et al*[5] reported 3 of metastasis in 33 cases. In our study, 60.0% significant statistical differences was seen. Our figure is near to that reported by Kwai *et al*.[3]

Most solitary lesions on bone imaging presented as "hot", but attention must be paid to "cold" and a streak like lesions. In the latter, probability of metastatic lesion is

high.[4]

Comparing our results with the literature, in bone tumor patients, the incidence of metastasis is higher. Several factors may play a role: (1) We used the SPECT, while γ camera or rectilinear scanner were used in literature.[6] (2) Many of the solitary metastases were found in asymptomatic patients while taking follow up scans. It is therefore conceivable that if more frequent follow-up scans were performed then the proportion of solitary lesions might even rise, presumably showing that we are simply identifying the disease process in an earlier stage. (3) Atypical lesions were often reported in the literature and typical cases were excluded. Our study included all cases with solitary lesions. Of course, the actual percentages in this series might be considerably different if all the cases were finally proved, or if other criteria of proof were accepted. The reason for >6 months follow-up scan is that once bone metastasis occur, symptom will go down hill rapidly, generally within 6 months. Also, by means of radionuclide bone imaging, diagnosis of bone metastasis would be made 3–6 months earlier than x-ray, thus after 6 months, metastasis will be evident on x-ray or CT.

According to the above discussion, we suggest the following rational program for diagnosis:



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