Role of radionuclide imaging in the evaluation of wrist pain

The cause of hand and wrist pain can be difficult to determine, especially when standard radiographs are normal or show only nonspecific changes. This study reports the effectiveness of radionuclide imaging in the evaluation of patients with hand and wrist pain of uncertain cause. Eighty-eight patients with hand and wrist pain and initially normal standard radiographs were evaluated prospectively by additional radiographic methods including the following: routine tomography, wrist arthrography, computerized tomography, or magnetic resonance imaging. Each patient also had bone scintigraphy. The diagnosis established by clinical assessment and by other imaging methods was then compared with the scintigraphic findings. The presence or absence of focal scintigraphic abnormalities correlated with the presence or absence of focal pathology definable by the conventional methods in 88% of patients. As expected, scintigraphy was chiefly of value in defining the locus of an injury or other process in the wrist, rather than the nature of an abnormality. The scintigrams were abnormal in 95% of cases involving complete intrinsic ligament ruptures and fractures and were normal in 96% of patients with no definable injury. Scintigraphic findings correlated poorly with partial intrinsic ligament injuries and in cases of synovitis. Radionuclide imaging is a sensitive means of detecting focal lesions in patients with hand and wrist pain of unknown cause. (J HAND SURG 1988;13A:810-14.)

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The cause of hand and wrist pain can be difficult to diagnose and the selection of proper therapy is often delayed, particularly when conventional radiography reveals no abnormalities. Conservative management results in gradual resolution of symptoms in some patients. However, pain persists in others and they are often labeled empirically as having sprains, strains, synovitis, or even arthritis. Treatment with non-steroidal, anti-inflammatory agents, physical therapy and/or immobilization for weeks or months will result in little or no improvement. The role of wrist arthrog-

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Scintigraphic evaluation has also been recommended by several investigators. The purpose of this study was to determine the potential effectiveness of radionuclide imaging in guiding the further evaluation of patients with hand and wrist pain of unknown cause.

Materials and methods

Between January 1982 and February 1986, 88 patients with normal conventional radiographs and unexplained hand and wrist pain were evaluated prospectively. Conventional radiographs consisted of four views: lateral, oblique, posteroanterior, and scaphoid. Further testing of these 88 patients variably included wrist arthrography, fluoroscopy, tomography, spot films, magnetic resonance imaging (MRI), and computed tomography (CT) to establish the diagnosis. Radionuclide imaging of the hands and wrists was also performed in each of the 88 patients. Scintigraphy was done by administering 20 mCi of Tc 99m methylene diphosphat e as a bolus by rapid intravenous injection into the antecubital vein of the opposite extremity. Im-
aging was obtained in three phases as follows: (1) radionuclide angiography in either palmar or dorsal projection, (2) immediate postinjection static ("blood pool") imaging in both palmar and dorsal projections, and (3) delayed imaging at 2 hours. Magnification-delayed images in palmar and dorsal projections were obtained with converging collimation for 10 minutes per view (yielding 250,000 to 300,000 counts). Additional projections and/or pinhole magnification images were obtained as indicated by the initial clinical or scintigraphic findings. The scintigraphic images were evaluated for evidence of increased or decreased activity relative to the normal side and relative to the expected normal scintigraphic appearance of the hand and wrist.

On the basis of the composite information from the clinical history, physical examination, wrist arthrography, spot films, tomography, MRI, and/or CT, each patient was assigned to one of the following nine diagnostic categories: (1) no evidence of significant pathology, (2) asymptomatic intrinsic ligamentous abnormalities, (3) incomplete intrinsic ligamentous tears, (4) complete intrinsic ligamentous tears, (5) capsular or extrinsic ligamentous tears, (6) fracture, (7) soft tissue injury, (8) synovitis, and (9) reflex sympathetic dystrophy. This final diagnosis was then compared with the findings of bone scintigraphy (Fig. 1).

**Results**

**No evidence of significant pathology.** Twenty-six patients had no clinically or radiographically demonstrable abnormalities. Twenty-five of these patients had normal scintigrams. One patient had unexplained activity over the triquetrum, which did not correspond to the location of his point tenderness on examination. These 26 patients were all followed for at least 6 months, and in no case did the diagnosis change.

**Asymptomatic abnormalities.** Ten patients had asymptomatic abnormalities on arthrography. The term asymptomatic is used because the locus of the patient’s pain did not correspond with the location of the abnormality seen by arthrography. There were seven triangular fibrocartilage complex (TFCC) perforations and three lunotriquetral perforations. Nine of these 10 patients had normal bone scintigrams, while one asymptomatic lunotriquetral ligament tear was associated with focally increased activity.

**Incomplete intrinsic ligamentous tears.** Five patients had incomplete intrinsic ligamentous tears demonstrated arthrographically. There were three scapholunate tears, one TFCC tear, and one lunotriquetral ligament tear. Three patients had abnormal scintigrams correlating with the site of ligament rupture. Of the two patients with normal scans, one had an incomplete scapholunate tear and one had a small tear of the TFCC.

**Complete intrinsic ligamentous tears.** Complete intrinsic ligamentous tears were found on arthrography in 13 patients (Fig. 2). Two patients each had complete tears of two separate intrinsic ligaments. There were nine scapholunate tears, five lunotriquetral tears, and one TFCC tear. Twelve of 13 patients had abnormal scintigrams. Ten had focally increased activity at the site of the injury, and two had diffusely increased uptake of the radiopharmaceutical throughout the carpus. One patient with a complete lunotriquetral tear had a normal scintigraphic study.

**Capsular or extrinsic ligamentous tears.** Three patients had symptomatic capsular or extrinsic ligamentous tears by arthrography. All had abnormal bone scans. One patient had intense focal activity over the radiocarpal joint (the site of tear), and the other two had diffusely increased activity throughout the wrist.

**Fractures.** Ten patients had occult fractures not visualized on routine films but subsequently documented by tomography (Fig. 3). All 10 bone scintigrams dem-
Fig. 2. Ligamentous injury. This 47-year-old man injured his right wrist and has persistent pain. Palmar and dorsal delayed scintigrams show mild, diffusely increased activity in the right carpus, with slight focally greater increased activity in the lunate region. A lunotriquetral ligament tear was confirmed by arthrography.

Table I. Frequency of scintigraphic abnormalities

<table>
<thead>
<tr>
<th>Injury</th>
<th>Normal</th>
<th>Abnormal</th>
<th>% agreement with diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>No demonstrated pathology*</td>
<td>25</td>
<td>1</td>
<td>96</td>
</tr>
<tr>
<td>Asymptomatic abnormalities*</td>
<td>9</td>
<td>1</td>
<td>90</td>
</tr>
<tr>
<td>Symptomatic incomplete intrinsic ligamentous tears</td>
<td>2</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>Symptomatic complete intrinsic ligamentous tears</td>
<td>1</td>
<td>12</td>
<td>93</td>
</tr>
<tr>
<td>Capsular or extrinsic ligamentous tears</td>
<td>0</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Fractures</td>
<td>0</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Soft tissue injury</td>
<td>0</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Synovitis</td>
<td>5</td>
<td>9</td>
<td>64</td>
</tr>
<tr>
<td>Reflex sympathetic dystrophy</td>
<td>1</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>TOTAL</td>
<td>43</td>
<td>45</td>
<td>(77/88) 88</td>
</tr>
</tbody>
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* In these two diagnostic categories, a normal scintigraphic study was considered to be in agreement with the final diagnosis. In all other categories, an abnormal study was considered to be in agreement.

Demonstrated intense, focally increased activity at the site of the fracture. The trapezium was fractured in five cases. There were single fractures involving the scaphoid, hamate, capitate, distal ulna, and distal radius.

Soft tissue injuries. Four patients had sustained crush injuries with no demonstrable pathology other than soft tissue swelling. All four bone scintigrams showed multiple areas of increased activity. No fractures were detected. The arthrograms were normal.

Synovitis. Fourteen patients with wrist pain, swelling, and/or tenderness on physical examination and with normal films were diagnosed as having synovitis.

Nine patients had abnormal bone scintigrams showing diffusely increased uptake. This was often more prominent on the “blood-pool” images than on the delayed images as would be expected with an inflammatory process chiefly of periarticular soft tissues. The five patients with normal studies were judged clinically to have mild synovitis.

Reflex sympathetic dystrophy. Three patients were diagnosed as having classic reflex sympathetic dystrophy. Two had diffusely abnormal bone scans with findings typical of reflex sympathetic dystrophy. These findings included diffuse hyperperfusion of the hand and
The patients with wrist pain were found to have an abnormal scintigram in 88% of all cases. Scintigrams showing increased osseous activity with periarticular accentuation on the delayed images were observed. The third had increased activity in the distal radius and mildly increased activity in the carpus on the delayed images. There was neither hyperfusion nor hyperemia of the hand and wrist, nor was there increased activity in the hand on delayed images. These findings were believed not to be consistent with the diagnosis of reflex sympathetic dystrophy. However, the diagnosis of reflex sympathetic dystrophy was independently confirmed by two hand surgeons and a neurologist.

Discussion

In this study, the results of the scintigraphic evaluations corresponded with the final diagnostic assessments in 88% of all cases (Table I). In severe injuries (complete intrinsic ligamentous tears and fractures), the scintigrams were abnormal in more than 95% of cases. Conversely, the scintigrams were normal in 96% of patients in whom no demonstrable injury was present and in 90% of those with asymptomatic abnormalities demonstrated by arthrography. Bone scintigraphy was less helpful in synovitis and in incomplete intrinsic ligament injuries.

As a result of our experience, bone scintigraphy has assumed an important role in our evaluation of unexplained wrist pain (Fig. 4). Bone scintigraphy identifies areas with altered bone blood flow, active new

Fig. 3. Hook of hamate fracture. This 37-year-old man fell and injured his right wrist 3 weeks ago. Plain radiographs at the time of the injury were negative, but he continued to have persistent pain, swelling, and tenderness over the hook of the hamate. Dorsal and palmar delayed scintigrams show moderately intense, focally increased activity in the region of the right hamate. A medial projection (not shown) confirmed that the increased activity was in the hook of the hamate.

Fig. 4. Strategy for evaluating unexplained wrist pain. "Further evaluation" consists of one or more of the following: instability series, spot films, magnified views, fluoroscopy, CT, and MRI.
bone formation, or both. In areas of intense, focally increased tracer uptake, an occult fracture must be excluded with spot films or tomography.

Mildly increased focal activity suggests a ligamentous injury and the need for arthrography. Alternatively, these abnormalities may be further examined by wrist arthroscopy. The mechanism for increased tracer accumulation in such cases may be related to periosteal reaction secondary to ligamentous avulsion, early degenerative disease, or bone remodeling accompanying altered stress. A nonspecific increase in activity may be obtained in the presence of an inflammatory process. In this event, laboratory screening (chemistry profile, hematologic profile, erythrocyte sedimentation rate, rheumatoid factor, and anti-nuclear antibody) should be performed to exclude the presence of a rheumatologic disorder. Any abnormality should be pursued by further testing and possibly medical consultation. A normal scintigram argues against major osseous pathology and can be used to avoid unnecessary immobilization and further diagnostic tests. However, in no case should the scintigraphic result supersede clinical judgment. A normal study should be discounted if pathology is clinically apparent.

When used early in the diagnostic course, radionuclide imaging appears to be a sensitive method for evaluating patients with unexplained hand and wrist pain. It can reliably separate those patients who need further evaluation from those without demonstrable pathology. However, it appears that, after an indeterminate time following an injury, the sensitivity of scintigraphy may decrease. In the three patients with symptomatic intrinsic ligamentous tears who had normal scintigrams, the average duration of symptoms was 21.8 months, compared with an average of 9.0 months in patients with similar pathology and positive scintigrams. Bone scintigraphy seems to be less reliable in evaluating these remote injuries.

Finally, it must be emphasized that the scintigraphic result must be evaluated in conjunction with clinical information. With the exception of the intensely increased focal activity associated with an occult fracture, abnormal scintigraphic findings are generally nonspecific, and there is much overlap in the scintigraphic appearances of various disorders associated with wrist pain. Although a negative result may permit cessation of diagnostic efforts, a positive study warrants clinical correlation and further radiographic evaluation, with particular attention to the locus of scintigraphically demonstrated abnormalities.

REFERENCES