The pertechnetate joint scan

II. Clinical correlations

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There are two distinct phases in the assessment of a patient presenting with symptoms in and around the joint. The first is to determine whether joint inflammation is actually present; the second is to elucidate the cause of the inflammatory arthritis, if present. This study relates to the first of these problems. It is a frequent observation that patients presenting with symptoms of arthritis may initially have few definite findings on objective evaluation and may only later manifest obvious joint swelling or other clear-cut signs of inflammation. This presentation of symptoms without definite signs may last for a long time in patients who eventually prove to have rheumatoid arthritis. It is also likely that, in some patients who finally develop advanced destructive disease, objective signs of inflammation are never overt. We believe that the joint scan is a valuable adjunct to the identification and documentation of patients with joint inflammation.

Methods

We used intravenous technetium in the form of pertechnetate ($^{99m}\text{TcO}_4^-$) in a dosage of 15 mc. and examined the areas of interest with a scintillation camera in 24 control subjects at varying time intervals up to 1 hr after administration of the isotope for unrelated studies. In these normal subjects, some minimal differences in pattern were seen but, with experience, these could easily be distinguished from the joint abnormalities seen in arthritic patients. Our experience, therefore, differed from that of Cohen and Lorber (1971). Although the official reading for purposes of this study was done by one observer, subsamples read independently by another observer were in excellent agreement. The normals were derived from the same hospital population as the arthritis patients and their ages were comparable. We found, as have other workers, that inflamed joints stand out as areas of increased radioactivity (Alarcón-Segovia, Tovar, Adame, and Trujeque, 1969; Whaley, Pack, Boyle, Dick, Downie, Buchanan, and Gillespie, 1968; Powell, 1968; Green and

Hays, 1969). Not all joints are easily visualized with this method: the hands, wrists, feet, knees, and ankles are the most accessible to study.

Since it is difficult to prove that joint scan abnormalities can represent mild degrees of inflammation not otherwise detectable, we have assessed the value of joint scan in a selected group of 53 patients with inflammatory rheumatic diseases from the Buffalo Veterans Administration Hospital. These patients were characterized clinically and radiologically in addition to the scan. The scans from the normals subjects were not mixed with those from the arthritic patients, but only a minority of the latter group had many abnormal joints or areas. This means that the 'index of suspicion' would not be very much less than if the 53 normals had been mixed with the eighteen normal subjects. One observer interpreted the scans and the other the x-rays and clinical examination independently. Only one observer read the x-ray studies for the purposes of this study. However, subsample re-study indicated excellent intra-observer agreement, and for comparison with the other parameters this would appear to be satisfactory. Results of these three parameters were blindly and independently recorded, and the data were subsequently collated. For the clinical examination, the usual signs of soft tissue swelling, effusion, tenderness, diminished range of motion, and deformity were identified as positive. Some of these changes could reflect permanent damage rather than continued inflammation, but all these criteria were included in order to increase the sensitivity of the clinical examination. Since mild degrees of inflammation are difficult to be sure of clinically, by assuming that a deformed joint might have some residual inflammatory activity, we in a sense 'challenged' the joint scan to be even more sensitive. For radiological assessment, erosive changes and joint space narrowing were the predominant criteria, but deformity and soft tissue swelling were also observed. Isolated juxta-articular osteoporosis, osteophytes, cysts, or questionable sclerosis were not considered sufficient. These parameters either have no definite relation to inflammatory joint disease or are too subjective for reliable use. Joint scan positivity was identified as an area of abnormally increased radioactivity.

The patients selected for study included persons with definite diagnosis of rheumatoid arthritis, gout, Reiter's disease, psoriatic arthritis, and ankylosing spondylitis with peripheral joint involvement. These cases were grouped together since the scan does not distinguish between causes of inflammatory joint disease (Weiss, Maxfield, Murison, and Hidalgo, 1965). There was a wide range of duration of disease. Patients with degenerative joint disease were also studied to a more limited extent.

Results

There was some variability in normal scans of the hands and feet but areas of questionably increased uptake in the normal subject, were, fortunately, almost always located away from joints. As a result, the interpretation of joint scans as positive or negative was usually accomplished with very little difficulty. One or more abnormal joints were seen in each of the group of 53 patients, all except three of whom were males. Tables I to IV show the analysis of the correspondence among clinical, x-ray, and scan studies. The studies of the wrists (Table I) showed that in eighteen wrists there was complete concordance of the x-ray, scan, and clinical findings pointing to abnormality of the joint. Similarly, in 39 wrists (all of these patients had positive findings elsewhere at the same time), there was concordance of these three methods of examination, indicating that the study was normal. In six joints, the x-ray and scan were positive but the clinical examination was negative. In fifteen joints, the x-ray was negative but the scan and clinical examination were positive, and in ten wrists the scan was the only abnormal finding. In the few patients in whom the scan was negative, review of the original data showed, in retrospect, that diminished dorsiflexion was the only abnormal finding. These might be instances of burnt-out disease.

Table I Wrist studies

<i>X-ray findings</i>	<i>Positive</i>		<i>Negative</i>	
<i>Clinical findings</i>	<i>Pos.</i>	<i>Neg.</i>	<i>Pos.</i>	<i>Neg.</i>
Positive	18	6	15	10
Scan				
Negative	1*	4	3†	39‡

* Diminished extension only.

† 2/3 diminished extension only.

‡ Positive findings elsewhere at same examination.

In Table II, the data obtained from the second metacarpophalangeal joint show that, in nineteen joints, there was complete concordance for abnormality and in 40 joints there was complete concordance for normality. In twelve joints, the x-rays

Table II Metacarpophalangeal joint 2

<i>X-ray findings</i>	<i>Positive</i>		<i>Negative</i>	
<i>Clinical findings</i>	<i>Pos.</i>	<i>Neg.</i>	<i>Pos.</i>	<i>Neg.</i>
Positive	19	12	7	10
Scan				
Negative	2	3	3	40*

* Positive findings elsewhere at same examination.

and scans were positive in the absence of clinical findings, and in ten joints the scan was the only positive finding. Table III presents the analysis of the first metacarpophalangeal joint. Fewer joints were x-ray positive compared with the other joints and in thirteen joints the scan was the only positive finding. Some scan-negative joints, in the presence of positive clinical findings, showed only subluxation. This, again, may indicate an inactive process.

Table III Metacarpophalangeal joint 1

<i>X-ray findings</i>	<i>Positive</i>		<i>Negative</i>	
<i>Clinical findings</i>	<i>Pos.</i>	<i>Neg.</i>	<i>Pos.</i>	<i>Neg.</i>
Positive	8	4	13	13
Scan				
Negative	1*	3*	3†	50‡

* Subluxation only.

† 1/3 subluxation only.

‡ Positive findings elsewhere at same examination.

The fourth and fifth metatarsophalangeal joints were analysed together as a unit because it is sometimes difficult both clinically and on scan to distinguish inflammation between these two joints. Table IV shows that in twenty joints all three examinations were positive and in 27 all three were negative. But, in contrast to studies in other joints, only one instance occurred in which the scan was the only abnormal finding. On the contrary, in seventeen joints the x-ray was the only abnormal finding. In this unique region, the x-ray changes are apparently of unusually great sensitivity, either because radiological changes take place early or because there is an insufficient mass of inflammatory tissue to make the positive scan an early finding. Alternatively, the radiographs could conceivably have been over-interpreted.

Table IV Metatarsophalangeal joints 4 and 5

<i>X-ray findings</i>	<i>Positive</i>		<i>Negative</i>	
<i>Clinical findings</i>	<i>Pos.</i>	<i>Neg.</i>	<i>Pos.</i>	<i>Neg.</i>
Positive	20	14	2	1
Scan				
Negative	3	17	0	27*

* Positive findings elsewhere at same examination.

In a special study patient, we performed a joint scan with the Anger camera 90 mins after pertechnetate injection and then aspirated the joint, removing 75 ml. synovial fluid. The joint scan was repeated. There was no significant difference in scan positivity before and after the aspiration (Fig. 1). The synovial fluid in a flask was then similarly positioned, counted to the same time period, and another scan obtained. This showed that only an inconsequential amount of scan positivity was accounted for by the synovial fluid radioactivity, in spite of the fact that this procedure would tend to give more external counts than the same fluid located inside the synovial cavity. The external counts from the fluid plus a *normal* scan in this area would clearly not add up to an abnormal scan.

A patient with psoriasis presented with marked swelling of the third left proximal interphalangeal joint and had no other joint symptoms or signs. On scanning the hands, we found a positive area, not only over the clinically involved joint, but also over the metacarpophalangeal and distal interphalangeal joint of the same digit (Fig. 2). There were also several areas of abnormal radioactivity of the feet.

Scans of patients with Heberden's nodes were generally negative but knee scans of patients with degenerative joints disease with pain and effusion were positive.

FIG. 1 Abnormal knee scan before and after aspiration of synovial fluid and a scan of the fluid removed

FIG. 2 Joint scan of a 40-year-old female with psoriasis presenting with signs and symptoms confined to the right third proximal interphalangeal joint. Scan positivity is also observed in the third metacarpophalangeal and distal interphalangeal joints

Application of heat (55°C., 10 min.) or cold (0°C., 10 min.) to the extremities before or during the scan study did not result in obvious alterations in the normal areas or in the areas of abnormal radioactivity uptake.

Discussion

Our studies with the pertechnetate joint scan in general confirm and extend the observations of McCarty, Polcyn, and Collins (1970a) on the clinical usefulness of the procedure. However, we were not able to confirm the finding of McCarty and others (1970a) of 'late visualization' of a large joint with a large effusion (McCarty, Polcyn, Collins, and Gottschalk, 1970b). These workers also feel that, where a large effusion is present, synovial fluid radioactivity may account for the positive scan. Our studies indicate that even a large effusion makes a very small contribution. Timing data, presented in the companion communication (Hays and Green, 1972) are incompatible with a significant contribution of synovial fluid radioactivity to joint scan positivity.

Our results document good correlation between scan positivity and other positive clinical findings. Although the sensitivity of the clinical examination was increased by the inclusion of parameters which may or may not reflect continuing inflammation, the scan appeared to be the most sensitive indicator studied. In addition, the scan was more reproducible and objective than clinical examination. The amount of patient radioactivity is not a limiting consideration and there is no significant discomfort from the procedure.

Correlation with clinical and radiological examina-

tion clearly shows that scan positivity is independent of x-ray abnormalities. Comparisons among the three methods of examination indicated, with the exception of the fourth and fifth metatarsophalangeal joints, that the scan was often positive when the other examinations were negative, but that the reverse was rare.

We found, using the scan, that a clinically suspected monoarticular arthritis may in fact show increased uptake in several different areas. This may be of value in differential diagnostic value (for example possible joint sepsis). The scans are also of value to assess the course in patients with known arthritis. However, the quantitative estimation of the degree of scan positivity on different examinations would be of greater value and this is currently being investigated. Recent investigations have suggested that this is feasible (Dick, Neufeld, Prentice, Woodburn, Whaley, Nuki, and Buchanan, 1970; Dick, Whaley, St. Onge, Downie, Boyle Nuki, Gillespie, and Buchanan, 1970).

Scan positivity in patients with degenerative disease of the knees is not too surprising a finding since the presence of effusion usually denotes some inflammatory component of the synovial reaction even when the underlying disease is 'degenerative'. This may also be true of some patients with early degenerative disease of the distal interphalangeal joints, but our patients with Heberden's nodes were scan negative.

Summary

Independent correlation of clinical and x-ray changes with pertechnetate scan positivity shows that this investigative technique is more sensitive than the other two, but agrees well with them.

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