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Value of bone scintigraphy in patients with carpal trauma

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Objective: We planned this study to evaluate the role of bone scintigraphy in patients with suspected carpal fracture and normal or suspicious radiographs following carpal injury. ***Methods:*** Three-phase bone scintigraphy using Tc-99m-MDP was performed on 32 patients with negative radiographs but clinically suspected fracture at two weeks after the trauma. Focally increased radiopharmaceutical uptake was interpreted as a fracture. The final diagnosis was established with clinical follow-up. ***Results:*** Twelve (38%) patients had a normal scan excluding fracture. Twelve patients had a single fracture. Multifocal fracture was present in 8 (25%) patients. Eight patients showed scaphoid fractures; of these three showed single scaphoid fracture, and the other five patients revealed accompanying fractures. Distal radius fractures and carpal bone fractures other than scaphoid were both observed in 12 patients. These were eleven fractures of distal radius; three fractures of pisiform; two fractures of hamate; and single fractures of lunate, trapezium and triquetrum. In one patient there was fracture of a first metacarpal bone. ***Conclusion:*** In patients with suspected carpal bone fracture and normal or suspicious radiographs, bone scintigraphy can be used as a reliable method to confirm or exclude the presence of a scaphoid fracture and to detect clinically unsuspected fractures of distal radius and other carpal bones.

Key words: bone scintigraphy, carpal trauma, fracture

INTRODUCTION

Scaphoid fractures are among the most common fractures of the wrist after fractures of the distal radius[1] and constitute 50–90% of fractures of the carpal bones.[2,3] Missed diagnosis and inadequate treatment of a scaphoid fracture frequently leads to nonunion and may cause pain and serious disability. With prompt diagnosis and subsequent treatment, bony union will be obtained in 94%–98.5% of such fractures.[4]

Tenderness in the anatomical snuffbox is the classical sign of scaphoid fractures. However physical examination findings are not specific and may be seen in patients without any fractures or with fractures of the radial styloid, trapezium and metacarpal bones.[2] In 35 to 75% of the cases scaphoid fractures are invisible on initial radiographs[5,6] and as a consequence patients are overtreated in order to avoid missing a scaphoid fracture. Patients can spend many weeks in cast unnecessarily.

Bone scintigraphy has been used as a diagnostic tool complementary to radiographic examination in patients with suspected scaphoid fracture.[5,7–13] It may be used to confirm or exclude the diagnosis of a fracture in patients with negative initial radiographs. In this study we aimed to evaluate the role of bone scintigraphy using technetium-99m-hydroxymethylene diphosphonate (Tc-99m-MDP) in patients with suspected carpal fracture and normal or suspicious radiographs following carpal injury.

MATERIALS AND METHODS

Patients

A prospective study was performed on patients with carpal trauma, showing clinical signs of scaphoid injury,

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but no radiographic evidence of a fracture on initial radiographs obtained at presentation and repeated 14 days after the trauma. Thirty-two patients were studied (18 men and 14 women; mean age ± SD: 31.2 ± 15.4 years).

Bone Scintigraphy

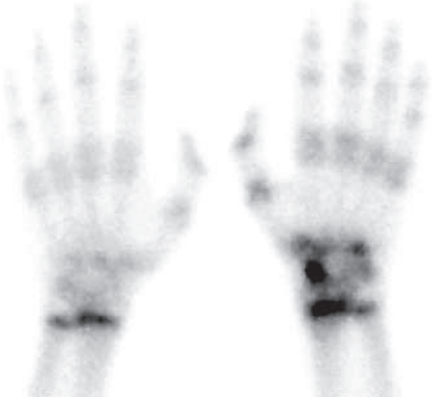
Bone scans were obtained on a single-detector gamma camera with a high-resolution collimator. A dose of 20 mCi (740 MBq) Tc-99m-MDP was injected intravenously, and simultaneously 2 s/frame dynamic acquisition for 2 min was performed in all patients with both wrists placed to the surface of the collimator. The injection was performed into an antecubital vein on the arm contralateral to the site of injury. Early blood pool and delayed static images were obtained in the same manner with wrists placed onto the surface of the collimator. Static views were acquired with an image matrix of 256 × 256 and zoom factor of 1.33. Delayed static images were obtained three hours after the injection and in a preset time of 5 min. An additional 10 min delayed static view using a pinhole collimator was obtained in order to localize the region of any focally increased activity precisely.

Table 1 Three-phase bone scintigraphy findings and distribution of fractures. (+), increased uptake; (–), normal uptake; NA, normal symmetrical activity; DA, diffusely increased activity

Patient no.	Blood flow	Blood pool	Delayed phase (Fracture localization)
1	+	+	Hamate
2	+	+	Scaphoid
3	+	+	Distal radius
4	–	–	NA
5	–	+	Scaphoid, distal radius
6	+	+	Scaphoid, triquetrium
7	+	+	Distal radius, pisiform
8	+	+	Distal radius
9	–	+	Scaphoid
10	+	+	Scaphoid, hamate
11	–	+	DA
12	–	–	NA
13	+	+	Distal radius
14	+	+	DA
15	+	+	Scaphoid, distal radius
16	–	–	NA
17	–	–	DA
18	–	–	DA
19	+	+	Distal radius, lunate
20	+	+	Scaphoid, distal radius
21	+	+	Distal radius, pisiform
22	+	+	Distal radius
23	–	–	NA
24	–	–	DA
25	–	–	NA
26	–	–	DA
27	–	–	DA
28	–	+	Scaphoid
29	+	+	Trapezium
30	–	+	Metacarpal bone
31	+	+	Distal radius
32	–	+	Pisiform

X-ray

Early phase

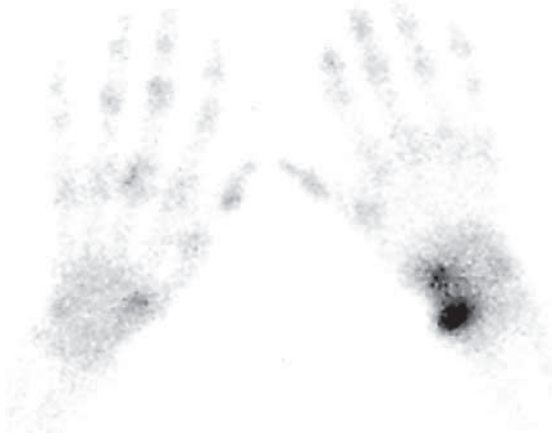


Delayed phase

Fig. 1 Focal hyperemia on early phase (*middle*) and increased activity accumulation on delayed phase scintigraphic images (*bottom*) supported the diagnosis of scaphoid and hamate fractures (patient no. 10). Initial radiograph obtained at presentation was without any evidence of a fracture.

X-ray

Early phase



Delayed phase

Fig. 2 Focal hyperemia on early phase (*middle*) and increased activity accumulation on delayed phase scintigraphic images (*bottom*) supported the diagnosis of distal radius and scaphoid fractures (patient no. 15). Initial radiograph obtained at presentation showed no evidence of a fracture.

The bone scan was considered to be positive for a scaphoid or another carpal bone fracture if focally increased activity in the concerned bone region was observed both in the early (dynamic flow and/or blood-pool) and late images (Figs. 1, 2). If there was symmetrical activity in both wrists, the bone scintigraphy was considered normal. Diffusely increased activity in the carpal region was reported to be secondary to post-traumatic changes and without any evidence for a fracture.

Follow-up and Management

After initial clinical and radiographic assessment, a plaster cast was applied from below the elbow to the knuckles, including the proximal phalanx of the thumb. The patients were then reviewed clinically and radiographically after two weeks. If radiographs were still negative but clinical signs persisted, the patients underwent bone scintigraphy while retaining the cast and were treated according to the result of the bone scan. A radiographically or scintigraphically established fracture was treated according to the usual practice of the orthopedics department. If no fracture was detected, casting was continued and the clinical and radiographic control was repeated at one or two week intervals until the tenderness disappeared or a fracture was revealed. All patients in the study were clinically and radiographically examined two months after the injury and were followed for a minimum period of one year after the trauma. At the final review, the patients were asked about pain, stiffness and discomfort. The carpal region was carefully palpated for tenderness and radiographic assessment was done.

RESULTS

Thirty-two patients with suspected scaphoid fracture following wrist injury were included in this study. There were 12 (38%) patients with normal symmetrical or diffusely increased carpal Tc-99m-MDP uptake excluding any fracture. Twelve patients had a single fracture. Multifocal fractures were present in 8 (25%) patients. The most common site of fracture was distal radius, and this fracture was observed in 11 patients. Scaphoid being the second most common site was fractured in 8 patients; of these three showed single scaphoid fracture and other five patients revealed accompanying fractures. Carpal bone fractures other than scaphoid were observed in 12 patients: These were three fractures of pisiform; two fractures of hamate; and single fractures of lunate, trapezium and triquetrum. In one patient there was fracture of a first metacarpal bone (Table 1). Although increased Tc-99m-MDP uptake was observed in blood pool phase corresponding to the fracture sites detected in delayed phase in every patient, 5 of these patients had normal dynamic flow images.

All patients who had fracture(s) shown in bone scintigraphy were accepted to have had fractures according to the

result of their control radiographs. During the follow-up none of these patients had nonunion; and in patients with negative scintigraphic findings, there were no complications and radiographs did not show any evidence of a fracture.

DISCUSSION

Fractures of the scaphoid bone are not always identified at the initial radiographic examination. Several reports conclude that the three phase bone scintigraphy is a sensitive and specific diagnostic modality in the diagnosis of scaphoid fracture.[2,5,6,9] Providing a correct diagnosis in the early post-traumatic period, bone scintigraphy is useful in shortening the duration of immobilization in cases without any fractures and decreasing complication rate in patients having fracture(s) showing the necessity of long-term immobilization.[13]

In patients with suspected scaphoid fracture and normal radiographs, 44–50% were reported to have fractures on bone scintigraphy,[6,9] The fracture rate in our patient group was rather high (62%) and this might be a result of the difference in the degree of severity of the trauma. The high frequency of multiple fractures (25%) observed in our patients supports this explanation. In a previous study, Tiel-van Buul et al. reported multiple fractures in 17% of their patients.[7]

A high number of fractures were observed in bones other than scaphoid in our patient group of suspected scaphoid fracture. The frequencies reported in several studies are similar to to the results in our patients: 13–17% distal radius, 25–36% scaphoid and 21–25% other carpal bone fractures.[5,9,13] The higher frequencies for distal radius (34%) and other carpal bone (38%) fractures found in our patients also might be a result of the difference in the severity of the trauma.

In a previous report, it was emphasized that a 'hot spot' seen on bone scintigraphy should be accepted as a fracture even if radiographic or computerized tomographic findings were normal.[2,7] In several studies only the delayed phase bone scintigraphy with increased osteoblastic activity accumulation was accepted as a fracture. However dynamic blood flow and early blood pool images of the three-phase bone scintigraphy may be useful in differentiating fracture from other pathologies such as degenerative changes, since increased blood flow and hyperemia are expected to be observed in case of fracture in the concerned area. Thus, we preferred to perform three-phase bone scintigraphy in all patients.

However in our patient group we did not consistently observe increased activity at the fracture site on the dynamic flow images in parallel with the increased uptake observed on blood pool and delayed phase images; five patients with fractures had normal dynamic flow images. This finding might be a result of an unsuitable bolus injection of the radiopharmaceutical or explained by the fact that fractured bones were too small to be detected on a dynamic flow study. In a different study by Tiel-van Buul, dynamic flow study phase was shown to be the least informative and reliable part of three-phase bone scintigraphy with low inter- and intra-observer agreement, irrespective of the experience of the observer.[14] So we conclude that a two-phase study with early blood pool and delayed images will be sufficient in scintigraphic evaluation of patients with carpal trauma.

Follow-up studies demonstrated that bone scintigraphy could be used to exclude a diagnosis of fracture when no focal increase in osteoblastic activity accumulation was observed.[8,11] In the follow-up of our patients without any focal increased uptake, there were no complications, and radiographs did not show any evidence of a fracture. Diffusely increased uptake in the carpal region on bone scintigraphy has been shown to be due to soft tissue trauma in the early period (<48 hours) and ligamentous injury or reflex sympathetic dystrophy in the late period (>3 months).[8,11]

CONCLUSION

Bone scintigraphy is a reliable method to confirm or exclude the presence of a suspected scaphoid fracture and also useful to detect clinically unsuspected fractures of distal radius and other carpal bones. We suggest that in patients with suspected scaphoid fracture following two weeks of immobilization if clinical suspicion persists despite negative radiographs, a two-phase bone scintigraphy should be performed.

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