We have reported that focal marrow replacement may be seen fortuitously as a lack of uptake of radiocolloid in bone marrow at the time of liver scintigraphy (1). Such a finding is usually very subtle. The impression that there is focal marrow disease can, however, then be confirmed by obtaining a supplementary view of marrow alone registering both more counts from marrow and using a higher intensity setting (a "saturated" image).

In was evident from our initial report (1) and our other experience including that with Paget's disease of bone (2) that this finding is not specific and that radiographic correlation, in particular, is desirable. Nevertheless disease otherwise unsuspected can thus be recognized.

Since our report, the incidental finding of focal marrow replacement associated with discitis has been described (3). Indeed it is self-evident that the differential diagnosis of focal marrow replacement (a marrow "cold spot") is the same as that for a radionuclide bone scan "hot spot" (4) except that both bone and marrow "cold spots" may result from local irradiation.

Our initial report concerned the serendipitous observation of focal marrow disease. We have since proceeded to analyze the value of adding a marrow image to our existing protocol for liver scintigraphy with radiocolloid (5). The results of that prospective study are reported here.

PATIENTS AND METHODS

In 205 consecutive patients referred for liver scintigraphy with radiocolloid at a cancer institute additional gamma camera images of the bone marrow in pelvis and lumbar spine were obtained posteriorly. These images were made by exposing for 300 sec at an intensity calibrated to produce saturated views of bone marrow (Fig. 1). Usually 150,000 to 250,000 counts are accumulated. It is necessary to image for a predetermined time rather than for a given number of counts if one is to be able to diagnose diffuse as well as focal marrow replacement (Figs. 2 and 3). This strategy thus adds a little over 5 min to the time taken for an examination of the liver and spleen with radiocolloid. The radiocolloid is manufactured and supplied by the Edmonton Radiopharmacy Centre.

Of the 205 patients, three proved to have had repeat examinations during the course of this study and two not to have malignant disease. Therefore, 200 consecutive patients with cancer had radiocolloid studies available for analysis and correlation with radiographs, bone scintigraphs, and biopsy data. The 200 patients had 206 cancers (Table 1).

The liver and marrow examinations were reviewed "blind" by three observers. Agreement by any two was considered to be definitive but all three agreed in 177 patients (89%). Equivalent results were disregarded, i.e., considered to be normal.
FIGURE 1
A normal marrow scan. Exposure 300 sec at an intensity
designed to produce this saturated image.

RESULTS

It will be evident from Table 2 that radiocolloid marrow examination has an accuracy, sensitivity, and
specificity comparable to radiocolloid liver imaging in
this selected group of patients with a history of malign-
ant disease. For reasons described in that table the
incidence of false-positive examinations is exaggerated,
since correlative data was not available to the “blinded”
physician in contrast to the situation in which he usually
makes inferences from scans.

The analysis by disease (Table 3) is not particularly
revealing except that the sensitivity of the technique is
poor (0.50%) compared with the marrow biopsy data
often available in patients with lung cancer.

The yield of bone marrow abnormalities in patients
with cancer of the bowel was zero (Table 4) and this
might have been anticipated from clinical knowledge
of these cancers. However, 8.0% of all marrow scans

FIGURE 2
A: Focal marrow replacement due to metastatic disease (arrow). B: A [99mTc]MDP bone scan obtained within 2 mo on
the same patient as in Figure 2A and showing complementary evidence of disease (arrow).

FIGURE 3
Diffuse marrow replacement in a patient with lymphoma
and biopsy-proven evidence of marrow infiltration.
were abnormal and 4.0% were abnormal when radiographs were normal. Two patients had abnormal marrow scans when both radiography and bone scintigraphy was negative, with disease present as confirmed by marrow biopsy and follow-up.

If patients with bowel cancer are excluded 12.4% of the remaining patients had abnormal marrow scan findings. This number is sufficiently large so that we continue to obtain single marrow images in clinical practice.

DISCUSSION

Ito et al. (6) have described experimental data which reflect the greater sensitivity of marrow imaging than bone imaging in the detection of metastatic disease involving the skeleton. The reality that prevents an application of this fact on a daily basis in clinical practice is the practical limitations of such marrow-imaging agents as are now available. In addition, marrow imaging of metastases seeks “cold” lesions in a “hot” ground, whereas the technetium-99m (99mTc) phosphates usually enjoy the more advantageous circumstance of revealing “hot” lesions on a “cooler” background.

Nevertheless, there are reports that marrow scintigraphy, despite its obvious practical limitations, may be more sensitive than other techniques in revealing metastatic involvement of the skeleton if, for these purposes, the skeleton is defined as both mineralized matrix and marrow (7–10).

Our contribution has been, first, to suggest that focal marrow lesions can be identified as an incidental finding on radiocolloid scintigraphy of the liver (1). The data presented here suggest, moreover, that a deliberate strategy of imaging part of the bone marrow at the time of liver colloid scintigraphy, except in patients with gastrointestinal cancers, by obtaining saturated images at appropriate intensities, will provide information useful in the management of patients. Given that focal marrow replacement is no more specific in its implications than focal increases in uptake of [99mTc] phosphates, then, if such images are analyzed with appropriate rigor and with radiographic correlation where indicated in patients known to have or have had cancer, we have already had cause to observe their usefulness in day-to-day clinical practice.

We have not formally examined the cost-benefit of the strategy we propose. Other views, for example of the dorsal spine, might increase sensitivity but we have chosen the one single view with the potential to yield most positive results with only a short penalty in time. Certainly it does not seem justified to extend the strategy to patients other than those with solid tumors which frequently metastasize to bone.

As indicated, it is our advice to clinicians concerning patients in whom the bone marrow scan reveals focal disease to obtain radiographic correlation, and, if this is negative, a radionuclide bone scan.

It should be noted that it has been suggested that an anterior view of the pelvis may also be helpful when colloid liver and spleen images are obtained in the context of trauma, to look for bleeding (11).
TABLE 4
Yield of Abnormal Findings on Radiocolloid Marrow Scans

<table>
<thead>
<tr>
<th>Disease</th>
<th>N</th>
<th>Positive</th>
<th>Positive with negative radiographs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer of large bowel</td>
<td>71</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cancer of breast</td>
<td>48</td>
<td>8 (17%)</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Cancer of lung</td>
<td>25</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>62</td>
<td>7 (11%)</td>
<td>5 (8%)</td>
</tr>
<tr>
<td></td>
<td>206</td>
<td>16 (7.7%)</td>
<td>8 (3.9%)</td>
</tr>
</tbody>
</table>

Some patients had more than one cancer but no such patient had an abnormal marrow scan to thus artificially increase the detection rate.

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