Rheumatoid involvement of the cervical spine

Radiological assessment

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Despite widespread appreciation of the frequency of cervical spine involvement in rheumatoid arthritis, largely as a result of the studies of Sharp, Purser, and Lawrence (1958), and Conlon, Isdale, and Rose (1966), assessment, which is predominantly radiological, remains difficult. The latter authors found radiological evidence of cervical spine involvement in 50 per cent. of 333 rheumatoid patients and Bland, Davis, London, van Buskirk, and Duarte (1963) in 86 of 100 patients. Yet it may be impossible to differentiate between rheumatoid disease and coincidental degenerative disease as a cause of symptoms in individual cases and, since radiological features of both conditions frequently coexist, it is desirable to determine which radiological signs are reliable indicators of the rheumatoid process. Conlon and others (1966) found vertebral subluxations the most characteristic and most easily recognized sign of rheumatoid arthritis of the cervical spine, but disc narrowing without accompanying osteophytes and vertebral end-plate erosions were seen frequently in rheumatoid and infrequently in non-rheumatoid subjects. The present study is an evaluation of these and other radiological signs in the diagnosis of rheumatoid involvement of the cervical spine and the more useful signs have been correlated with some of the clinical features.

Material and methods

Lateral radiographs of the cervical spine, taken in full flexion and full extension with the tube at 5 feet distance and centred on the second vertebra, were read by both authors according to an agreed plan and without knowledge of the clinical details. Some patients had additional views of the cervical spine, including tomograms, and these have been used to clarify and illustrate some of the lesions but were not included in the statistical analysis, which was based on lateral views only.

In the interpretation of radiographs, bony demineralization was assessed subjectively as present or absent. The range of flexion, assessed on radiographs only, was given a score of 3, 2, 1, or 0, according to whether it was normal, slightly restricted, severely restricted, or absent. Measurements of the atlanto-axial space were made on the flexion film between the midpoint of the posterior surface of the anterior arch of the atlas and the nearest point on the odontoid process, 2.5 mm. being taken as the extreme of normal. In the lower cervical spine loss of alignment of more than 1 mm. between the anterior profiles of two vertebrae on the flexion film was also considered abnormal. Whenever a radiological sign was doubtful it was interpreted as normal.

The patients studied, who were all adults, fell into four groups:

(1) RHEUMATOID DISEASES

There were 118 patients with a rheumatoid type polyarthritis, of whom 108 would be classified as definite and three as probable rheumatoid arthritis by the American Rheumatism Association criteria (Ropes, Bennett, Cobb, Jacox, and Jessar, 1959). Five patients had psoriasis and peripheral arthropathy (three sero-positive), one ulcerative colitis with sero-negative arthropathy, and one regional enteritis and sero-negative polyarthritis.

Patients receiving corticosteroids for more than one year at any time during their illness were included in the steroid-treated category.

To spread the work-load on the radiological services, no attempt was made to include every patient with rheumatoid disease attending the hospital. Instead, all patients with neck symptoms were included, together with a proportion of patients without neck symptoms selected only by the availability of radiological facilities. Clearly this will bias the group by including an excess of patients with severe disease and neck involvement.

(2) ANKYLOSING SPONDYLITIS

Twenty patients all presenting an appropriate clinical picture, radiological evidence of bilateral sacroiliac disease, with negative tests for rheumatoid factor.

(3) CERVICAL SPONDYLOSIS

41 patients with neck and shoulder pain or neurological manifestations attributed to cervical spondylosis. Tests for rheumatoid factor on 29 patients were all negative.

(4) NONRHEUMATIC SUBJECTS

35 patients without neck symptoms attending or admitted to hospital for fractures or general medical diseases.

Table I gives details of these groups of patients. As would be expected, the rheumatoid subjects included more females and the ankylosing spondylitics more young males than the other groups.

The χ^2 test was used for statistical comparisons with Yates' correction where appropriate.

Results

The incidence of each radiological feature in the four groups of patients is shown in Table II.

BONY DEMINERALIZATION

Though seen in more than half of the rheumatoid and ankylosing spondylitic patients and in significantly fewer spondylosis and nonrheumatic patients this feature was too common in all groups to have much diagnostic value.

ABNORMALITIES OF THE CERVICAL CURVE

These were also unhelpful. Although deformities such as a straight or even kyphotic cervical spine, exaggerated lordosis, angulation, and rarely marked torticollis were seen in rheumatoid patients, only the nonrheumatic group included significantly fewer with abnormal curves.

ATLANTO-AXIAL SUBLUXATION

Atlanto-axial separation in flexion exceeded 2.5 mm. in 44 (37.3 per cent.) of the rheumatoid and in three

Table I Details of patients studied. Comparisons between rheumatoid and other groups revealed significant differences expressed as follows: x = $P < 0.05$; xx = $P < 0.01$; xxx = $P < 0.001$.

Diagnosis	Rheumatoid arthritis	Ankylosing spondylitis	Cervical spondylosis	Nonrheumatic
Number of patients	118	20	41	35
Per cent. of females	70.3	35xx	51.2x	48.6x
Mean age (yrs)	57.6	44.4xxx	59.5	51.9xxx
Mean duration of disease (yrs)	12.9	19.4	—	—
Per cent. of patients treated with steroids > 1 year	42.4	15	0	0
Per cent. of patients with psoriasis	4.2	10	0	0

Table II Incidence of radiological features studied in each of four groups of patients. Comparisons between the rheumatoid and each of the other groups are expressed as in Table I.

Diagnosis	Rheumatoid arthritis	Ankylosing spondylitis	Cervical spondylosis	Nonrheumatic
Number of patients	118	20	41	35
Bony demineralization (per cent.)	53.4	65	19.5xxx	25.7xx
Abnormal curve (per cent.)	22.9	35	12.2	5.7xxx
Per cent. with atlanto-axial space > 2.5 mm.	37.3	15	2.4xxx	0xxx
Mean atlanto-axial space (mm.)	2.94	1.8xx	1.23xxx	1.1xxx
Per cent. with lower subluxation > 1 mm.	26.3	10	17.1	8.6
End-plate erosions (per cent.)	15.3	40x	4.9	0x
Narrow discs (per cent.)	72.9	30xxx	87.8	57.1
Apophyseal joints: fusion (per cent.)	17	45x	2.4x	2.9x
erosion (per cent.)	15.2	21.1	9.8	2.9
degenerative changes (per cent.)	44.9	25	34.1	28.6

(15 per cent.) of the ankylosing spondylitic patients but the spondylosis and nonrheumatic groups were very significantly different and included only one patient with excessive separation. The 44 rheumatoid patients with atlanto-axial subluxation included the only five patients with evidence of spinal cord damage. Nevertheless, some patients with atlanto-axial separation of up to 12 mm. on flexion showed no evidence of spinal cord injury. Of those with cord damage, three developed long tract signs acutely after trauma.

A 62-year-old man with sero-positive rheumatoid arthritis for 6 years, complained of neck and anterior chest pain which drew attention to a 12 mm. atlanto-axial subluxation. Later he fell while climbing into bed and then developed long tract signs but without any further radiological change.

A 77-year-old woman with long-standing psoriasis and sero-positive arthritis was skin-grafted under general anaesthesia for a large pressure sore. After operation she was nursed on her face for 2 weeks and during this period noticed paraesthesiae in the arms. Her subsequent inability to walk led to the discovery of a spastic paraplegia with 3 mm. subluxation at the atlanto-axial joint and what was probably more important, 3 mm. subluxation at C3-4.

A 57-year-old man, after 21 years of sero-positive rheumatoid disease, slipped while carrying slates on his head. Both legs were paralysed and flexion views showed 13 mm. atlanto-axial separation.

Lateral tomograms of the atlanto-axial region in a few patients gave sharper definition but yielded further information in only one case. Here excessive movement between atlas and axis was found to result from fracture or separation of the odontoid process.

SUBLUXATION BELOW ATLANTO-AXIAL LEVEL
This was less common and the measurement did not

exceed 3.5 mm. in any patient. Though slightly more frequent in rheumatoid than in cervical spondylosis patients (see Table II), the difference was not significant. Nor can much be deduced from the degree of subluxation. In the rheumatoid patients subluxations were seen at all levels in the cervical spine (Table III) and in eleven of these 31 patients the subluxation occurred at more than one level. This contrasts with the spondylosis patients who showed single subluxations confined to the C3-4 or C4-5 levels. Subluxations between the C2 and 3 were seen in seven rheumatoid patients (in two as isolated subluxations) but not in any of the other groups.

In the ankylosing spondylitic and nonrheumatic patients subluxations below atlanto-axial level were even less common but, possibly because of the small numbers involved, the incidences were not significantly different from that in rheumatoid patients.

END-PLATE EROSIONS

These were sometimes difficult to identify with certainty on the plain lateral films and while the present analysis is based upon these alone, subsequent tomography sometimes revealed much larger erosions than had been anticipated from the plain films (Fig. 1, opposite). Such erosions were seen in 15.3 per cent. of rheumatoid and 40 per cent. of ankylosing spondylitic patients (significantly more, $\chi^2 = 6.02$; $P < 0.02$). Erosions were seen at all levels in both groups. No end-plate erosions were seen in the films of nonrheumatic patients, but films from two spondylosis patients were thought to show erosions. However, it can be difficult to distinguish these from the piecrust effect of osteophytes around the perimeter of a degenerate disc on plain films alone.

In the majority of instances the disc at the level of eroded end-plate was narrowed. Indeed, in eighteen rheumatoid patients, erosions were seen at thirty separate sites and at only four of these was the disc

Table III *Incidence of radiological abnormalities at each level in the cervical spine in 118 rheumatoid patients*

Cervical level	1-2	2-3	3-4	4-5	5-6	6-7
Subluxation	44	7	15	17	4	1
End-plate erosion		4	5	8	6	7
Narrow disc		13	27	38	63	57
Anterior osteophytes		5	21	34	65	60
Apophyseal joints: Fusion	1	12	7	4	4	1
Erosion	0	10	4	7	7	2
Degenerative changes	1	18	17	16	20	16

not narrowed. There was no special tendency for end-plate erosions to be seen either at the site of vertebral subluxation or in association with eroded apophyseal joints.

FIG. 1 Antero-posterior tomogram of cervical spine in rheumatoid arthritis to show size of vertebral end-plate erosions.

NARROW INTERVERTEBRAL DISC SPACES

While the incidence of disc narrowing was not greatly different in patients with cervical spondylosis and rheumatoid arthritis, and it was only a little less in nonrheumatic patients, disc narrowing was very significantly less frequent in ankylosing spondylitics ($\chi^2 = 10.85$; $P < 0.001$). The figures are shown in Table II.

When each disc is considered separately, the spondylosis patients showed a narrow C5-6 disc more often than the rheumatoid patients ($\chi^2 = 5.33$; $P < 0.05$), but the incidence at C2-3 was similar in both groups. No patient in any group showed narrowing of the latter joint space alone.

OSTEOPHYTES

Anterior and posterior osteophytes followed much the same distribution as did narrow disc spaces and for this reason the detailed figures have been

omitted. Osteophytes were seen with similar frequency in the rheumatoid, spondylosis, and non-rheumatic patients, but were significantly less common in the ankylosing spondylitic patients.

Since disc narrowing without corresponding osteophytes has been regarded as a useful radiological feature of rheumatoid arthritis, the present figures were analysed according to whether disc spaces at each level were normal, narrow without osteophytes, or narrow with osteophytes. Narrow disc spaces without osteophytes were seen at all levels in the cervical spine and were equally frequent in rheumatoid and spondylosis patients (Fig. 2).

FIG. 2 Analysis of 118 rheumatoid (Upper diagram) and 41 spondylosis (Lower diagram) patients to show incidence of narrow intervertebral disc spaces with and without osteophytes at same level in cervical spine.

APOPHYSEAL JOINT CHANGES

These joints were scrutinized for evidence of fusion, erosion, and degenerative changes. Owing to the variable oblique plane from the midline outwards, the joints between C2 and 3 were sometimes poorly visualized on plain lateral films. In the lower joints, fusion was fairly obvious but erosions were particularly difficult to identify with certainty. It was easier to be definite about degenerative changes such as osteophytes, localized or generalized loss of joint space, and sclerosis of the joint margins.

Fused apophyseal joints, predominantly in the upper cervical spine, were seen in twenty (17 per cent.) rheumatoid patients, but were significantly

more common in ankylosing spondylitis ($\chi^2 = 6.51$; $P < 0.02$) and in these patients affected all levels of the cervical spine equally. Single patients in the spondylosis and nonrheumatic groups were thought to show one or more fused apophyseal joints, in each case an incidence significantly less than that of the rheumatoid patients. Erosions of the apophyseal joints followed a similar pattern in rheumatoid patients but were seen less commonly in spondylitic patients. The incidence and distribution of degenerative changes in the cervical apophyseal joints was not significantly different in any of the four groups of patients.

Analysis of the rheumatoid patients revealed that bony demineralization, atlanto-axial and lower subluxations, end-plate erosions, and apophyseal joint fusion were significantly associated with one another and most showed an association with duration of disease and corticosteroid therapy. As an example, the analysis of patients with atlanto-axial subluxation is shown in Fig. 3. By contrast, intervertebral disc narrowing and osteophytes occurred together and were significantly associated with

increasing age and with crepitation on neck movement (Fig. 4). Crepitation was also significantly more frequent in patients with degenerative changes affecting the apophyseal joints. As might be expected, limitation of neck movement, as assessed on the flexion and extension views, was seen in association with apophyseal joint fusion, but there was no evidence that intervertebral disc narrowing led to any restriction, possibly because of compensatory movement higher up the cervical spine.

Discussion

Atlanto-axial subluxation was undoubtedly the most helpful and easily identified sign of rheumatoid involvement of the cervical spine. With the exception of one woman with cervical spondylosis, it was observed only in rheumatoid arthritis and ankylosing spondylitis. Though most commonly seen in patients with long-standing disease, our experience confirms that of Mathews (1969), who observed cases of atlanto-axial subluxation early in the disease. In two of our patients it was seen within

FIG. 3 Analysis of 118 patients with rheumatoid disease arranged according to presence or absence of atlanto-axial subluxation. Numbers above each column are absolute numbers of patients in each group.

FIG. 4 Analysis of 118 rheumatoid patients according to presence or absence of narrowed intervertebral disc spaces. Numbers above each column are absolute numbers of patients in each group.

2 years of the initial symptom.

Lower subluxations were slightly less helpful and less frequent. Although patients with cervical spondylosis showed subluxations of up to 3.5 mm. on flexion, these were usually single and confined to the C3-4 and C4-5 region and often just above an apparently rigid lower cervical spine resulting from disc degeneration. Thus multiple subluxations and especially subluxations between C2 and 3 were very suggestive of rheumatoid disease.

Other radiological signs were far less helpful, being less common, often difficult to identify with certainty, and mostly developing late in the disease. This certainly applies to end-plate erosions which may require tomography before the rather similar appearance sometimes seen with simple disc lesions can be excluded. The higher incidence of end-plate erosions in patients with ankylosing spondylitis is not surprising in view of the frequency of other extra-articular and periosteal lesions in this disease.

Despite the claims of Sharp and others (1958) and of Conlon and others (1966), we did not find disc narrowing without corresponding osteophytes to be of any assistance in the diagnosis of rheumatoid disease, the sign being equally common in patients with cervical spondylosis. Nor could anything be deduced from the site of the narrow discs, for even the disc below the axis was affected sufficiently often in spondylosis to make this an unreliable sign of rheumatoid disease.

Apophyseal joint fusion and perhaps also erosions would be useful if they were easier to identify. Certainly fused apophyseal joints were more common in rheumatoid patients than in spondylosis and nonrheumatic patients, but the tendency to involve the upper cervical spine and the difficulty in some patients of getting a clear picture of the apophyseal joints between C2 and 3 reduces the value of these signs in rheumatoid disease. In ankylosing spondylitis fused apophyseal joints were more helpful because of the higher incidence and the tendency to affect all of the cervical apophyseal joints.

Although bony demineralization was seen more frequently in rheumatoid and ankylosing spondylitis, it has little diagnostic value, but the association with cervical subluxations should be borne in mind.

Analyses of the clinical association of atlanto-axial subluxation have produced curiously conflicting results. Conlon and others (1966) found a statistical relationship with various indicators of disease severity, including joint instability and x-ray changes, subcutaneous nodules, and positive latex-agglutination tests, but no significant relationship with sex, oral corticosteroid therapy (minimum duration not stated), or disease duration. Mathews (1969), on the other hand, claimed that atlanto-axial

subluxation was related to disease duration, and was more common in male subjects, and in those with positive tests for rheumatoid factor, subcutaneous nodules, and severe erosions, and also in patients receiving corticosteroids. From analysis of the figures, only the association with corticosteroid treatment was statistically significant ($\chi^2 = 7.99$; $P < 0.01$).

In our analysis atlanto-axial and lower subluxations, bony demineralization, end-plate erosions, and evidence of fusion or erosion of the apophyseal joints were statistically associated with one another and were almost all related to disease duration and corticosteroid therapy. The association with disease duration is not unexpected from clinical experience and undoubtedly corticosteroid treated patients would include the most severely ill who might be expected to show radiological abnormalities. Quite apart from this the anti-anabolic effect of corticosteroids, by reducing bone substance and collagen content of ligaments and other connective tissues, would be expected to favour subluxations. Our finding of an excess of younger and female patients with atlanto-axial subluxation is not paralleled by any of the other radiological signs. Possibly younger patients, being more active, expose the cervical spine to greater stress, but there is no obvious explanation for the sex bias.

The infrequency of spinal cord damage and the tendency for atlanto-axial and lower subluxations to occur in the same patient, make it difficult to know which is causing neurological signs in some patients. Because the spinal canal is so much larger in the upper cervical region, quite severe atlanto-axial subluxation can exist without neurological signs, but these patients are clearly vulnerable and a number of reports describe sudden deaths due to medullary compression by the odontoid process (e.g. Davis and Markley, 1951; Martel and Abell, 1963; Storey, 1958). Slight trauma such as disabled patients so readily sustain, either during daily activities or more tragically while their neck muscles are relaxed by general anaesthesia, may precipitate disaster. It is these neurological complications that make regular assessment of the cervical spine so important in rheumatoid disease, though the risk of a clinically silent subluxation cannot be predicted on present knowledge.

Although assessments are predominantly radiological, some information can be gleaned from clinical examination. Mathews (1969) found that palpation of the atlanto-axial region through the posterior pharynx was useful in the diagnosis of subluxation. Our own studies show that limitation of neck flexion gives some indication of apophyseal joint fusion and erosion but not of disc damage, presumably because abnormal mobility above the

affected disc frequently compensates for any restriction at the level of the narrowed disc. On the other hand, crepitation on neck movement suggests degenerative changes affecting intervertebral discs and or apophyseal joints.

Summary

Lateral radiographs taken in flexion and extension from the following groups of patients were analysed:

- (1) Rheumatoid disease, 118 patients.
- (2) Ankylosing spondylitis, 20 patients.
- (3) Cervical spondylosis, 41 patients.
- (4) Nonrheumatic diseases, 35 patients.

Atlanto-axial separation exceeded 2.5 mm. on flexion in 37.3 per cent. of rheumatoid and 15 per cent. of spondylitic patients, and in one other patient with spondylosis. It was the most reliable and easily assessed sign of rheumatoid disease. Five of these patients were paraplegic.

Subluxations below the atlanto-axial level were less frequent but, when multiple or affecting the C2-3 level, strongly favoured rheumatoid disease.

Erosions of vertebral end-plates were often difficult to identify but tomography sometimes revealed surprisingly large lesions. They were seen in 15.5 per cent. of rheumatoid, 40 per cent. of spondylitics (significantly more), and 4.9 per cent. of spondylosis patients.

Narrow intervertebral disc spaces were common in all groups except the ankylosing spondylitics. Narrow upper cervical disc spaces without corresponding osteophytes were not confined to rheumatoid patients and had no diagnostic value.

Apophyseal joint changes were often difficult to interpret but fusion was recorded in the upper cervical spine in 17 per cent. of rheumatoid and throughout the spine in 45 per cent. of spondylitic patients.

Discussion

DR. A. G. S. HILL (*Stoke Mandeville*) For obvious practical reasons there had to be some selection. I wondered whether the selection gave any bias towards patients with lesions of the neck in that you x-rayed patients because they had neurological lesions?

DR. WILKINSON We had to include any rheumatoid patient who had a cervical spine x-ray. This obviously gave a bias towards those with neck symptoms.

DR. A. G. S. HILL (*Stoke Mandeville*) The interfacetal joint fusion—was there any link between this and psoriasis?

DR. WILKINSON No, there were not enough with psoriasis in the series to make it a worth-while analysis.

DR. D. WILSON (*Chichester*) Have you any experience in the use of an image intensifier in these cases? I have used one myself for about 14 years and, in the early stages of symptoms related to the rheumatoid cervical spine, I have found that it is extremely useful for localization assessment. I would agree about the site of the lesion. I have found that in the early stages there is failure of movement between two or three blocks of vertebrae, particularly upper vertebrae. Later on you may get these moving as one piece and the symptoms may then be referred to lower down the cervical spine. As regards the lesions higher up, at the atlanto-axial joint, I found them occurring relatively late in the disease when there has been almost bony fusion in the apophyseal or interfacetal joints.

DR. WILKINSON I have no experience of the image intensifier. Atlanto-axial subluxation is certainly increasingly common with disease duration, but there were some cases in which it occurred earlier.

DR. A. G. S. HILL (*Stoke Mandeville*) I certainly endorse the usefulness of the image intensifier, with very much shorter experience than Dr. Wilson; it is very useful indeed for such things as checking the amount of movement at unstable atlanto-axial joints while the patient is wearing a collar.

DR. D. A. PITKEATHLY (*Manchester*) Could you predict which patients with rheumatoid arthritis were on steroid therapy? It has been my impression, particularly in young people who have been on steroid therapy perhaps for a number of years, that you can recognize this. I have seen multiple subluxations, for example, all the way down the spine associated with osteoporosis.

DR. WILKINSON I agree; my impression would be that you could make a fair guess from the films.

DR. J. SHARP (*Buxton*) I note that you took 2.5 mm. separation of the anterior arch and the odontoid as the upper limit of normality. In studies we did some years ago it appeared that to some extent the normal value was age related; that up to the age of 45 anything up to perhaps 4 mm. might be normal, whereas after that age over 3 mm. was abnormal and highly likely to be associated with rheumatoid arthritis. I wonder whether this might have a bearing on the fact that the prevalence in your series is higher in the younger subjects?

DR. WILKINSON Slightly higher, yes. But whether you took 2.5 or 3 mm. as the limit of normal would not alter the figures.

DR. F. DUDLEY HART (*London*) The frightful problem is, here's a thing we keep finding, but how much notice should we take of it? You can terrify a patient into wearing a ghastly collar which does him no good at all. What is the real percentage of risk in these patients?

DR. WILKINSON I do not think you can tell. It is a matter of follow-up to assess what the danger is, but there is no doubt that a trivial accident or an anaesthetic is a danger that should be guarded against.

DR. A. G. S. HILL (*Stoke Mandeville*) I think that two important points emerge. One is that, as a specialist society, we ought to be able to give the profession guidance. There is a case for pooling our experience so as to be able to give more accurate guidance on prognosis, although perhaps the condition is so common that an

individual centre could provide this information. Secondly, there is the question whether treatment with corticosteroids is important in the genesis of this lesion. Perhaps two centres at which the policy about using these hormones is different could compare groups of equal duration and equal severity of rheumatoid arthritis.

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