

Strontium 87m scanning of the sacroiliac joints in ankylosing spondylitis

M. VAN LAERE, E. M. VEYS, AND H. MIELANTS

From the Department of Physical Medicine and Orthopaedic Surgery (Dir. Prof. Dr. H. Claessens), University of Ghent, Belgium

Strontium 87m scanning can provide useful information about a variety of skeletal diseases: malignant tumours (Kostamis, Constanides, Papavasiliou, Binopoulos, Sfontouris, and Malamos, 1968; Parsons Williams, Hill, Frost, and Lapham 1969; Wendeberg, and Yamamuro 1965), osteomyelitis (Bauer and Wendeberg, 1959; Gofton, 1968; Dymling and Wendeberg, 1965), osteonecrosis (Ahlbäck, Bauer, and Bohne, 1968; Mörscher, 1970; Müheim and Bohne, 1970), and Paget's disease (Bessler, 1969). We therefore thought that scanning with ^{87m}Sr could possibly be useful in the early detection of ankylosing spondylitis (AS) and in understanding its pathology.

Lövgren and Dowén (1969) described the results of ⁸⁵Sr scintigraphy of sacroiliac (SI) joints in Reiter's disease, spondylarthritis, and psoriatic arthritis. We carried out this study on a larger number of patients and restricted the investigations to AS. In order to give the strontium fixation a more quantitative value, we calculated the total of all counts registered in a well-defined area. We compared the results with a control group, and investigated whether there is an increased fixation in the SI joints in patients with AS. We also sought to find a correlation between the external counting of ^{87m}Sr and several parameters that are commonly used to determine the degree and the activity of the disease: age, duration of disease, radiological stage, erythrocyte sedimentation rate, and subjective condition (Nold, Ott, and Hentschel, 1968). Finally we assessed the value of this technique as a criterion for the early detection of AS.

Scintillation scanning permits the diagnosis of every change in bone metabolism at its earliest stage, whereas this change is radiologically visible only when the lesion covers more than 1.5 cm. and is already decalcified from 50 to 70 per cent. (Bauer and Ray, 1958; Bauer and Wendeberg, 1959; Charkes, 1970; Godlee, 1970). In many cases of AS the onset is early (between 10 and 20 years of age) with arthritis of the peripheral joints. Much later the disease can be diagnosed on the basis of the classic criteria. The

most typical characteristics of AS are the radiological changes in the SI joints (Kåss, 1968). As these joints take their definite form only at about the age of 20 years (extreme limit 22 years), their radiological features are difficult to evaluate in young patients (Coste and Vallée, 1957). Moreover, the radiological lesions appear only some 10 years after the onset of the clinical symptoms (Ellefsen, 1967).

Methods and material

We used a dose of ^{87m}Sr, which is within the permissible radiation limits, even in young growing patients (Bessler, 1969; Myers, 1960). Two hours after the intravenous administration of 1 to 3 millicuries Strontium 87m, the SI joints were recorded with the Picker Magna scanner, which provides a photoscanning and a colourscanning. The radiostrontium uptake in the lumbar and sacral spine and in the SI joints was registered with the patient lying prone. Using a 3-inch collimator focus, 10 to 60,000 counts can be registered per minute, depending on the dose administered. The scan speed amounted to 80 cm. per minute and the examination took about 30 minutes. ^{87m}Sr was obtained with an Yttrium-Strontium 87m generator. The radiation exposure during this examination was 0.3 rad (0.1 rad/1 mc Str 87m) and corresponds with one-third of the radiation exposure of a pelvic x ray. As the 8-colour ribbon of the photoscanner shifts proportionally to the amount of activity, each colour can be given a well-defined value (Morrison, Olde, Louis, and Evans, 1968). In this way the intensity of a specific area can be calculated.

In scintillation scanning, corresponding areas on both sides are usually compared. In this investigation we cannot compare the two SI joints to one another because most of the time they are affected symmetrically. The results are reported as a ratio of counts: the number of counts registered in the area of one SI joint versus the number of counts registered in a similar area of the sacral spine (Fig. 1, overleaf).

This analysis was performed on 23 patients with AS, and three patients younger than 22 years with peripheral arthritis of ill-defined aetiology were also examined. All patients with AS are older than 22 years (mean 34.5). The diagnosis of AS was made according to the criteria reported by Gofton (1968). The radiological stage of the sacroiliac joints was classified by the criteria reported by Bennett and Burch (1968).

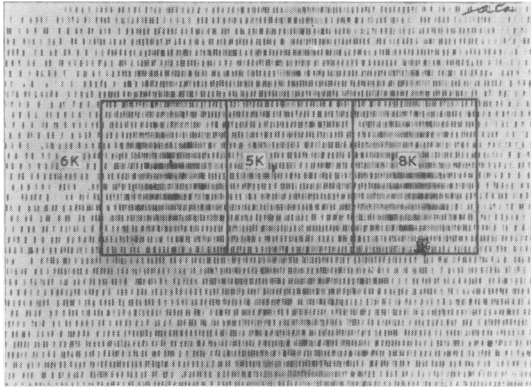


FIG. 1 ^{87m}Sr scanning of SI joints, indicating three areas counted

Twelve control patients older than 22 years and seven younger than 22 years were also examined. From this group, as well as from the series of patients with AS, every disease possibly affecting the SI joints (psoriasis, rheumatoid arthritis, ulcerative colitis, Reiter's disease, and juvenile rheumatoid arthritis) was excluded.

The visual interpretation of the scans allowed us to divide the patients with AS into two groups: in the first the radioactivity fixation seemed to be increased and in the second the radioactivity seemed to be similar to that in the control subjects.

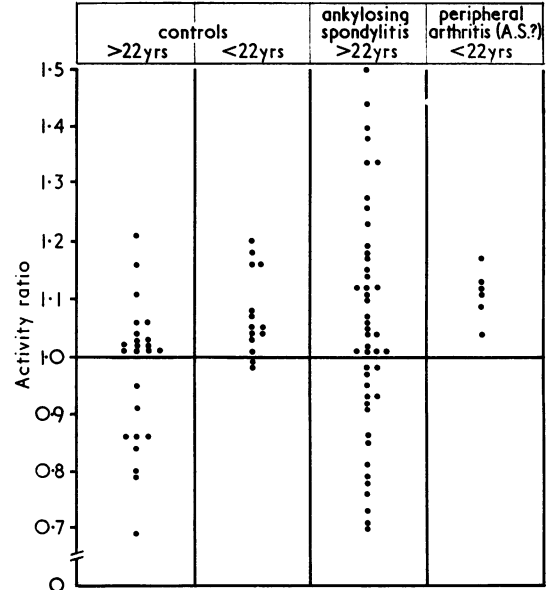


FIG. 2 Activity ratio of SI joints of all subjects studied

Results

The results are reported in Tables I to IV and in Fig. 2.

The activity ratio in the group of normal persons was less than 1:1 in those older than 22 years, except

Table I Characteristics of 23 patients with AS

Patient no.	Sex	Age (yrs)	Duration of disease (yrs)	x-ray stage of SI joint involvement	Subjective symptoms of SI joint inflammation*	Erythrocyte sedimentation rate (mm./hr)	Ratio of counts	
							Left	Right
1	F	29	15	II	-	38	0.73	0.70
2	M	37	5	III	-	40	0.98	1.01
3	M	43	5	II	+	20	1.01	1.01
4	M	28	12	IV	-	26	0.95	0.81
5	M	39	4	I	++	75	1.23	1.38
6	M	27	6	I	++	22	1.44	1.34
7	M	54	9	II	+	6	1.04	1.14
8	M	35	17	IV	-	11	0.92	1.04
9	M	28	1	I	+++	120	1.07	1.15
10	M	27	2	I left, II right	++ right	20	1.18	1.26
11	M	31	2	I	+	3	1.12	1.19
12	M	39	±10	II	+++	53	1.15	1.40
13	M	25	10	II	+	88	1.12	1.17
14	M	32	15	II	-	20	1.34	1.50
15	M	37	7	II	+	9	1.05	1.10
16	M	35	10	II	-	20	0.91	0.98
17	M	50	±20	III	-	25	0.79	0.85
18	M	27	5	II	-	15	1.06	0.97
19	M	27	9	I	++	3	1.12	1.11
20	M	25	2	III	-	37	0.71	0.78
21	M	48	5	II	-	16	0.76	0.93
22	M	41	10	IV	-	46	0.93	1.01
23	M	28	6	II	-	23	0.86	1.02

*+++severe; ++moderate; +mild.

Table II Strontium 87m external counting rates in 19 control subjects

Patient no.	Sex	Age (yrs)	Ratio of counts	
			Left	Right
1	M	27	1.03	0.69
2	M	29	0.84	0.86
3	M	45	1.06	1.21
4	F	55	0.80	0.86
5	M	65	1.01	0.95
6	F	29	1.01	1.16
7	M	27	1.04	1.02
8	F	56	1.02	1.06
9	M	32	0.79	0.91
10	M	29	1.11	1.03
11	M	45	1.01	1.02
12	M	45	1.01	0.86
13	M	21	1.04	1.07
14	M	20	1.03	1.18
15	M	16	1.01	1.08
16	M	15	1.05	1.05
17	M	16	0.99	1.16
18	M	16	1.04	0.98
19	M	17	1.16	1.20

for two cases for which no explanation can be given; however, only one of the two SI joints in these two cases gave an activity ratio higher than 1.1, the other joints being normal. The activity ratio was less than 1.0 in nine joints.

In the control group younger than 22 years, only two cases gave values lower than 1.0 (in one case 0.99, in another 0.98).

In patients with AS who were older than 22 years, the activity ratios of the SI joints showed wide variation (range 1.5 to 0.7).

In the small number of patients younger than 22 years with peripheral arthritis all values were above 1.0, but there were no extremely high values. The range was similar to that observed in the control group younger than 22 years.

Discussion

Between both control groups (patients older and younger than 22 years) we found very divergent activity values for the SI joints. There is a significant difference between these two groups ($0.0025 < P < 0.0005$). Therefore, the cases with AS, all aged above 22 years, were compared with the control group older than 22 years. Between these two groups we

Table III Characteristics of the three patients with peripheral arthritis and possible evolution to AS

Patient no.	Sex	Age (yrs)	Duration of disease (yrs)	Joints affected	Clinical manifestations of SI joint involvement*	Erythrocyte sedimentation rate (mm./hr)	Ratio of counts	
							Left	Right
I	M	16	8	Knees	-	10	1.04	1.12
II	M	16	2	Knees and shoulders	-	24	1.09	1.13
III	M	18	4	First metatarsophalangeal joint right and left	+	2	1.17	1.11

* + tender; - painless.

Table IV Activity ratio of SI joints

Group	No. of SI joints	Mean activity ratio	Standard deviation	Standard deviation of the mean
Ankylosing spondylitis	46	1.0571	0.1979	0.0291
Normal subjects	>22 yrs	24	0.9769	0.1232
	<22 yrs	14	1.0786	0.0707
^{87m} Sr fixation on visual assessment	Increased	16	1.2637	0.1276
	Normal	30	0.9468	0.1272
Patients with peripheral arthritis	6	(1.1149)	(0.0412)	(0.0168)

again found a significant difference ($0.025 < P < 0.005$). However, the diagnostic value of this method is limited because of the wide variation in ^{87}mSr uptake levels in the patients with AS. This is probably due to the heterogeneity of the material. Indeed we examined patients in the initial phase of the disease and with minimal involvement of the SI joints as well as cases with pronounced lesions of these joints. In the latter we observed erosions and sclerosis, even total fusion of the joint space and fading of the bony condensation.

Attempts were made to give the external counting technique a quantitative value. We noticed that the visual interpretation of the scan generally correlated with the quantitative values obtained by counting. Therefore it seemed appropriate to divide the patients with AS into two groups: one apparently having an increased Sr uptake in comparison with a normal scan, and the other having an uptake within the normal range. Between these two groups we found a significant difference ($P < 0.0005$). These data certainly prove that the visual evaluation of a colour scan gives useful information.

Is there any correlation between the external counting rate and the different parameters determining the stage and evolution of the disease?

- (1) No correlation was found with age or with the duration of the disease.
- (2) Is the ^{87}mSr uptake related to the radiological stage of SI joint involvement (Fig. 3)?

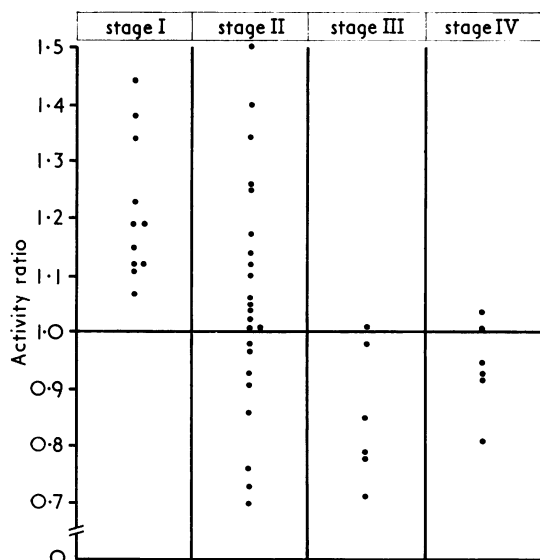


FIG. 3 Correlation between radiological stage of SI joint involvement and activity ratio

The highest values were found in Stages I and II, while values were in the normal range for Stages

III and IV. A significant difference was found between the patients in Stages I and II ($0.01 < P < 0.0125$) and between the patients in Stages I and III + IV (for statistical investigations we considered Stages III and IV as one class) ($P < 0.0005$). Between the patients in Stage II and those in Stages III and IV the difference was again significant ($0.005 < P < 0.01$). Elevated ^{87}mSr uptake values are more frequently recorded in the early stages of the disease, and later the uptake tends to be normal. To permit further conclusions a study of a larger group of patients would be necessary.

- (3) A significant difference was found only between the patients with an erythrocyte sedimentation rate < 20 mm./hr and those with a rate > 40 mm./hr ($0.025 < P < 0.05$) (Fig. 4). We do not think that the erythrocyte sedimentation rate is a useful indicator of disease activity in AS. In addition, it is quite possible that, although there is a halting of the pathological process at the SI joints, further inflammation might occur at another region of the spine or in a peripheral joint.

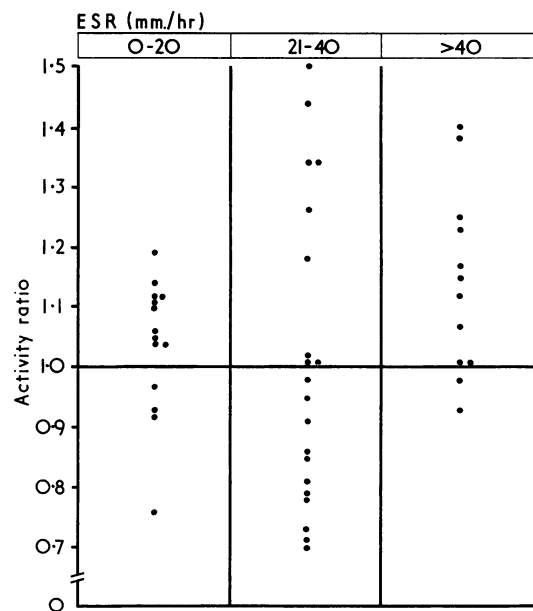


FIG. 4 Correlation between erythrocyte sedimentation rate and activity ratio

- (4) A positive scintigram was observed in patients with subjective complaints of morning stiffness or pain (spontaneous or by deep pressure) (Fig. 5). A highly significant difference was found between the patients with subjective complaints and those without ($0.005 < P < 0.0025$).

A local disturbance in the bone metabolism with a subsequent increased uptake of radioactive

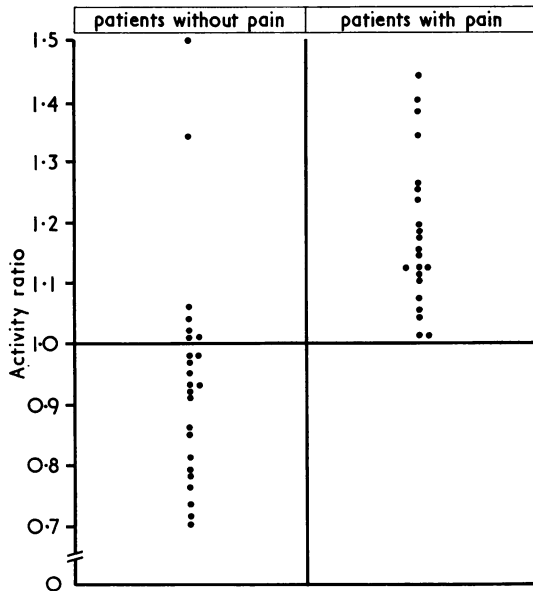


FIG. 5 Correlation between subjective condition and activity ratio

strontium is a possible explanation for our findings in the first group of patients. This disturbance originates either in chronic subchondral inflammation or in a periarticular ossification without any previous inflammation.

Could the strontium scintigraphy provide a new criterion for the early diagnosis of ankylosing spondylitis?

Before the age of 22 the radiological evaluation of the SI joints is difficult. The joint space is much wider and irregular than in adults. Unfortunately these features are the first symptoms of sacroiliitis. In addition, wide variations occur in the SI joints of normal adults and in patterns of development during

the growing-period (Coste and Vallée, 1957), making the evaluation of SI changes very difficult. When successive x rays reveal identical findings and then suddenly sclerosis and pronounced erosions appear, the diagnosis of sacroiliitis is highly probable.

Consequently, in the early diagnosis of AS, x rays are of little value, at least in patients below 22 years of age. Therapeutically it is important to know which patients with peripheral arthritis are likely to develop the clinical picture of ankylosing spondylitis. The patients with peripheral arthritis, aged less than 22 years were compared with a control group of the same age. All the activity values were in the range of $m \pm 2s$ (m = mean; s = standard deviation) of normal persons, since an increased uptake of strontium is frequently found in SI joints of young normal subjects. Under the age of 22 therefore, strontium scanning cannot be used for the diagnosis of ankylosing spondylitis.

Summary

Strontium 87m scintigraphy of the sacroiliac joints was performed in 23 patients with ankylosing spondylitis, three with peripheral arthritis clinically suspected of ankylosing spondylitis, and 19 control subjects.

The uptake of ^{87m}Sr was increased in some patients with ankylosing spondylitis and in those with peripheral arthritis. No correlation was found with the age or with duration of disease. The highest values of ^{87m}Sr uptake were found in joints showing radiological involvement of Stages I and II. A significant difference was found between the patients in whom the erythrocyte sedimentation rate was below 20 mm./hr and those in whom it was above 40 mm./hr. A positive scintigram was observed in patients with subjective complaints.

Below the age of 22 years strontium scintigraphy does not provide a useful criterion for the early diagnosis of ankylosing spondylitis.

References

- AHLBÄCK, S., BAUER, G. C. H., AND BOHNE, W. H. (1968) *Arthr. and Rheum.*, **11**, 705 (Spontaneous osteonecrosis of the knee)
- BAUER, G. C. H., AND RAY, R. D. (1958) *J. Bone Jt Surg.*, **40A**, 171 (Kinetics of Strontium metabolism in man)
- , AND WENDEBERG, B. (1959) *Ibid.*, **41B**, 558 (External counting of Ca^{47} and Sr^{85} in studies of localised skeletal lesions in man)
- BENNETT, P. H., AND BURCH, T. A. (1968) 'The epidemiological diagnosis of ankylosing spondylitis', in 'Population Studies of the Rheumatic Diseases,' ed. P. H. Bennett and P. H. N. Wood, p. 305. International Congress Series, No. 148. Excerpta Medica Foundation, Amsterdam
- BESSLER, W. (1969) 'Skeletztintigraphie mit Radiostrontium', in 'Ergebnisse der Medizinischen Radiologie', band 2, p. 1, ed. R. Glauner, A. Ruthmann, P. Thurn, M. Viamonte, and E. Vogler. Thieme, Stuttgart
- CHARKES, N. D. (1970) *Radiol. Clin. N. Amer.*, **8**, 259 (Bone scanning; principles, technique and interpretation)
- COSTE, F., AND VALLÉE, G. (1957) *Sem. Hôp. Paris*, **33**, 1264 (Aspect radiographique des articulations sacro-iliaques chez l'adolescent)
- DYMLING, J. F., AND WENDEBERG, B. (1965) *Acta orthop. scand.*, **36**, 8 (External counting of ^{85}Sr and ^{47}Ca in localized bone infections)

- ELLEFSSEN, F. (1967) *Acta rheum. scand.*, **13**, 14 (Juvenile ankylosing spondylitis)
- GODLEE, N. (1970) *J. Bone Jt Surg.*, **52B**, 593 (Bone scanning in orthopedics)
- GOFTON, J. P. (1968) 'Report from the subcommittee on diagnostic criteria for ankylosing spondylitis', in 'Population Studies of the Rheumatic Diseases', ed. P. H. Bennett and P. H. N. Wood, p. 314. International Congress Series No 148. Excerpta Medica Foundation, Amsterdam
- KÄSS, E. (1968) *Acta rheum. scand.*, **14**, 197 (Diagnostic criteria in spondylarthritis ankylopoietica)
- KOSTAMIS, P., CONSTANTINIDES, C., PAPAVALIOU, C., BINOPOULOS, D., SFONTOURIS, J., AND MALAMOS, B. (1968) 'Early detection of bone lesions by photoscanning with ^{87m}Sr ' in International Atomic Energy Authority Symp. Med. Radioisotopic Scintigraphy, Salzburg, 1968
- LÖVGREN, O., AND DOWÉN, S. A. (1969) *Acta rheum. scand.*, **15**, 327 (^{85}Sr scintigrams of the sacroiliac joints)
- MORRISON, R. T., OLDE, G., LOUIS, H., AND EVANS, T. C. (1968) *J. nucl. Med.*, **9**, 140 (Color coding counting-rate data on ektacolor paper—a new technique)
- MÖRSCHER, E. (1970) *Z. Orthop.*, **108**, 520 (Die Strontium-szintigraphie in der Diagnostik der Femurkopfnekrose)
- MÜHEIM, G., AND BOHNE, W. H. (1970) *J. Bone Jt Surg.*, **52B**, 605 (Prognosis in spontaneous osteonecrosis of the knee)
- MYERS, W. G. (1970) *J. nucl. Med.*, **1**, 125 (Radiostrontium 87m)
- NOLD, F., OTT, V. R., AND HENTSCHEL, H. D. (1969) 'Kriterien des Behandlungserfolges bei Ankylosierender Spondylitis', in 'Ankylosierender Spondylitis—Rheumadokumentation—Neue Rheumaheilmittel (Vorträge des Kongresses der Deutschen Gesellschaft für Rheumatologie, Bad Nauheim, 1968)', ed. V. R. Ott and R. Schoen, p. 292. Steinkopff, Darmstadt
- PARSONS, V., WILLIAMS, M., HILL, D., FROST, P., AND LAPHAM, A. (1969) *Brit. med. J.*, **1**, 19 (^{85}Sr scanning of suspected bone disease)
- WENDEBERG, B., AND YAMAMURO, T. (1965) *Acta orthop. scand.*, **36**, 21 (Mineral metabolism in primary bone tumors studied by external counting of ^{85}Sr)