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^{99m}Tc HMDP bone scanning in generalised nodal osteoarthritis. II. The four hour bone scan image predicts radiographic change

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SUMMARY In 14 patients with generalised nodal osteoarthritis a four hour bone scan image was found to predict the changes that occur on the radiograph at follow up between three and five years later. The scan abnormality appeared to precede the development of radiographic signs, and joints abnormal on scintigraphy showed most progression. Normal joints and joints abnormal on *x* ray alone showed little progression, and those that did subsequently alter became abnormal on scan. Scanning may provide a sensitive technique for monitoring osteoarthritis, it may enable a greater understanding of the underlying disease process, and allow evaluation of modifying therapeutic procedures.

The diagnosis and monitoring of osteoarthritis is dependent on demonstrating characteristic radiographic features. In early disease radiographic findings are minimal, difficult to assess, and merge with normal age related features.[1 2] Later in the disease process the radiographic features are more dramatic but have no predictive value in assessing subsequent progression since they represent gross anatomical abnormality. From our previous work scanning appears to be a sensitive method of detecting abnormality which may be present in radiographically normal joints. Joints, however, may also be abnormal just on *x* ray.[3] This prospective study analyses the value of scanning and predicting *x* ray change.

Patients and methods

Fourteen patients with typical clinical and radiographic features of generalised nodal osteoarthritis[4] were screened to exclude other rheumatic diseases. None had clinical evidence or a family history of seronegative arthritis, all were negative for rheumatoid factor and antinuclear factor. The group comprised two men and 12 women, mean age 62 years, and mean disease duration four years. An initial *x* ray and ^{99m}Tc HMDP scan was obtained and then repeated between three and five years later. A four hour gammacamera image after a 555 mBq dose of ^{99m}Tc hydroxymethylene diphosphonate using a Technicare 438 gammacamera was obtained. This image was then compared with a standard hand radiograph. A single observer assessed abnormalities and graded them on a 0 to 3 scale. Each picture was evaluated without knowledge of the patient's identity, its date, consecutive scan or *x* ray, or follow up scan or *x* ray. Care was taken to include only definite abnormality. Because of the difficulty of imaging the scaphotrapezial and the first carpometacarpal joint these were grouped as a single entity, the thumb base. Other joints in the carpus were grouped as a single unit, the wrist. The pattern of abnormality could then be evaluated on a binary level, whether a joint was abnormal or not, and on a simple quantitative level to assess change. The statistical significance of changes was assessed with a χ^2 test, assuming that each joint behaves as an independent variable.

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Results

Table 1 shows the abnormalities that occurred on *x* ray at follow up, compared with the initial *x* ray, related to the initial scintigraphic finding, either scan positive or scan negative. There was a highly significant difference ($p<0.001$) between the two groups; 44% of scan positive joints showed progression compared with 10% of scan negative joints.

Table 2 shows the pattern of abnormality on both the initial *x* ray and initial scan. A joint could be

Table 1 *x Ray change at follow up related to initial scan*

Initial scan	*Number of joints (%)*				
	Total	*Progression*	*Unchanged*	*Regression*	*Fused*
Scan positive	101 (100%)	44 (44)	52 (52)	3 (3)	2 (1)
Scan negative	347 (100%)	34 (10)	305 (88)	6 (1·5)	2 (0·5)

Table 2 *x Ray change at follow up related to pattern of initial scan and x ray*

Initial pattern	*Number of joints (%)*				
	Total	*Progression*	*Unchanged*	*Regression*	*Fused*
Normal	288 (100)	26 (9)	262 (91)	—	—
x^+(*x* ray alone abnormal)	59 (100)	8 (14)	43 (73)	6 (10)	2 (3)
S^+(scan alone abnormal)	20 (100)	14 (70)	6 (30)	—	—
x^+S^+(*x* ray and scan abnormal)	81 (100)	30 (37)	46 (57)	3 (4)	2 (2)

Table 3 *x Ray change in the DIP and PIP joints related to initial scan*

Initial scan	*Number of joints (%)*				
	Total	*Progression*	*Unchanged*	*Regression*	*Fused*
Scan positive	74 (100%)	33 (45)	37 (50)	2 (2·5)	2 (2·5)
Scan negative	178 (100%)	25 (14)	147 (83)	4 (2)	2 (1)

Table 4 *Pattern of abnormality on x ray and scan related to subsequent x ray change*

Initial pattern	*Number of DIP and PIP joints (%)*				
	Total	*Progression*	*Unchanged*	*Regression*	*Fused*
Normal	121	17 (14)	104 (86)	—	—
x^+(abnormal only on *x* ray)	57	8 (14)	43 (75)	4 (7)	2 (4)
x^+S^+ (abnormal on *x* ray and scan)	63	24 (38)	35 (56)	2 (3)	2 (3)
S^+(abnormal only on scan)	11	9 (82)	2 (18)		

Table 5 *Follow up x ray change related to initial x ray pattern*

Initial pattern	*All joint groups (%)*				
	Total	*Progression*	*Unchanged*	*Regression*	*Fused*
x Ray abnormal	140	38 (27)	89 (64)	9 (6)	4 (3)
x Ray normal	308	40 (13)	268 (87)	—	—

abnormal on scan alone, abnormal on *x* ray alone, or have both images normal, or both abnormal. Fourteen per cent of the joints abnormal on *x* ray alone showed progression compared with 70% of the joints abnormal on scan alone. Nine joints showed apparent resolution as indicated by a decrease in their severity scores and four joints ankylosed. This pattern of scan positive joints showing progression was more striking when the distal interphalangeal (DIP) joint and the proximal interphalangeal (PIP) joints were analysed separately from the metacarpophalangeal joints and the joints of the wrist and the thumb base (Tables 3 and 4). If analysis of subsequent progression was related to whether the joints were abnormal on *x* ray or not initially, there was no significant demonstration of the predictive value of *x* ray change (Table 5).

These features are illustrated in Figs 1 and 2.

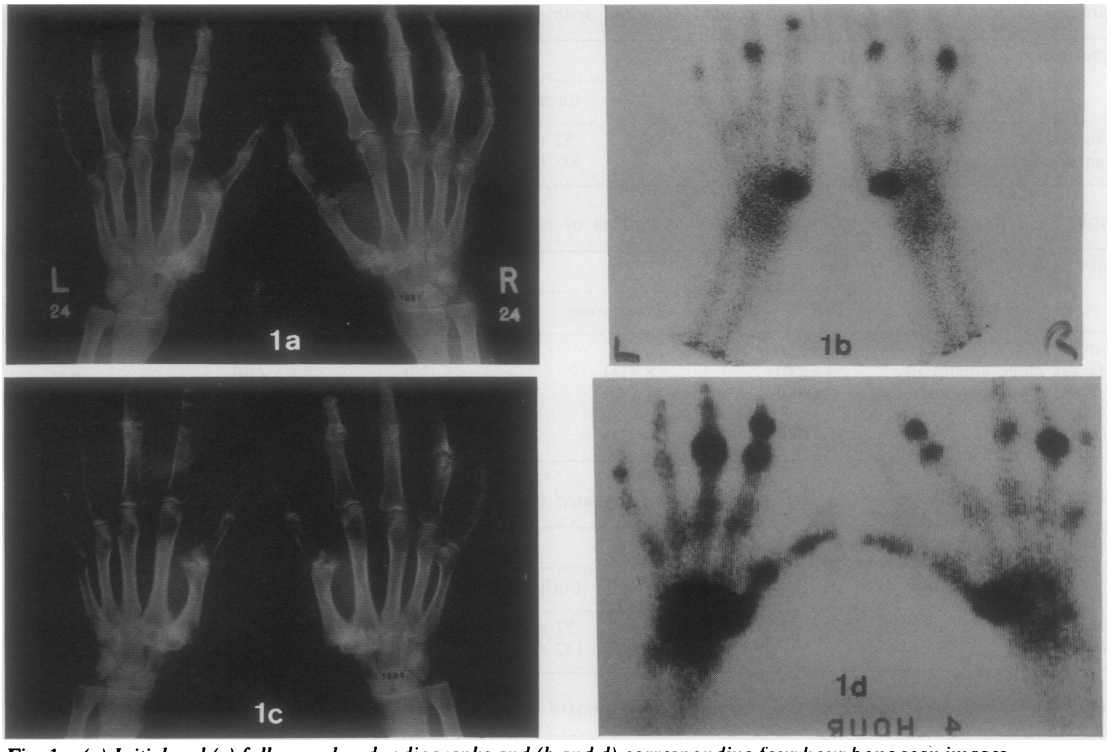

Fig. 1 *(a) Initial and (c) follow up hand radiographs and (b and d) corresponding four hour bone scan images of a patient with generalised nodal osteoarthritis. (1) All joints initially abnormal on both x ray and scan show marked progression (right PIP, left index DIP, left little DIP). (2) The left middle PIP and right ring PIP show minimal radiographic abnormality but are markedly abnormal on scan. Follow up shows the development of marked x ray abnormality. (3) No joints normal on scan progress, even if there is associated radiographic abnormality. (4) The follow up scan, though technically slightly different, shows the left index PIP and right index DIP have become markedly abnormal on scan but show only minimal change on x ray. (5) The scan of the right index PIP has become markedly less active on follow up.*

Discussion

The diagnosis and monitoring of osteoarthritis is presently dependent on demonstration of radiological abnormality. This study shows that bone scanning may provide additional information on the evolution of the disease. It detects abnormality before radiographic signs can be identified, predicts subsequent development, and therefore opens the possibility of evaluating disease modifying therapy before severe joint damage occurs. Scanning, however, has several limitations. It is difficult to get identical scanning conditions, and though digital image can be made, detailed quantitative assessment is not possible. Minor changes of position, for example, will alter the apparent activity over a joint. Different machines will produce slightly different images. Analysis has been simplified in the current study in order to overcome this problem. To obtain a full picture of the changes that are occurring over a period of time would require several scans and excessive radiation exposure. Here only two time points have been studied. Even with these constraints, however, the importance of scanning as a demonstrator and predictor of change is apparent. To try to quantify further would require complex computer analysis, a larger number of patients, and would be confronted by the difficulty of quantifying radiographic abnormality.

The process the scan monitors appears to be phasic, suggesting that osteoarthritis is phasic rather than a continually progressive disease. Joints are initially abnormal on scan, the radiographic signs then develop, then later the scan activity diminishes, and no further radiographic change occurs. In any one hand, joints appear to be in different states of

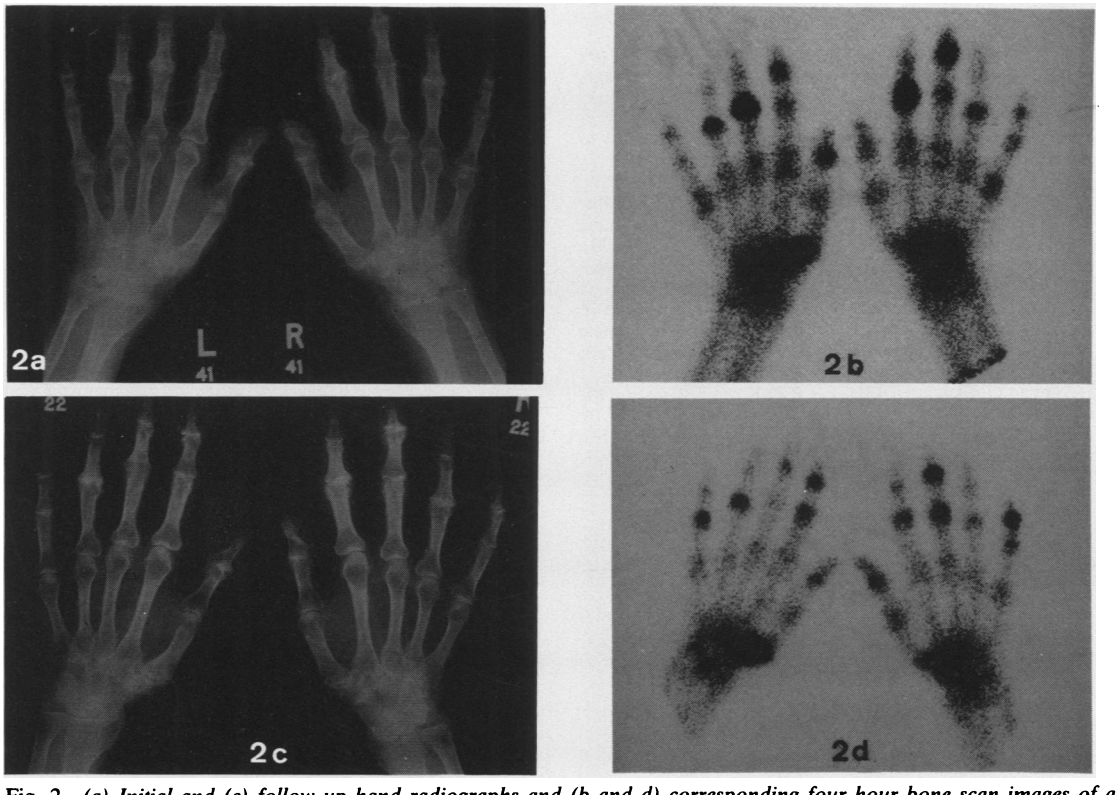

Fig. 2 *(a) Initial and (c) follow up hand radiographs and (b and d) corresponding four hour bone scan images of a patient with generalised nodal arthritis. The following points can be noted: (1) Joints that are abnormal both on scan and x ray with varying degree of abnormality on each modality. (2) Progression of all initially scan positive joints. (3) Lack of change of radiographic features of x ray abnormal but scan normal DIP left little finger. (4) Ankylosis of left middle PIP in association with loss of scan abnormality. (5) Progression of the DIP left little finger of the right hand that is initially scan normal but becomes scan abnormal. (6) Development of marked scan abnormality of the right middle PIP with only minimal radiographic abnormality.*

evolution. Some joints are abnormal on scan alone, others on *x* ray and scan, and some are abnormal only on *x* ray. It appears that in the joints abnormal only on *x* ray the osteoarthritis process is stopped. The joints in a single hand appear to be behaving independently as if the process is a monoarthritis multiplex rather than a generalised disorder throughout the hand.

Generalised nodal osteoarthritis may be a subgroup of osteoarthritis or may be a separate disease entity.[4] Therefore the findings that we have observed in this group of patients may not relate to abnormalities that occur in osteoarthritis at other joints. Moreover, a number of different processes are known to be involved in osteoarthritis,[1 2] so it is uncertain what process the scan may be monitoring. Studies in other arthritides suggest that the abnormality monitored is non-specific.[5–8] The sensitivity of scanning allows early detection of a number of conditions, particularly septic arthritis,[9 10] rheumatoid arthritis,[8 11] ankylosing spondylitis,[12] and psoriasis.[8] In osteoarthritis the discordance of the *x* ray and scan has been noted previously,[7 13] with joints shown to be abnormal on *x* ray but normal on scan. We have described the pattern of involvement in the hand, and noted the presence of joints abnormal just on scan and normal or with only minor abnormality on *x* ray.[3] This study shows the importance of this pattern to subsequent changes that occur in osteoarthritis. It may allow a more quantifiable method of assessing change in osteoarthritis. It may also give greater insight into the pathological processes that are actually involved.

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References

1 Bland J H. Cooper S M. Osteoarthritis: a review of the cell biology involved and the evidence for reversibility. Management rationality related to known genesis and pathophysiology. *Semin Arthritis Rheum* 1984; **14:** 106–33.

2 Peyron J G. Epidemiologic and etiologic approaches to osteoarthritis. *Semin Arthritis Rheum* 1979; **8:** 288–306.

3 Hutton C W, Higgs E R, Jackson P C, Watt I, Dieppe P A. ^{99m}Tc HMDP bone scanning in generalised nodal osteoarthritis. I. Comparison of the standard radiograph and four hour bone scan image of the hand. *Ann Rheum Dis* 1986; **45:** 617–21.

4 Kellgren J H, Moore R. Generalised osteoarthritis and Heberden's nodes. *Br Med J* 1952; **i:** 181–7.

5 McCarty D H, Polcyn R E, Collins P A. ^{99m}Tc scintigraphy in arthritis. II. Its non-specificity and clinical and roentographic correlations in rheumatoid arthritis. *Arthritis Rheum* 1970; **13:** 21–32.

6 Bekerman C, Genant H K, Hoffer P B, Kozin F, Ginsberg M. Radionuclide imaging of the bones and joints of the hand. A definition of normal and a comparison of sensitivity with ^{99m}Tc pertechnate and diphosphonate. *Radiology* 1976; **118:** 653–9.

7 Sy W M, Bay R, Camera A. Hand images: normal and abnormal. *J Nucl Med* 1977; **18:** 419–24.

8 Weissberg D L, Resnick D, Taylor A, Becker M, Alazraki N. Rheumatoid arthritis and its variants: analysis of scintiphotographic, radiographic, and clinical examination. *Am J Roentgenol* 1978; **131:** 665–73.

9 Gilday D L, Paul D J, Paterson J. Diagnosis of osteomyelitis in children by combined blood pool and bone imaging. *Radiology* 1975; **117:** 331–5.

10 Lisbona R, Rosenthall L. Observations on the sequential use of ^{99m}technetium phosphate complex and ^{67}Ga imaging in osteomyelitis, cellulitis and septic arthritis. *Radiology* 1977; **123:** 123–9.

11 Maxfield W S, Weiss T E, Shuler S E. Synovial membrane scanning in arthritic disease. *Semin Nucl Med* 1972; **2:** 50–70.

12 Chalmers I M, Lentle B C, Percy J S, Russell A S. Sacroiliitis detected by bone scintiscanning: a clinical, radiographic and scintigraphic follow-up study. *Ann Rheum Dis* 1979; **38:** 112–7.

13 Hoffer P B, Genant H K. Radionuclide joint imaging. *Semin Nucl Med* 1976; **6:** 121–37.