THE ROLE OF GALLIUM SCANNING IN THE DETECTION OF
BONE AND JOINT SEPSIS

by

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SUMMARY
The value of gallium ($^{67}$Ga) scanning in the diagnosis of septic disease of bone or joint was assessed in 34 patients. The results show a sensitivity of 60 per cent and specificity of 64 per cent. The low accuracy of this method for the detection of bone and joint sepsis (62 per cent) means that gallium scanning can be used only as an adjunct to other investigative techniques.

INTRODUCTION
Gallium citrate scintigraphy is a relatively easy test to perform. It has been found of value in the detection of sarcoid tissue, some neoplasms and infection. Gallium ($^{68}$Ga) is also localised in the colon, healing wounds, fractures and inflamed synovial tissues. Concentration of $^{67}$Ga at sites of inflammation is believed to be due to the exudation of in vivo labelled serum proteins and leucocytes, particularly neutrophils. Gallium accumulation at the site of bone infection was first reported in 1975, and gallium scintigraphy was reported to be of value in the elucidation of the problems of painful hip replacements in 1981.

Practising clinicians require accurate information on the reliability of diagnostic techniques currently employed in their own centres and, although gallium scans have been in use for five years at the Royal Victoria Hospital, critical analysis of the results of this technique had not been performed. Its usefulness has been assessed elsewhere, one such review showing sensitivity and specificity to be 90 per cent and 64 per cent respectively.

Over a five-year period, 34 patients had gallium scanning performed as part of their investigation for suspected infection of bone or joint. The aim of this review is to assess the accuracy of $^{67}$Ga scans carried out in this centre for this purpose.

MATERIALS AND METHODS
Information was obtained from hospital records. The symptoms of all 34 patients at presentation led to a differential diagnosis which included infection. In all cases, a final diagnosis based on the data available was obtained, and these diagnoses were compared with the conclusions obtained from the gallium scans, from which the sensitivity, specificity and accuracy of the methods could be calculated. The ages of the group ranged from 15 to 87 years; the mean age was 62 years; 23 patients were female. Most patients suffered from conditions which could be grouped in three broad clinical categories: diabetes (five patients), pain following total hip replacement (19 patients), and rheumatoid or osteoarthritis (seven patients). Three patients could not be assigned to any of these groups. The differential diagnosis considered in each of the clinical groups is listed in Table I.

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TABLE I
Differential diagnosis in subgroups a-d

| Clinical categories | Differential diagnosis |
|---------------------|------------------------|
| (a) Diabetes (5 patients) | Infection  
|                      | Ischaemia  
|                      | Diabetic osteodystrophy |
| (b) Painful total hip replacement (19 patients) | Infection  
|                      | Loosening  
|                      | Periarticular ossification |
| (c) Osteoarthritis and rheumatoid arthritis (7 patients) | Infection  
|                      | Flare-up  
|                      | Discitis |
| (d) Other (3 patients) | Infection  
|                      | Discitis  
|                      | Osteoporosis |

A final diagnosis of infection was accepted if positive cultures were obtained from joint fluid aspirate, swab samples, blood culture or tissues obtained at operation. It was accepted that infection was present if pus was discovered at arthroscopy or if histopathology of a tissue specimen showed an infective process. Results of technetium phosphate scans, plain radiographs and erythrocyte sedimentation rate were recorded where available.

The following formulae were used: expressed as percentages, sensitivity equals the number of true positive results divided by the total of true positive and false negative results; specificity equals the number of true negative results divided by the total of true negative and false positive results; accuracy is the total of true positive and true negative scans divided by the total scans performed.

RESULTS

Ten of the 34 patients had an infective process as the cause of their symptoms. Gallium scanning correctly indicated this in six patients (six true positive). However, there were nine false positive scans, and four patients with infection had negative gallium scans (four false negative). There were 15 true negative scans (see Table II). The sensitivity of the scans is 60 per cent for the total group, 71 per cent for the bacteriologically proven group and 33 per cent for the 16 patients in whom the final diagnosis was made by clinical methods. The specificity of the method for each of the above categories is 64 per cent, 55 per cent and 69 per cent respectively.

In only one patient did gallium scanning favour the correct interpretation of symptoms where other tests were inconclusive. However, there are several cases where gallium scanning has given the only incorrect result among several other investigations performed. In the ten patients with infection the ESR ranged from 30-130 mm/l hr (mean = 64), seven has radiographs suggestive of infection and six ⁹⁹Tc-PP scans performed were suspicious of infection.
**TABLE II**

**GALLIUM SCAN ANALYSIS**

Positive and negative results shown for 34 patients who had gallium scans

|                      | 18 patients with bacteriological proof of final diagnosis | 16 patients without bacteriological proof of final diagnosis | 34 patients who had gallium scans |
|----------------------|--------------------------------------------------------|-----------------------------------------------------------|---------------------------------|
| true positive        | 5 (28%)                                                | 1 (6%)                                                    | 6 (18%)                         |
| true negative        | 6 (33%)                                                | 9 (56%)                                                   | 15 (44%)                        |
| false negative       | 5 (28%)                                                | 4 (25%)                                                   | 9 (26%)                         |
| false negative       | 2 (11%)                                                | 2 (13%)                                                   | 4 (12%)                         |
| Sensitivity          | 71%                                                    | 33%                                                       | 60%                             |
| Specificity          | 55%                                                    | 69%                                                       | 64%                             |
| Accuracy             | 61%                                                    | 63%                                                       | 62%                             |

Nineteen of the 24 patients without infection had an ESR recorded; these ranged from 1-22 mm/1 hr (mean = 31). Plain radiographs were available for 21 patients, three of which suggested infection as a cause of their symptoms. $^{99}$Tc-PP scans were performed in 18 patients, six of which were false positive for infection. Among 28 patients who had their white cell count recorded, only one showed an elevated count ($19.5 \times 10^9$/l); this patient had a salmonella infection of a hip joint. Records of antibiotic therapy either before or during investigation were complete in five patients, two of whom had proven infection. In these five patients the results of gallium scanning were three true negative, one true positive and one false negative (from which staphylococcus aureus was cultured).

**DISCUSSION**

Patients were selected because of a clinical suspicion of infection and the possibility that this might be clarified by examination of the uptake and distribution of gallium. In this series, patients with bacteriological proof of infection show sensitivity of 71 per cent and specificity of 55 per cent for gallium scanning. These figures are lower than other published results, where sensitivity is given at 90 per cent and specificity 64 per cent; however, each centre must evaluate the test and determine reliability in the context of its own results. Relatively poor specificity and sensitivity have been found elsewhere. One centre now favours indium-labelled oxyquinoline WBC scanning in its investigations because of difficulty in interpreting the gallium scans combined with a low specificity and a high amount of radioactivity in the colon. A major anxiety in the application of gallium scans in the clinical dilemma is the occurrence of false negative results which even on review are still read as negative for infection.
It has been suggested that gallium-67 accumulation in sites of infection is not hindered by antibiotic therapy; our numbers, though small, tend to support this argument. Exclusion of small groups, such as diabetics, makes no difference to the specificity and sensitivity of the method. In our series of 34 consecutive patients, gallium scanning as an aid to diagnosis of infection was shown to have relatively low accuracy. In our experience, the ESR, plain radiographs and technetium scanning should be performed to screen patients with suspected bone and joint sepsis, and in difficult cases additional information from gallium scanning may occasionally be helpful.

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