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Diagnostic value of sacroiliac joint scintigraphy with 99^m technetium pyrophosphate in sacroiliitis

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SUMMARY Using a quantitative method, scintigraphy of SI joints was performed by means of 99^m technetium pyrophosphate in 21 patients with definite ankylosing spondylitis, in 17 control patients, and in 26 patients 'at risk', i.e. patients with complaints of back pain of the inflammatory type where on clinical grounds there was a possibility of sacroiliitis developing but with normal *x*-ray findings of the SI joints. Radioisotope uptake was higher in the ankylosing spondylitis group than in the other two groups, although the difference was not statistically significant with regard to the group 'at risk'. The high variance in the three groups considerably reduces the diagnostic value of the examination.

In the ankylosing spondylitis group no correlation was found between radioisotope uptake and age, duration of disease, erythrocyte sedimentation rate, or radiological stage of scaroiliitis. Since the specificity and sensitivity of scintiscanning are lower than that of clinical and radiological diagnosis of the disease, we conclude that scintigraphy is not very helpful in the early diagnosis of sacroiliitis, at least by the techniques used here.

According to various authors, scintiscanning of the sacroiliac joints (SI joints) by means of 99^m technetium pyrophosphate (99^mTc) shows an increased radioisotope uptake at the level of the SI joints in sacroiliitis (Sturrock *et al.*, 1975; Lentle *et al.*, 1977). This increased uptake can be quantified by comparing the activity over the SI joints with a similar area over the sacrum in order to produce an SI/sacrum ratio (Russell *et al.*, 1975). The use of the ratio of the average count rates rather than the absolute uptake permits exclusion of errors due to inaccurate handling in different types of counters of the injected product. It also excludes errors of absorption differences between patients due to different absorption of the 99^mTc 140 KeV gamma ray in the overlying fat and muscles.

To assess whether this procedure is of diagnostic value in screening for early sacroiliitis, scintiscanning of SI joints was performed in 21 patients with definite ankylosing spondylitis (AS), in 17 control patients, and in a group of 26 patients designated 'at risk' of sacroiliitis. We also wanted to find out whether in the patients with definite AS a correlation existed between radioisotope uptake and the erythrocyte sedimentation rate, radiographic degree of sacroiliitis, and duration of the disease. Finally, the specificity and the sensitivity of the method were compared to known clinical, biochemical, and radiological features of the disease.

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Materials and methods

The studies were done with 15 mCi Tc-stannous pyrophosphate complex (Subramanian and Mac Affee, 1971; Merrick, 1975); the radiopharmaceutical was prepared according to the manufacturer's instructions. 3 to 4 hours after injection the bladder was emptied before obtaining the image of the sacral region on an OHIO nuclear, series 100, gamma camera fitted with a parallel hole collimator, Medium 280 KeV. Data from the camera were introduced simultaneously into a small computer unit PDP 11/20 where a 64/64 point TV picture was obtained. With the aid of a joy stick, three important areas were indicated: the sacral area between the right and left SI joints, and each SI joint separately. The average count rate per channel was derived, and the ratios between the right SI joint to sacrum, and the left SI joint to sacrum were compared.

Three groups of patients were studied: 21 patients with definite AS (according to the criteria of Gofton, 1968); 17 control patients who had had no back or joint symptoms, patients with psoriasis, ulcerative colitis, Crohn's disease being excluded; 26 patients 'at risk', i.e. with inflammatory back pain in whom possible early sacroiliitis was considered, although *x*-rays of the SI joints were normal. The three groups were comparable for age and sex (Tables 1–4).

The radiological stage of the SI joints was classified according to the criteria of Bennett and Burch (1968). Measurement of anterior spinal flexion was made by a modification of a technique described by Schober (1937) and reported by Macrae and Wright (1969) and Moll and Wright (1971). Chest expansion was measured at the level of the fourth intercostal space by a technique described by Moll and Wright (1972). Both clinical criteria were regarded as abnormal if the value was less than 2 SD from the mean for that particular sex and decade (Moll and Wright, 1973).

Results (Tables 2–7)

When comparing the control group with the AS group, Table 6 shows that the mean activity ratio was higher in the AS group and that the difference is statistically significant ($P<0.01$). The variance in the AS group was also higher than in the control group (Table 7), for the right as well as the left; this difference is statistically significant (right $P<0.002$; left $P<0.04$). When comparing the control group with the group 'at risk', the mean activity ratio was higher in the group 'at risk', the difference not being significant ($P<0.10$). The variance was higher in the group 'at risk' than in the control group; here the difference is statistically significant (right $P<0.007$; left $P<0.006$). When comparing the AS group with the group 'at risk' it is notable that the difference between the two groups is not statistically significant for the mean activity ratio or for the variance.

Table 1 *Age and sex of subjects studied*

	Ankylosing spondylitis	*Controls*	*At risk*
Number	21	17	26
Mean age (years)	33·7	38·4	36·3
Sex ratio M/F	4·25/1	4·5/1	3·5/1

Table 2 *Details of 21 patients with AS*

Case no.	*Sex*	*Age (yrs)*	*Duration of disease (yrs)*	*X-ray stage of SI joint involvement*	*ESR (mm/h)*	*HLA B27*	*Ratio of counts*	
							Right	*Left*
1	M	38	18	4	14	+	1·04	1·03
2	M	29	1	2	4	+	1·87	1·68
3	M	22	3	3	31	+	1·19	1·17
4	M	31	6	2	12	+	1·22	1·12
5	M	43	10	3	50	+	1·06	1·13
6	M	39	2	0	37	+	1·26	1·24
7	M	47	13	3	40	+	1·02	1·06
8	M	27	5	3	71	+	1·21	1·34
9	F	37	5	3	23	+	1·70	1·46
10	M	39	4	2	12	+	1·28	1·21
11	M	21	14	4	27	+	1·31	1·20
12	M	37	6	3	11	+	1·17	1·22
13	F	30	7	3	20	+	1·51	1·48
14	M	33	13	3	52	+	1·31	1·30
15	M	45	11	3	12	+	1·36	1·25
16	M	30	5	3	18	+	1·48	1·37
17	M	38	5	4	15	+	1·59	1·53
18	M	44	1	2	38	+	1·01	1·10
19	F	22	1	1	40	+	1·36	1·29
20	F	27	2	2	34	+	2·16	1·75
21	M	37	4	3	27	+	1·10	1·00

Table 3 *Details of control subjects*

Case no.	*Sex*	*Age (yrs)*	*HLA B27*	*Ratio of counts*	
				Right	*Left*
22	M	47	−	1·17	1·20
23	M	47	−	1·05	1·15
24	M	47	−	1·10	1·12
25	M	48	−	1·03	1·03
26	F	35	−	1·14	1·17
27	M	45	+	1·10	1·06
28	M	25	−	1·26	1·21
29	M	30	−	1·18	1·19
30	M	36	−	1·07	1·09
31	M	34	−	1·26	1·23
32	F	35	−	1·12	0·97
33	M	21	−	0·95	1·00
34	M	47	−	1·03	1·20
35	M	37	−	1·03	1·01
36	M	42	−	1·12	1·07
37	M	46	−	1·12	1·16
38	F	37	−	1·52	1·35

Table 4 *Details of patients at risk*

Case no.	*Sex*	*Age (yrs)*	*HLA B27*	*Ratio of counts*	
				Right	*Left*
39	M	42	−	1·27	1·25
40	F	30	−	1·80	1·52
41	M	35	−	1·15	1·12
42	M	39	−	0·97	0·95
43	M	50	−	1·12	1·06
44	F	29	−	1·50	1·36
45	M	40	−	1·21	1·17
46	M	38	−	1·19	1·17
47	M	30	−	1·10	1·27
48	M	26	+	1·12	1·13
49	F	42	+	1·10	1·02
50	F	24	−	1·25	1·20
51	F	20	−	1·34	1·27
52	M	43	−	0·87	1·25
53	M	25	−	1·91	1·77
54	F	50	+	1·24	1·06
55	M	54	−	0·99	0·96
56	M	24	−	1·39	1·36
57	M	51	−	1·09	1·12
58	M	43	−	1·33	1·17
59	M	28	−	1·30	1·17
60	M	55	−	1·00	1·04
61	M	21	+	1·16	1·02
62	M	37	−	1·33	1·48
63	M	30	−	1·21	1·28
64	M	29	−	1·54	1·39

Table 5 *Activity ratio of SI joints*

Group	No. of SI joints		Mean activity ratio	Standard deviation	Standard deviation of the mean
	Right	Left			
AS	21	21	1·34	0·29	0·06
			1·28	0·20	0·04
Controls	17	17	1·13	0·13	0·03
			1·12	0·10	0·02
At risk	26	26	1·25	0·24	0·05
			1·21	0·13	0·05

Table 6 *Comparison of means (Wilcoxon two sample test)*

	Mean	P	Mean	P
Controls *vs* AS	R 1·13		L 1·12	
		<0·01		<0·01
	R 1·34		L 1·28	
Controls *vs* patients at risk	R 1·13		L 1·12	
		<0·10		NS
	R 1·25		L 1·21	
AS *vs* patients at risk	R 1·34		L 1·28	
		NS		NS
	R 1·25		L 1·21	

Table 7 *Comparison of dispersons (variance ratio)*

	Mean	P	Mean	P
Controls *vs* AS	R 0·13		L 0·10	
		<0·002		<0·04
	R 0·29		L 0·20	
Controls *vs* patients at risk	R 0·13		L 0·10	
		<0·007		<0·006
	R 0·24		L 0·19	
AS *vs* patients at risk	R 0·29		L 0·20	
		NS		NS
	R 0·24		L 0·19	

Discussion

Although the radioisotope uptake scores for the AS group as a whole were higher than in the other two groups, the variance in the three groups was high, with a significant overlapping in both directions, e.g. many 'normal' scores in the AS group, many high scores in the control and 'at risk' groups (Fig. 1). As a consequence of the high variance in the control group, the tolerance limits of the right SI/sacrum ratio are 0·70 to 1·50, and of the left SI/sacrum ratio 0·84 to 1·41 (with tolerance probability 0·95 and confidence probability 0·95). In practice it comes down to this, the scintiscans can only be considered to be pathological if the SI/sacrum ratio is higher than 1·50/1. This does not correspond with the findings of Russell *et al.* (1975), who found values less than 1·20/1 in 74 patients with no disease of the axial skeleton, as well as in 64 patients with osteoarthrosis or rheumatoid arthritis. Here it should be pointed out that in our control group 14/17 SI joints, both right and left, were below this limit, and 16/17, both right and left, were below 1·30/1. It is therefore probably true that most normal SI joints have an activity ratio below 1·20/1, though exceptions above this value are frequent. Some have expressed the opinion that these high uptakes in the control group do not relate to normal SI joints, but to pathological joints, the pathology of which is still unknown. This is of course possible. It is important that the patients with high activity ratios but no evidence of clinical disease be followed carefully (both clinically and radioisotopically) to see if they develop sacroiliitis at a later stage.

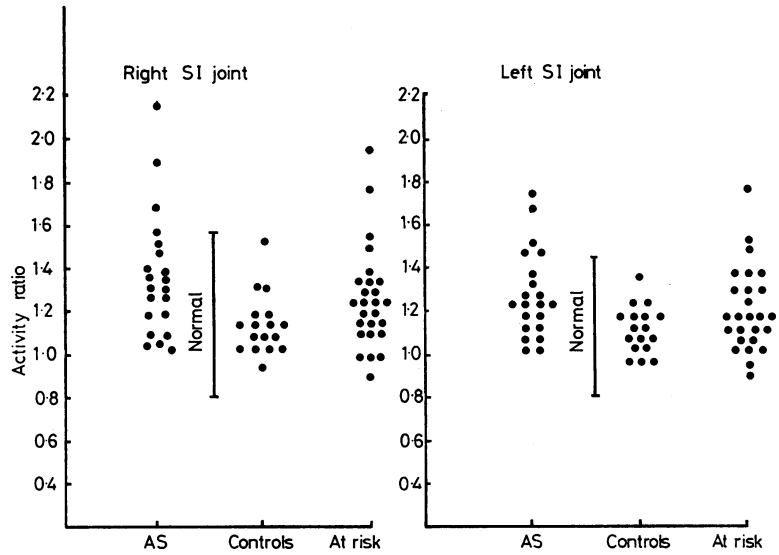

Fig. 1 *Activity ratio of SI joints. AS=ankylosing spondylitis.*

A group of patients 'at risk' was included in the trial to see whether scintigraphy could be used for early diagnosis of sacroiliits, meaning clinically 'suspicious' cases with a normal radiography of the SI joints. In this group there was no correlation between the presence of the HLA B27 antigen and scintigraphy: the 4 patients with the HLA B27 antigen all had normal scan values (with activity ratios ranging from 1·02 to 1·24). From a 3-year follow-up it has been shown that despite the high uptakes none of the patients developed sacroiliitis (Table 8); on the contrary, the patients with high uptake all seemed to fall into the category of mechanical-type back pain (caused by spondylosis, or back pain of discal or postural origin). Therefore, the fact that higher uptakes were found in the group 'at risk' than in the control group is apparently not due to the presence in this group of patients with sacroiliitis. On the contrary, we conclude that in mechanical-type backaches increased SI joint uptake can also be found.

Since from earlier reports (Van Laere *et al.*, 1972) it appeared that high uptakes are mostly found in 'active' diseases, the correlation between activity ratio on the one hand and erythrocyte sedimentation rate, radiological stage, and duration of disease on the other was also examined in the AS group. Fig. 2 shows that there is no correlation between the activity ratio and the erythrocyte sedimentation rate. Van Laere *et al.* (1972) did find a statistically significant difference between a group with an ESR below 20 mm in 1 hour and a group with an ESR above 40 mm in 1 hour; they did not however use ^{99m}Tc pyrophosphate, but strontium 87^{m} as radio-isotope).

Table 8 *Evolution of disease of patients at risk*

AS	*Mechanical back disease*	*Sero-positive RA*	*Sero-negative poly-arthritis*	*No diagnosis*	*Lost to follow-up*
54$^{(B27)}$	39	57	41	49$^{(B27)}$	61$^{(B27)}$
	40*		47	51	63
	42		48$^{(B27)}$	55	
	43		59	53*	
	44*			52	
	45				
	46				
	50				
	56*				
	58				
	60				
	62*				
	64*				

*Uptake >1·30/1.

Fig. 3 shows that the highest activity ratios were found in patients with sacroiliitis in radiological stage II; the difference however between radiological stages I and II on the one hand and stages III and IV on the other is not statistically significant. Sturrock

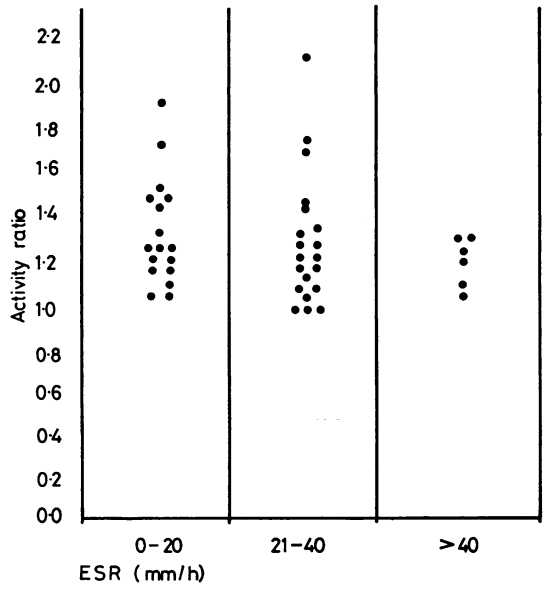

Fig. 2 *Correlation between erythrocyte sedimentation rate and activity ratio.*

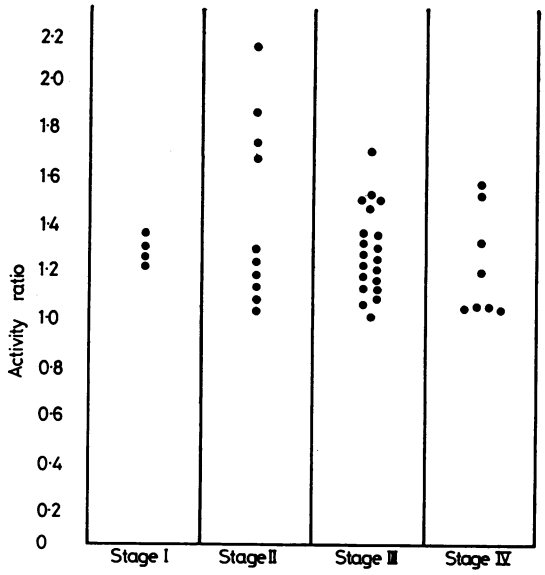

Fig. 3 *Correlation between radiological stage of sacroiliitis and activity ratio.*

et al. (1975) found no correlation between scintigraphy and the radiological stages of the disease. Van Laere *et al.* (1972) did find statistically significant higher values in patients with sacroiliitis in radiological stages I and II.) No correlation was found between uptake and age of the patient and duration of the disease.

Sensitivity and specificity of scintigraphy were compared with some of the most important clinical biochemical, and radiological parameters of the disease (Tables, 9, 10). We stress that the sensitivity resulting from the composition of the groups is too low: a consequence of the fact that the ratio of AS patients to controls, and of AS patients to patients 'at risk' was much higher in this trial than in an average population. For the same reason there is a possibility that the specificity is too high.

Table 9 *Ankylosing spondylitis patients versus controls*

	Specificity	*Sensitivity*	*Validity*	*P*
HLA B27	0·95	1·00	0·97	$<10^{-9}$
Bilateral sacroiliitis	1·00	0·89	0·95	$<10^{-8}$
Morning stiffness	1·00	0·81	0·89	$<3\cdot10^{-7}$
Presence of syndesmophytes	1·00	0·74	0·84	$<5\cdot10^{-6}$
Limited anterior spinal flexion (Schober)	1·00	0·74	0·84	$<10^{-5}$
Limitation of chest expansion	1·00	0·63	0·73	$<6\cdot10^{-4}$
Scanning right	0·84	0·50	0·57	0·1449 (NS)
Scanning left	1·00	0·48	0·59	0·04
Scanning bilateral	1·00	0·49	0·53	0·157 (NS)

Table 10 *Ankylosing spondylitis patients versus patients at risk*

	Specificity	*Sensitivity*	*Validity*	*P*
Bilateral sacroiliitis	1·00	0·93	0·96	$<5\cdot10^{-11}$
HLA B27	0·84	1·00	0·91	$<2\cdot10^{-9}$
Presence of syndesmophytes	0·94	0·81	0·85	$<10^{-6}$
Limited anterior spinal flexion (Schober)	0·88	0·79	0·82	$<2\cdot10^{-5}$
Limitation of chest expansion	0·84	0·70	0·73	$<3\cdot10^{-3}$
Morning stiffness	0·59	0·78	0·66	<0·02
Scanning right	0·63	0·59	0·60	0·47 (NS)
Scanning left	0·63	0·59	0·60	0·47 (NS)
Scanning bilateral	0·60	0·57	0·57	0·3965 (NS)

From this study it appears that scintiscanning is the least reliable of the parameters used. Radiographic charactristics of the disease (on which the diagnosis is based) would be expected to be more sensitive than scintiscanning. It appears, however, that the clinical parameters are more sensitive than either. We conclude that scintigraphy by the techniques used here is not an important method for the early diagnosis of sacroiliitis.

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