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REGIONAL SCINTIMETRY IN SCAPHOID FRACTURES

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A quantitative scintigraphic method was introduced to examine the proximal, middle and distal third of the carpal scaphoid bone. ^{99m}Tc-Sn-pyrophosphate scintimetry was obtained by the use of a gamma camera equipped with a pinhole collimator. Of six patients in whom a unilateral fresh fracture of the scaphoid was clinically suspected, radiology showed a fracture of the scaphoid in four and no fractures in two. The method may be suitable in early diagnosis and further localization of clinically suspected fractures with initially non-diagnostic radiographs.

Key words: isotope scanning; quantitative scintigraphy; radiology; scaphoid bone fractures

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Early diagnosis and adequate treatment is important in clinically suspected fractures of the carpal scaphoid bone to prevent complications (Russe 1960) and to avoid overtreatment (Ganel et al. 1979). A few per cent of the fractures are only radiologically apparent after a week or more has passed (Böhler et al. 1954, Leslie & Dickson 1981). In order to shorten the time before a correct diagnosis is obtained isotope bone scanning has been used as a supplementary technique to radiography. Hitherto isotope scanning of the scaphoid has been performed as a survey image of the wrist and has been evaluated visually (Ganel et al. 1979, Jørgensen et al. 1979). Ganel et al. (1979) performed scintigraphy within the first 3 days after trauma, and found that a normal scan excluded fractures, and that all fractures not apparent on initial radiographs showed an abnormal scan. Jørgensen et al. (1979) found that nearly one half of all abnormal scans did not represent scaphoid fractures but rather fractures in the surrounding areas or other bone diseases. The scaphoid thus seems badly defined on a survey-scan of the wrist, and the resolution power of a survey-scan is too small to allow detailed analysis of the scaphoid. The present study introduced a quantitative scintigraphic method (scintimetry) to examine the regional distribution of the activity in the scaphoid in order to diagnose and further localize the fracture of the scaphoid.

PATIENTS AND METHODS

The investigation included six patients with clinical suspicion of a fresh fracture in the scaphoid on account of an actual trauma of the wrist, painful limitation of wrist motion and tenderness in the anatomical snuffbox (Mazet & Hohl 1963). There were two females and four males with a median age of 26 years (range 17–59). All patients were clinically and radiologically investigated within the first 24 hours after the trauma. On the initial radiographs scaphoid fractures were apparent in four patients: one patient had a fracture in the proximal third of the scaphoid, two had a transverse fracture in the middle third and one had a horizontal oblique fracture in the middle third (this subdivision is described by Russe (1960)). The other two patients showed no fractures on initial radiographs or on radiographs taken 10 days and 5–7 months later, and were symptomless at the last investigation. None of the

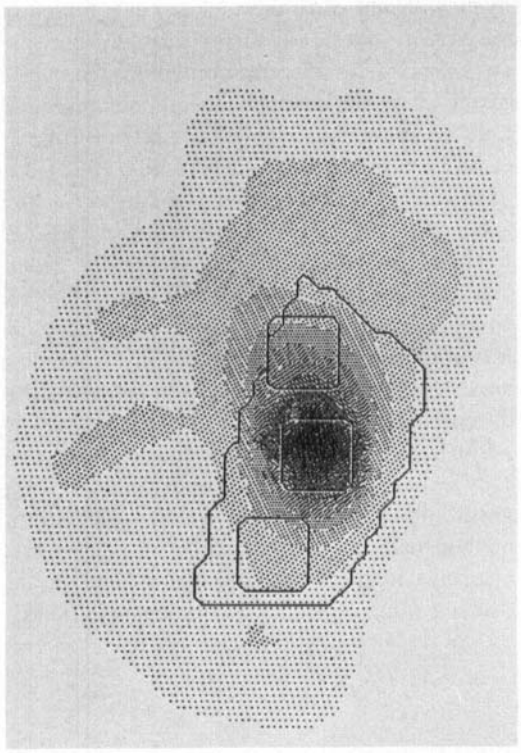

Figure 1. The dorsal ^{99m}Tc-image of the carpal scaphoid bone with the drawn contour of the scaphoid and with squared regions of interest placed in the proximal, middle and distal third of the imaged scaphoid. The highest level of activity is located in the middle third of the scaphoid corresponding to a radiological fracture of the middle third.

patients had clinical or radiological signs of affection of the scaphoid contralateral to the wrist with symptoms. The six symptomless scaphoid bones were used as controls.

Bone scintigraphy was performed 3–4 days after the trauma in patients with fractures on initial radiographs and after 14–20 days in patients with non-diagnostic initial radiographs. Immediately before performance of scintimetry both hands and underarms of the patient were immobilized in a volar splint with ulnar deviation of the hands and with the anatomical snuffbox uncovered. During X-ray image amplification the contours of both scaphoid bones were drawn on the dorsal surface of the wrists.

Two of the authors performed all the scintigraphic examinations without any knowledge of anamnestic, clinical or radiological findings. Two to three hours after quantitative injection in a cubital vein of ^{99m}Tc-Sn-pyrophosphate (200 μCi per kg b.w., Hoechst) first the right and then the left scaphoid was imaged and the exact time noted. A dorsal image of the scaphoid was obtained by the use of a gamma camera (General Electric Radi Camera II) equipped with a 6-mm pinhole collimator, placed 20–25 mm above the dorsal surface of the anatomical snuffbox, and interfaced to a 16K computer. Counts were selected for a 10-min period. Small ^{51}Co sources were placed on the contour of the scaphoid drawn on the skin and visualized on the same oscilloscope as the ^{99m}Tc-image. The contour of the scaphoid was drawn on the oscilloscope with a light-pen by connection of the imaged ^{51}Co sources (Figure 1). Squared regions of interest were placed in the proximal, middle and distal third of the imaged scaphoid and were in all cases of the same size (Figure 1). The measured activity in each region was decay-corrected to the time of i.v. injection and expressed as a fraction of the injected dose measured in a scintillation counter.

Statistical evaluation was performed by non-parametric statistics, and normal 95 per cent confidence limits were calculated from the t-distribution in the six unaffected scaphoid bones.

RESULTS

The results of the scintimetry are given in Figure 2. In the six scaphoid bones without symptoms the activity did not differ significantly between the proximal, middle and distal third of the

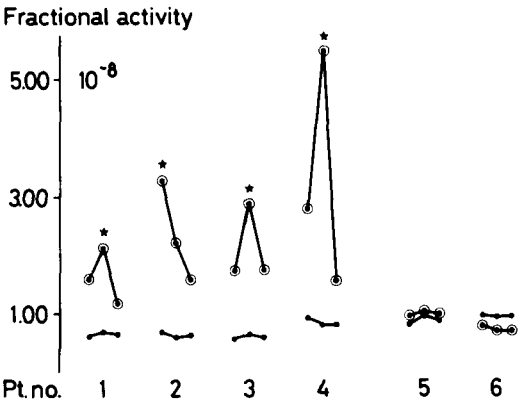

Figure 2. Regional scintimetry of the carpal scaphoid. Six patients with clinical suspicion of unilateral fracture of the scaphoid, radiologically diagnosed in four but no fractures in the last two. From left to right each curve represents the activity, expressed as a fraction of the given dose, in the proximal, middle and distal third of the scaphoid.

○ *anatomical snuffbox with symptoms.*
● *anatomical snuffbox without symptoms.*
✱ *radiological location of the fracture.*

scaphoid ($P > 0.10$). In the four fractured scaphoid bones all regions had an increased activity compared to the regions of symptomless scaphoids and compared to the upper normal 95 per cent confidence limit. The region corresponding to the location of the radiological fracture had a higher activity than the other two regions in the fractured scaphoid ($P < 0.125$). The smallest gradient of activity between the fractured region and the adjacent regions in the fractured scaphoid was significantly higher than the largest gradient of activity between regions in the control bones ($P < 0.01$). In the two scaphoid bones with clinical symptoms and no radiological fractures the regional activities and their differences were within the 80 per cent confidence limits of the six symptomless scaphoids.

DISCUSSION

The clinically suspected fractures without radiological fractures showed a normal scintimetric pattern. The fractured scaphoid bones were scintimetrically characterized by an overall increased activity, and an activity peak located in the region of the radiological fracture with increased gradients of activity to the adjacent regions in the scaphoid. The hyperaccumulation of the isotope in the fractured region of the bone indicates the increased formation of new bone (Greiff 1978), whereas the increased activity in the adjacent regions may reflect an increased formation of new bone, unspecific reactive changes or a "spill over" from the activity in the fractured region.

The method introduced has some advantages over the hitherto used scintigraphic methods (Ganel et al. 1979, Jørgensen et al. 1979). The pinhole collimator has a higher resolution power than a rectilinear scanner (Jørgensen et al. 1979) and an all-purpose collimator (Ganel et al. 1979). The image of the scaphoid is examined quantitatively with regard to the regional distribution of the activity, while the survey-scans were evaluated visually. As a fracture in the proximal third of the scaphoid needs a longer immobilization time for union (Russe 1960) and often is complicated by avascular necrosis (Editorial 1962), it is of interest to know the location of the fracture more precisely. By the presented method all fractures were correctly localized to the radiologically fractured regions of the scaphoid, whereas positive survey-scans may represent fractures in the scaphoid or in the surrounding areas (Jørgensen et al. 1979). The method introduced thus seems valuable as a supplement to positive survey-scans in early diagnosis of clinically suspected scaphoid fractures with non-diagnostic initial radiographs. The scintimetric method may further be suitable in diagnosis of avascular necrosis and non-union, and in the study of fracture healing of the scaphoid bone.

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