THE UTILITY OF BONE SCANS IN RHEUMATOLOGY

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ABSTRACT

Introduction: Bone scans are the commonest diagnostic imaging services requested by Australian Rheumatologists who order $50,000 (AUS) worth of bone scans annually.

Aims & Methods: To determine the reasons why Rheumatologists request bone scans and how it affects their patient management a 2 part prospective survey administered before and after every bone scan ordered by four Rheumatologists over a six month period in 1996.

Results :A total of 136 bone scans were requested and the primary indications for scanning were (1) to confirm a clinical diagnosis(38%); (2) to exclude a diagnosis (34%) ; (3) to localise site of pain (17%). The common diseases that Rheumatologists were attempting to confirm / exclude with bone scanning were inflammatory arthritis, malignancy, and fracture. However the commonest provisional and final diagnosis was soft tissue rheumatism (18%) followed by inflammatory arthritis (15%) and osteoarthritis (11%). The bone scan was successful in excluding a diagnosis in 87% and confirming a diagnosis in 80%. In 32% the bone scan altered the clinical diagnosis and in 43% it altered management. The bone scan result prevented further investigations in 60%.

Introduction

In the 1995/96 financial year the Medicare Rebate for 132 Rheumatologists practising in Australia was $2.6 million (Aust). This underestimates the true cost of bone scanning as it does not include costs borne by the State Public Hospital system, Department Veteran's Affairs, third parties, private insurers, gap payments, and many others. This test is the commonest form of diagnostic imaging ordered by Australian Rheumatologists. Most clinicians intuitively accept that bone scanning is a useful test. Why is this? Is this justifiable?

In rheumatology the reasons for doing bone scans are often complex and multiple. Most studies on bone scanning focus on its value in the assessment of specific pathologies and this has limited relevance when evaluating the test in real practice. Few studies have been done to assess the value and clinical utility of bone scanning across the spectrum of disorders presenting to a rheumatologist. Indeed there is little evidence-based medicine in relation to the use of bone scanning in any speciality. A medline search (from 1966 to July 1997) using the term radionuclide imaging and subheadings [diagnostic use], [utility], and [standards] obtained only 270 references of which only 9 made any evaluation of the clinical or diagnostic value of bone scanning.

This study was undertaken to broadly evaluate the clinical utility of bone scanning in rheumatology. The principal aims were to ascertain:

1. Why do Rheumatologists request bone scans?

2. Does the scan answer the questions posed by the requesting physician?

3. What is the nature and usefulness of the diagnostic information?

4. How often does it affect patient management?

Methods

A Prospective self-administered survey of the Rheumatologists in the Australian Capital Territory was undertaken over a six month period (March '96 - Sept. '96). All scans ordered on adult patients over this period were included. The majority of scans were on outpatients but a small number of inpatients were included. The survey was divided into 2 parts administered -one before and one after each scan undertaken (see Figure 1). All bone scans were done using Tc-99m labelled methylene diphosphonate. Both whole body (anterior and posterior) sweeps and regional scans were done on standard gamma cameras with low energy high-resolution collimators. Early phase blood flow and pool images were done in all regional scans and in those whole body scans for suspected regional pathology, polyarthritis, stress fractures, Paget's disease, osteonecrosis, infection, and synovitis. Spot views were undertaken where a suspicion of regional pathology was indicated or to further delineate an abnormality seen on the whole body scans. SPECT was not routinely undertaken.

The major variables assessed were: type of bone scan ordered, indication(s) for scan, pre-scan diagnosis, pre-scan treatment plan, post-scan diagnosis, post-scan treatment plan, clinician's diagnostic certainty, need for further tests, and patient satisfaction. The diagnostic categories used were inflammatory polyarthritis, monoarthritis, osteoarthritis, other arthritides, facet joint pain, fracture, infection, joint prosthesis, metastatic disease, osteonecrosis, other bone disorders, spondylosis, Paget's disease, reflex sympathetic dystrophy, sacroiliitis, soft tissue rheumatism, Spondyloarthritis, and neurogenic pain. Entities that are associated with a normal late phase bone scan were classified as either soft tissue rheumatism (fibromyalgia, regional pain syndromes, tendinitis, etc), spondylosis (spinal degeneration, disc and muscle pain), or neurogenic (nerve root or peripheral nerve lesions).

Results

Four Rheumatologists completed a total of 136 questionnaires over the six-month period (92 females and 44 males). There was an age range of 17 to 82 years. Ninety were whole body scans (66.2%) and the remaining 46 (33.8%) were regional. SPECT (single-photon emission computed tomography) was carried out in 8 cases (5.9%). Table1 shows the primary indications for ordering the scans.
The main indications for the study were to either to confirm or exclude a diagnosis. Table 2 and 3 lists the more common conditions Rheumatologists stated they were trying to confirm or exclude and that outcome where this was stated as an indication. Inflammatory arthritis, malignancy, and fractures were the major indications while soft tissue rheumatism, inflammatory arthritis, osteoarthritis, and fractures were the commoner diagnoses (table 4). Figure 2 shows an example where the indication was firstly to exclude metastatic disease and secondly localise the source of pain. Interestingly bone scans were not indicated to assist in patient management in any diagnosis except in Paget's disease where this was the indication in 5 of 8 cases.

Inflammatory polyarthritis (rheumatoid arthritis and other peripheral polyarthropathies) was the final diagnosis in 20 cases and in these patients the principal indications for undertaking the scan was confirming a diagnosis (11 cases), excluding a diagnosis (5 cases), and localising site of pain (4 cases). In one case of Rheumatoid arthritis an unsuspected talar dome fracture was found. In many cases the clinicians commented they were looking to increase the confidence of diagnosis where clinical signs were lacking. In four cases a final diagnosis of inflammatory polyarthritis was made where this was not the provisional diagnosis.

Provisional diagnosis (PD) and final diagnosis were the same in 76% of cases. Bone scan changed PD in 31 (24 %) of cases. 6 of 15 fractures (40%) were unsuspected. The commonest diagnosis was soft tissue rheumatism (STR) in 25 cases (18% total) and in this subgroup the post scan analysis shows 6 cases removed from the diagnosis and another 6 cases added.

Bone scans confirmed 80% of diagnoses where this was the indication for the scan. Bone scans excluded 87% of diagnoses where this was the indication (excluding those 26% where result not stated). Additional indications were listed for most scans. In 84% a second and 58% a third indication was listed

The more common 2nd indication were localising source of pain (32%), to assist in management (20%); exclude diagnosis (19%), confirm diagnosis (14%). The more common 3rd indications were confirming a diagnosis (38%); localise pain (20%); and patient related (15%).

The clinical diagnostic certainty was altered in 56.6% and patient management altered in 43%. In 60% of cases, further tests were prevented.

Discussion

This study has attempted to more precisely define the clinical utility of bone scanning in the area of rheumatology. Pre and post-test surveys allow us to assess whether a scan fulfils the objectives set by the referring doctor. A failure to satisfy this criterion either indicates a deficiency in the test, a deficiency in its interpretation, or unreasonable objective(s) on behalf of the referring physician.

The predominant reasons for rheumatologists ordering bone scans were either to confirm a diagnosis of inflammatory arthritis, osteoarthritis or fracture, or, to exclude clinical suspicion of inflammatory arthritis, malignancy or fracture. However the most common pre and post scan diagnosis was soft tissue rheumatism (STR) with one third of the diagnoses being made only after the scan. This demonstrates that a test can have a role in a diagnostic algorithm despite any direct sensitivity or specificity for the diagnosis (eg soft tissue rheumatism). In such cases the rheumatologist makes his diagnosis by using the bone scan to exclude significant bone and joint pathology which may mimic the symptom complex.

While there are many studies demonstrating the sensitivity of bone scans for specific pathologies their specific diagnostic utility has been investigated very little. McLean et al [1,2] are the only prior studies to specifically address the issue of bone scanning utility in clinical practice. McLean et al [1,2] carried out a study of 2 private and 2 hospital practices (200 bone scans) which showed bone scanning changed diagnostic certainty significantly. Their referral population consisted of mixed general practitioner & specialist referrals. They found the commonest diagnoses were metastases (34%) and fractures (23%). Two studies on head and neck cancer found routine use of bone scans was of limited value[3,4]. Several studies have described current usage patterns but drawn no specific conclusions[5,6].

This study and those of McLean et al[1,2] confirm bone scanning as a test with a high clinical utility. This study confirms that in rheumatology the reasons for doing bone scans are often complex and multiple. There were over 20 provisional diagnoses listed and in 86% of scans there were multiple indications for the test. Figure 3 (sacral fracture) is an example where exclusion of fracture, need to localise source of pain, and to help further management were all cited as indications. This complexity needs to be addressed when evaluating or benchmarking this or similar investigations

The cost effectiveness could be better assessed by more closely determining the alternative diagnostic sequences and specifically what further tests were being considered when bone scans are ordered. We did not specifically address the role of other imaging modalities. Failure of other imaging modalities may also be a legitimate indication -figure 4 demonstrates Paget's disease of R scapula more confidently reported on the plain radiograph after bone scan confirmation.

This study has attempted to more precisely define the clinical utility of bone scanning in the area of rheumatology. To get some notion of its relative clinical value it needs to be compared to other imaging modalities in the broadest sense. For example osteoarthritis was a common indication for ordering a bone scan despite its lack of diagnostic specificity in this condition. Most patients with this condition do not have a diagnostic bone scan. Figures 5(plain radiograph) and 6 (bone scan) show the same pathology but either or both may be most appropriate depending on the question the clinician is asking. In osteoarthritis the rheumatologist knows there is a poor correlation between patient's symptoms and radiograph findings but a much better correlation with bone scan findings.

This study has found bone scans alter the diagnosis in 25% and management in up to 43% of cases. Bone scanning prevented further tests in 60% The test was successful in excluding a diagnosis in at least 45 of 71 cases (63-88% depending on incomplete data) and the outcome was not stated in another 19 of these cases. A worst case scenario makes the test successful in excluding 63% of diagnoses. A best case scenario makes it 88% successful. It was successful in confirming a diagnosis in 57 of 71 cases (80%).

Further studies could be done with multiple imaging modalities using improved methodology and thus allow comparison of several tests for their broader clinical application. Only then can we make a more rational judgement as to the appropriateness of current investigation strategies and whether there is room for further improvement.

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Legends for Tables and Figures

Table 1: Primary reasons for ordering bone scans

Table 2: The scan outcome for each provisional diagnosis where the primary reason for ordering the scan was to confirm the diagnosis.

Table 3: The scan outcome for each diagnosis where the primary reason for ordering the scan was to exclude such a diagnosis.

Table 4: The pre scan and post scan diagnosis made by the referring rheumatologist

Figure 1: The self-administered questionnaire used in this survey.

Figure 2: Demonstration of probable metastatic disease at the second thoracic vertebra in a women with back pain and a history of breast carcinoma several years previously.

Figure 3: "H" fracture of sacrum in a 73-year-old lady with recent onset of lower back pain.

Figure 4: 61-year-old man with recent colonic resection for adenocarcinoma. Plain xray was initially reported as metastatic disease but after the bone scan a diagnosis of Monostotic Paget's disease R scapula could be confidently made.

Figure 5: Patient with severe wrist pain. Plain radiograph demonstrates osteoarthritis of 1st carpo-metacarpal joint.

Figure 6: Correlative bone scan of patient figure 5. This clearly defines the arthritis seen on radiograph as the likely source of the patient's symptoms. Blood pool scan (not shown) demonstrated hyperaemia indicating active synovial inflammation in this patient.

Table 1: Primary reasons for ordering bone scans

Primary Indication	Number	%
To confirm a diagnosis	53	39%
To exclude a diagnosis	48	35%
To localise source of pain	21	15%
To assist management	9	7%
Patient related	3	2%
Others	2	1%
Grand Total	136	

Table 2: The scan outcome for each provisional diagnosis where the primary reason for ordering the scan was to confirm the diagnosis.

Diagnosis to confirm	**No**	**Yes**	not stated	**Total**
Inflammatory arthritis	2	12	1	15
Osteoarthritis	2	6	0	8
fracture	0	6	0	6
Soft tissue rheumatism	1	5	0	6
sacroiliitis	0	5	0	5
Paget's disease	0	5	0	5
metastatic disease	0	3	0	3
infection	1	2	0	3
osteonecrosis	1	2	0	3
Spondyloarthritis	1	2	0	3
other bone disorders	0	3	0	3
Neurogenic pain	1	2	0	3
Facet joint pain	1	1	0	2
joint prosthesis	1	1	0	2
Other arthritides	1	1	0	2
spondylosis	0	1	0	1
sympathetic dystrophy	1	0	0	1
Grand Total	13	57	1	71

Table 3: The scan outcome for each diagnosis where the primary reason for ordering the scan was to exclude such a diagnosis.

Diagnosis to exclude	**No**	**Yes**	not stated	**Total**
Inflammatory arthritis	2	10	6	18
metastatic disease	2	12	3	17
fracture	2	8	2	12
infection	0	4	2	6
osteonecrosis	0	3	2	5
sacroiliitis	0	1	4	5
Spondyloarthritis	1	1	0	2
Osteoarthritis	0	1	0	1
Facet joint pain	0	1	0	1
joint prosthesis	0	1	0	1
other bone disorders	0	1	0	1
spondylosis	0	1	0	1
sympathetic dystrophy	0	1	0	1
Grand Total	7	45	19	71

Table 4: The pre scan and post scan diagnosis made by the referring rheumatologist

Diagnosis	**No**	**%**	**No**	**%**
	Pre-scan		**Post-scan**	
Soft tissue rheumatism	25	18%	25	18%
Inflammatory arthritis	20	15%	20	15%
Osteoarthritis	13	10%	15	11%
Fracture	11	8%	15	11%
Spondylosis	10	7%	10	7%
Paget's disease	9	7%	8	6%
Other bone disorders	8	6%	4	3%
Neurogenic pain	8	6%	10	7%
sacroiliitis	5	4%	4	3%
Spondyloarthritis	5	4%	5	4%
other arthritis	3	2%	5	4%
infection	3	2%	1	1%
metastatic disease	3	2%	3	2%
osteonecrosis	3	2%	1	1%
miscellaneous	3	2%	5	4%
Facet joint pain	2	1%	2	1%
joint prosthesis	2	1%	1	1%
reflex sympathetic dystrophy	2	1%	1	1%
monoarthritis	1	1%	1	1%
Grand Total	136		136	