Is there a place for radionuclide bone scintigraphy in the management of radiograph-negative scaphoid trauma?

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Objective. To evaluate the role of radionuclide bone scanning in patients with suspected scaphoid trauma, particularly in those with negative radiographs.

Design. Prospective. Radionuclide scans and carpal bone radiography were performed on all participants in the early post-injury period.

Setting. Cape Town tertiary centre trauma unit.

Participants. Fifty patients who presented with clinical features suggestive of scaphoid trauma.

Main outcome measure. Definitive radiographic diagnosis of fracture or persistent clinical features of scaphoid trauma.

Results. All patients who had fractures demonstrated on standard radiography either at the initial visit (13 patients) or at 2 weeks (8 patients) had positive scintiscans (sensitivity 100%). Four of 6 patients who had a positive scan but negative first and second radiographs had persistent tenderness on clinical examination which required extended immobilisation in a plaster cast. The overall positive predictive value of scintigraphy was 93%. All patients with a negative scan were clinically and radiologically negative at 2 weeks (negative predictive value 100%). Evidence of multifocal injury was present in 12 scans, but only 1 radiograph. Thirty-one patients (62%) were scanned within 48 hours of injury.

Conclusion. Bone scintigraphy can be used in radiograph-negative scaphoid area injury to exclude the need for further follow-up reliably, but those with positive scans still require clinical examination and radiography at 2 weeks.

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A number of studies have shown the importance of bone scintigraphy in the detection of fractures in radiograph-negative skeletal trauma.[1-3] The early detection and immobilisation of fractures of the scaphoid are thought to be essential in preventing the disabling sequelae of avascular necrosis and pseudo-arthrosis.[4] Several studies allude to the unreliability of plain radiographs in the initial detection of these fractures.[5-11] A second radiograph approximately 2 weeks after the first detects a number of fractures missed initially, but probably still does not have 100% sensitivity even at this stage.[6] It would be very helpful to have a test which, in the first few days, could reliably exclude the need for further radiographic follow-up and interim plaster cast immobilisation. The purpose of this study was to determine the sensitivity, specificity and negative predictive value of early bone scintigraphy in patients with possible scaphoid injury and to make recommendations about its use in emergency units.

Patients and methods

Fifty patients who presented to the trauma unit between 1 August 1989 and 31 January 1991 with clinical features suggestive of scaphoid fracture were included in this prospective study. Pregnant patients and those refusing informed consent were excluded.

Plain radiographs of the wrist, including scaphoid views, were obtained in all cases and the wrist was then immobilised in a plaster cast, even when no abnormality was seen on the radiograph. A single scintigraphic examination was done at the earliest convenient time after admission, usually at least a day later. A bolus of 740 MBq (20 mCi) of technetium-99m methylene diphosphonate (MDP) was used, followed by three-phase bone scintigraphy and a pinhole study. The scintigraphic images were interpreted without prior knowledge of the radiographic findings by one of the authors (B.K.A.); uptake on the affected side was compared with that of the normal side and graded subjectively on a scale of 0 to 3+ (no increase, minimal, moderate or marked increase in uptake on the affected side). Fig. 1 demonstrates a typical abnormal scintigram in a patient with a fracture of the left scaphoid.

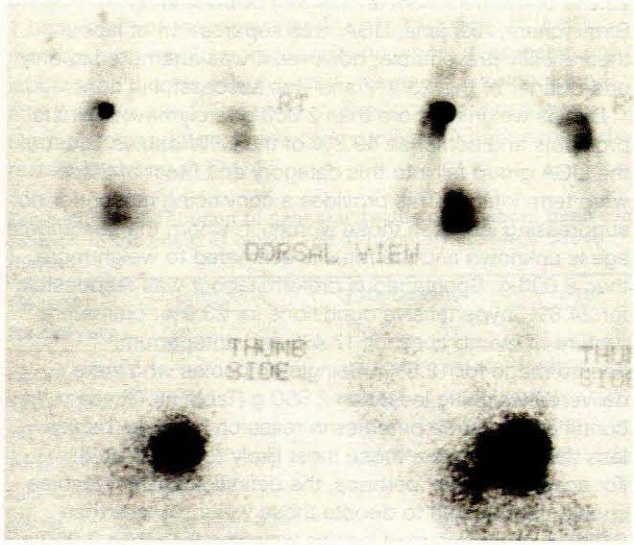

Fig. 1. Scintigram of a patient with a negative radiograph showing increased uptake in the injured scaphoid.

Two weeks later a second clinical and radiographic examination were performed in all cases where a fracture had not already been detected on the initial radiograph. When a fracture was now demonstrated or significant clinical signs were still present, the arm was immobilised for a further 4 - 6 weeks. Patients with negative scintigraphy who were also clinically and radiographically normal at 2 weeks were discharged from the study.

Results

Fifty patients were entered into the study. Eighty per cent of the patients were under 40 years of age with a median age of 33 years.

The outcome for all patients is shown in Fig. 2 and the analysis of the scintigraphic results is shown in Table I. Of note were the overall sensitivity and negative predictive value of 100%, with specificity of 92% and accuracy of 96%. The average interval between the injury and the imaging was 67.2 hours, the range being 8 - 266 hours. There were no missed fractures in the 31 patients who were scanned in 48 hours or less from the time of injury. Table II gives the scintigraphic intensity of the studies according to the time interval since injury. There was no apparent correlation of intensity with time. Fig. 1 shows a typical positive scintigram of a patient with a scaphoid fracture that was only evident at 2 weeks on the second radiograph.

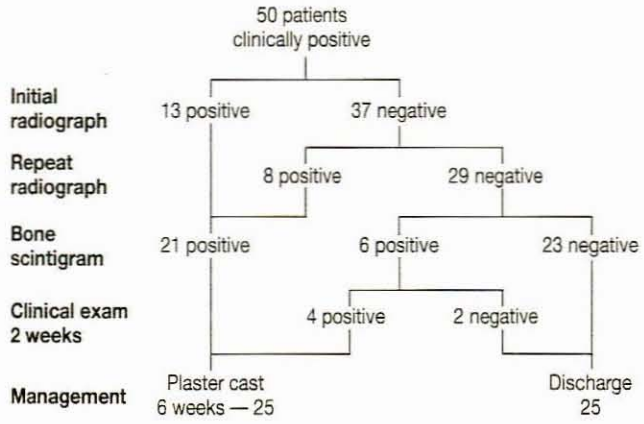

Fig. 2. Outcome of patients with suspected scaphoid trauma.

Six of the 27 patients with positive scintigrams had normal initial and second radiographs, but 4 of these had persistent clinical features requiring prolonged plaster cast immobilisation and were regarded as true positives from a management point of view. The other 2 who were asymptomatic at 2 weeks after the injury were regarded as false positives. In 1 of these patients, a previous injury to the scaphoid showed up as calcification on the radiograph; in the other, poor definition of carpals on the radiograph resulted in a suboptimal view of the scaphoid that appeared to demonstrate focal uptake. None of the 21 patients with negative scintigraphy had clinical or radiological evidence of scaphoid injury at 2 weeks.

Table III lists details of 35 cases of non-scaphoid focal uptake visualised in 30 patients on scintigraphy. Injuries to the distal radius accounted for 17 positive non-scaphoid foci, only 7 of which were visible on the initial radiographs. In all, only 11 out of 35 non-scaphoid foci were visualised radiographically. Fig. 3 shows the bone scintigram of a patient who had multiple abnormal foci.

Table I. Analysis of scintigraphic results

True positive	25
True negative	23
False positive	2
False negative	0
Sensitivity	100%
Specificity	92%
Positive predictive value	93%
Negative predictive value	100%
Accuracy	96%

Table II. Intensity of scintigraphic uptake in relation to interval between injury and imaging

	Scintigraphic intensity				
Interval (h)	0	1+	2+	3+	Total
⩽ 12			2		2
13 - 24	7	1	3	1	12
25 - 36	1	1	2		4
37 - 48	6	2	3	2	13
49 - 60	2			1	3
61 - 72			2	2	4
> 72	7	1	2	2	12
Total	23	5	14	8	50

Table III. Other sites of abnormal focal increased uptake in relation to radiographic findings

	Positive bone scan	Positive radiograph	Associated scaphoid
Radius	17	7	6
Lunate	4	3	3
Trapezium	6	0	2
Hamate	3	0	0
Triquetrum	2	0	1
Trapezoid	1	0	0
Metacarpal	1	1	1
Ulna (shaft)	1	0	0
Total	35	11	13

Fig. 3. Scintigram showing multiple foci of uptake in the injured wrist.

Discussion

Our results confirm the known sensitivity and excellent negative predictive value of bone scintigraphy in the early detection of scaphoid fractures. In all series there has been an absence of false-negative scintigraphy.[4,5,7,10,11] This means that patients with negative initial radiographs and negative scintigraphy can be discharged from hospital, even if clinically suspicious at that time, with confidence that significant injury will not be missed. Although false-positive scans may result from previous injury or degenerative joint disease, these groups comprised a very small part of our patient population, but may be more important in older populations.

A particularly interesting aspect of the study was the great number of incidental foci discovered that represented either fractures or, at least, severe trauma to other bones. These are often missed radiographically because the 'scaphoid views' are not the best for visualisation of the other carpals. These extra foci of injury may well account for significant delay in return of the wrist to full function in certain patients and this would seem to be useful information not obtainable by standard means.

In conclusion, we agree with the recommendation of Gelberman *et al.*[12] that scintigraphy, where available, be used routinely if initial radiography has failed to confirm the diagnosis of scaphoid fracture. It is reasonable to wait until 24 hours have elapsed since the injury, but it is probably not necessary to wait the regulation 48 hours. If the scintigram is negative, the plaster cast can be removed immediately and the patient discharged. Well over 90% of those with positive studies will have fracture of the scaphoid confirmed at repeat radiography or will require conventional immobilisation on clinical grounds for continuing tenderness and pain. Bone scintigraphy is a simple, non-invasive and relatively cheap method of investigating patients suspected of having scaphoid fractures. Besides, scintigraphy can be performed effectively on a patient wearing a plaster cast, so it has the added advantage of improving the detection of concurrent injuries of the carpals, metacarpals, radius and ulna.

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