

A Prospective Study of the Progression of Rheumatoid Arthritis of the Cervical Spine

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ABSTRACT: This prospective study was begun in 1974 to determine the progression of rheumatoid arthritis of the cervical spine. Of 163 patients with complaints about the cervical spine followed in the Arthritis Clinic, 106 were available for study five years later.

At the start of this study, forty-six (43 per cent) of these 106 patients already had radiographic evidence of rheumatoid involvement of the cervical spine, consisting of atlanto-axial subluxation in twenty-eight (61 per cent), atlanto-axial subluxation combined with subaxial subluxation in nine (20 per cent), and subaxial subluxation alone in five (11 per cent). The remaining four patients (8 per cent) had combinations of these findings together with superior migration of the odontoid process. At the end of the study, seventy-four (70 per cent) of the patients had radiographic evidence of cervical involvement, primarily of the combined type.

Twenty-one patients died during the period of follow-up. None of the known causes of death could be attributed to disease of the cervical spine.

Three features of rheumatoid cervical disease were evaluated: pain, neural involvement, and radiographic abnormalities. Although all three features were progressive, radiographic deterioration was a more prominent feature than progressive neural dysfunction. At the final evaluation, the disease in twenty-seven (36 per cent) of the patients was noted to have progressed neurologically while in sixty patients (80 per cent) it had progressed radiographically. Pain was the only feature of the disease that showed any tendency to improve.

The development of subaxial subluxation or superior migration of the odontoid process in a patient with pre-existing atlanto-axial subluxation was found to be a bad prognostic sign.

Spontaneous apophyseal fusion occurred in four patients (3.8 per cent). In one of these there was an improvement in the neural status and in another, progressive dysfunction followed.

Seven of the seventy-four patients who had radiographic involvement by the end of the study underwent surgical stabilization for severe neural dysfunction.

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Only one of the seven had had no radiographic findings at the beginning of the study; thus, six (13 per cent) of the patients who had radiographic involvement initially ultimately came to surgical stabilization for pain and instability associated with neural dysfunction.

Rheumatoid involvement of the cervical spine was reported in 1890 by A. E. Garrod (son of A. B. Garrod, "father of modern rheumatology"). He noted that 36 per cent of his 500 patients with rheumatoid arthritis had involvement of the cervical spine as judged clinically, without the benefit of radiographs. Over the last two decades the literature has reflected a heightened interest in this problem. In 1964, Martel et al. noted atlanto-axial subluxation in 34 per cent of the patients attending their arthritis center. Two years later, Conlon et al. stated that 88 per cent of 333 patients with rheumatoid arthritis had symptoms referable to the cervical spine and 50 per cent had radiographic involvement. In 1974, Bland noted that depending on the particular study and diagnostic criteria, involvement of the cervical spine may be found in from 25 to 90 per cent of patients with rheumatoid arthritis.

The pathological alterations have been studied by Ball and Sharp and by Eulerink and Meijers. Malalignment and instability are caused by synovial destruction of bone and the supporting ligament structures, which lie in close proximity to the thirty-two synovium-containing joints within the cervical spine.

The pathological changes may result in compression of the second cervical-nerve root, causing pain radiating into the neck and occiput. More ominous are the neural abnormalities that may result. Radiating pain or paresthesias, long tract signs, posterior column dysfunction, and sphincter dysfunction indicate involvement of the spinal cord, which may progress to quadriplegia or quadriplegia¹⁵.

Treatment in the early stages of cervical disease most commonly consists of a firm collar for relief of pain and protection against sudden trauma. The timing and indications for surgical intervention remain a difficult problem. Isdale and Conlon stated that subluxations tend to stabilize, that neural complications are rare, and that surgery infrequently is indicated. Ranawat et al. and Ferlic et al. suggested earlier surgical intervention for severe

pain and impending neural deficit as determined by radiographic and clinical criteria.

One of the keys to proper treatment is an understanding of the progression of the disease process. In a six-year radiographic follow-up, Isdale and Conlon noted a significant increase in atlanto-axial subluxation. However, they did not examine superior migration of the odontoid process or subaxial subluxation. Although they stated that no patient showed evidence of gross neural damage, their neurological assessments were incomplete. Smith et al. followed fifty-five patients with atlanto-axial subluxation and noted that 61 per cent remained radiographically unchanged or improved¹². They reported, however, a progressive superior migration of the odontoid process in patients with anteroposterior subluxation. Additionally, in 10 per cent of their patients spinal cord dysfunction developed. Mathews, in a five-year follow-up study, reported that 17 per cent of patients with atlanto-axial subluxation and 33 per cent with superior migration of the odontoid process had radiographic deterioration. More importantly, in 15 per cent of his patients spinal cord involvement had developed at the completion of the study.

The present study was undertaken to determine the natural history of rheumatoid arthritis of the cervical spine as it relates to pain, radiographic abnormalities, and neural dysfunction. An understanding of the relationship between radiographic deterioration and progressive neural dysfunction is necessary to select the proper plan of management for the patient.

Material and Methods

The Comprehensive Arthritis Program at The Hospital for Special Surgery is a combined medical and surgical service for rheumatoid arthritis patients with severe involvement. The majority fall into the American Rheumatism Association¹⁴ functional Class III; the remainder are divided between Class II and Class IV.

In early 1974 we examined the records of all patients who were being followed in the clinic on at least a semi-annual basis. There were 163 adult patients who had undergone radiography of the cervical spine, and in whose charts there was documentation of a neck and neurological examination. This group of patients formed the basis for our study and represented 47 per cent of the approximately 350 adult patients who were actively registered in the clinic.

A letter was prepared for each chart requesting that the examining physician note the appropriate physical findings and history and obtain radiographs of the cervical spine if indicated. The patients were reviewed during the autumns of 1977 and 1979, thus ensuring a minimum five-year follow-up. Some patients had had radiographs of the cervical spine made prior to 1974, resulting in an average follow-up of 6.1 years.

At the time of final review, twenty-one patients had died. Twelve deaths were due to cardiopulmonary disease and two were caused by gastrointestinal complications in

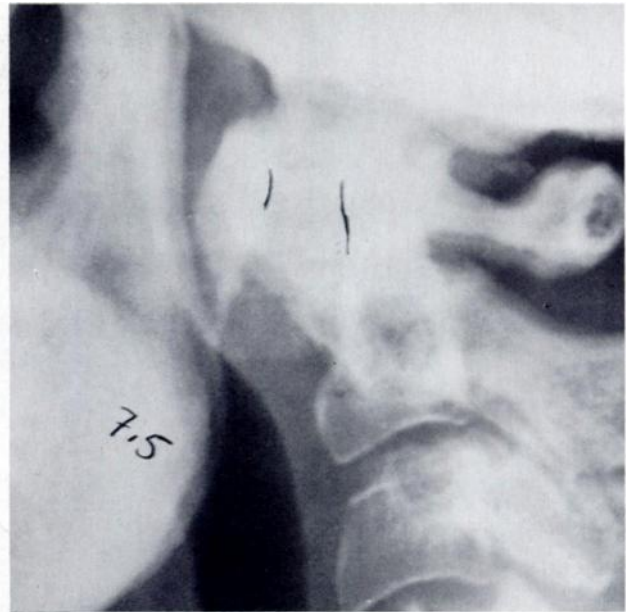


FIG. 1

Atlanto-axial subluxation measuring 7.5 millimeters.

patients who were taking corticosteroids. The causes of death in the remaining seven patients were unknown.

Thirty-six patients could not be located for follow-up. The cases of the remaining 106 patients were reviewed, and two-thirds of them were examined by three of us. The remainder had accurately detailed recent examinations

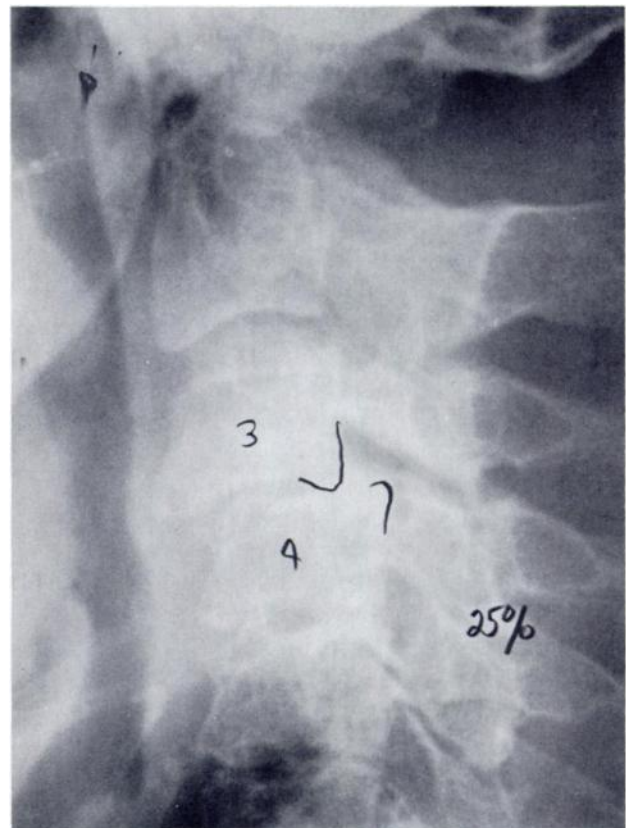


FIG. 2

Subaxial subluxation of 25 per cent.

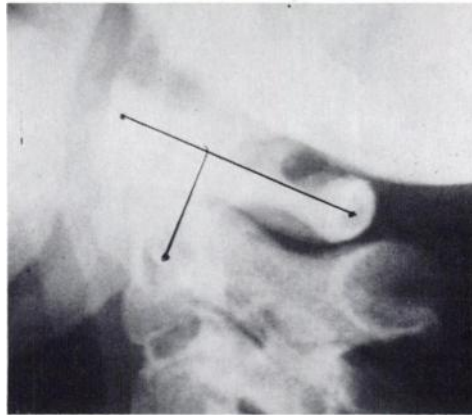


FIG. 3

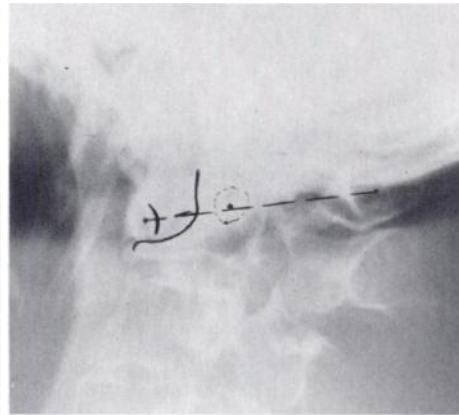


FIG. 4

Fig. 3: The perpendicular distance from the center of the pedicles of the second cervical vertebra to the line connecting the anterior arch and spinous process of the first cervical vertebra normally is greater than thirteen millimeters. This patient has mild superior migration of the odontoid process, since the distance measures only 11.5 millimeters.

Fig. 4: Combined lesions of atlanto-axial subluxation and superior migration of the odontoid process. The circle represents the level of the pedicles of the second cervical vertebra.

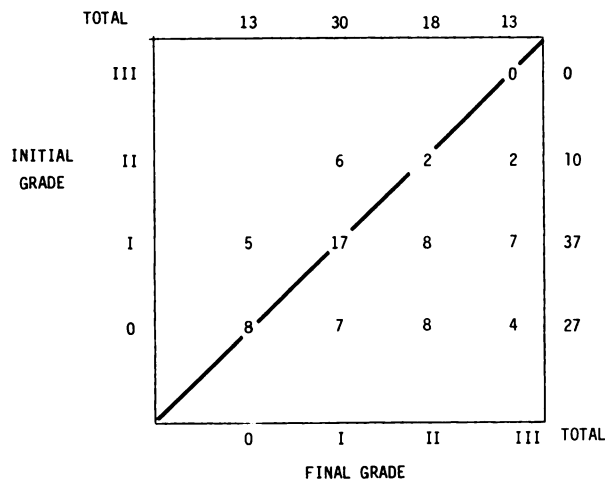


FIG. 5

Progression of pain. The table should be read from the vertical axis to the number, then down to the horizontal axis. This will give the number of patients whose lesion began with the initial grade on the vertical axis and progressed (or improved) to the final grade on the horizontal axis. Thus, all patients on the line remained the same, those to the right deteriorated, and those to the left improved.

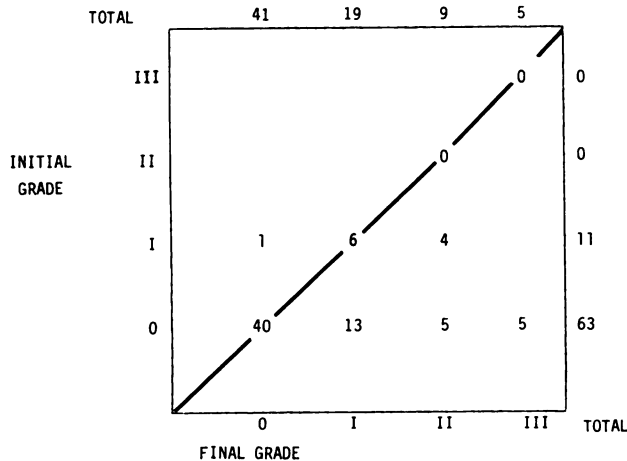


FIG. 6

Neural progression. See legend for Fig. 5.

recorded in their clinic charts as well as recent radiographs of the cervical spine available on file.

There were eighteen men and eighty-eight women. The average age was 56.5 years and was slightly less for the men than the women. The youngest patient was twenty-five years old and the oldest was eighty. The duration of disease averaged twenty-four years, with a range from six to forty-five years.

The presence of rheumatoid involvement of the cervical spine was judged by the radiographic findings of atlanto-axial subluxation, subaxial subluxation, and superior migration of the odontoid process. Atlanto-axial subluxation was considered to be present if the distance between the posterior cortex of the anterior arch of the first cervical vertebra and the anterior cortex of the odontoid process measured three millimeters or more in women and 3.5 millimeters or more in men (Fig. 1)³. Significant subaxial subluxation was present if the displacement of the superior on the inferior vertebra measured 15 per cent or more (Fig. 2)¹³. Superior migration of the odontoid process was measured by the technique described by Ranawat et al. (Fig. 3).

In order to make a meaningful comparison of the findings between the initiation and completion of the study, a classification of pain, neural dysfunction, and radiographic abnormalities was developed. This classification (Table I) was modified from those described by previous authors^{11,13}.

Results

Forty-six patients (43 per cent) had radiographic evidence of involvement of the cervical spine at the beginning of the study period, and in twenty-eight additional patients (27 per cent) radiographic abnormalities developed during the period of the study. The data presented here are based on these seventy-four patients except when it is instructive to examine only the forty-six patients with initial involvement.

TABLE I
CLASSIFICATION

Grade	Pain	Neural Involvement	Radiographic Involvement*
0	None	None	None
I	Intermittent, relieved by non-narcotic analgesics	Hyperreflexia, dysesthesias	2.5 mm < AAS < 5 mm; 15% < SAS < 25%; SM 6-12 mm
II	Intermittent, requiring collar and narcotics for relief	Mild weakness, posterior column deficit	5 mm ≤ AAS < 8 mm; 25% ≤ SAS < 33%; SM 0-5 mm
III	Constant and disabling	Severe weakness resulting in significant functional disability	AAS ≥ 8 mm; SAS ≥ 33%; SM C2 pedicles above C1 line

* AAS = atlanto-axial subluxation, SAS = subaxial subluxation, and SM = superior migration of odontoid process.

The majority of the patients with radiographic involvement had atlanto-axial subluxation. The remaining patients had subaxial subluxation and superior migration singly or in some combination with atlanto-axial subluxation (Table II) (Fig. 4).

At the beginning of the study, forty-five (64 per cent) of the patients who would later comprise the involved group noted some neck pain. None were in Grade III. At the conclusion of the study, sixty-one (82 per cent) suffered from neck pain and thirteen patients (19 per cent) were in the Grade-III pain category. Eleven patients (14 per cent) improved over the course of the study and twenty-seven (37 per cent) remained unchanged. Thirty-six patients (49 per cent) had increased pain (Fig. 5).

At the start of the study, eleven patients (15 per cent) had Grade-I neural deficits, while the remaining sixty-three patients (85 per cent) had no abnormal neural findings. At the end of the study, forty-six patients (62 per cent) had remained unchanged, and one had improved. Thus, twenty-seven patients (36 per cent) had deteriorated neurologically, the large majority by one grade, although Grade-III neural dysfunction had developed in five patients (Fig. 6).

Of the forty-six patients who had radiographic involvement initially, thirty-seven (80 per cent) had no neural deficit at the onset of the study. Interestingly, the twenty-eight patients (61 per cent) who remained neurologically unchanged and the seventeen patients (37 per cent) whose neurological findings deteriorated did not differ proportionately from the over-all group of seventy-four patients.

At the start of the study, forty-six patients (62 per cent of the seventy-four patients who ultimately had radiographic involvement) had such involvement of the types already mentioned. At the conclusion of the study, seventy-four patients were found to have radiographic evidence of rheumatoid arthritis in the cervical spine. Thirteen patients (18 per cent) had shown no change and one patient had improved. Thus, sixty patients (80 per cent) deteriorated radiographically over the course of the study (Figs. 7-A, 7-B, and 8).

Four patients (5 per cent) who had subluxation were also noted to have or to undergo spontaneous apophyseal fusion. In one patient this seemed to result in improvement of a minor neural deficit (Fig. 9). In another patient with a spontaneous posterior fusion, a symptomatic subaxial sub-

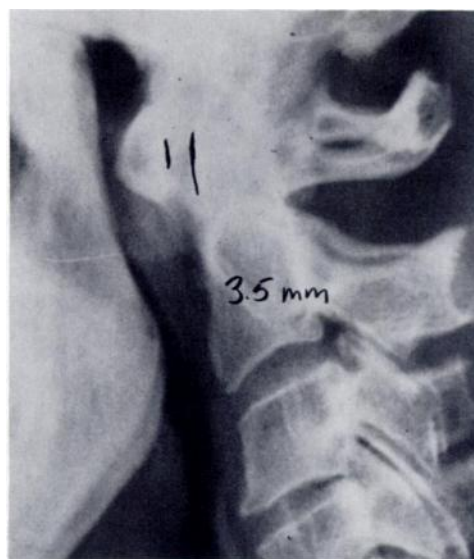


FIG. 7-A

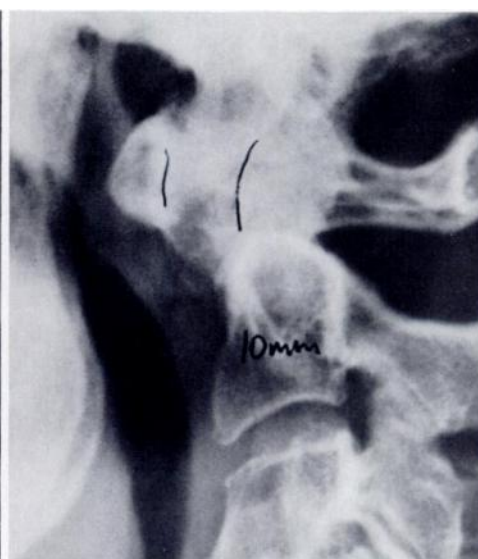


FIG. 7-B

Figs. 7-A and 7-B: Case 6. Progression of atlanto-axial subluxation.
Fig. 7-A: August 1975.
Fig. 7-B: April 1978.

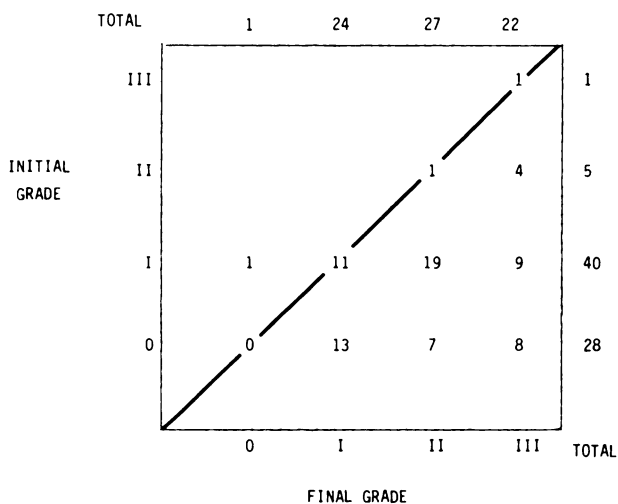


FIG. 8

Radiographic progression. See legend for Fig. 5.

luxation developed inferior to the fused segment and required surgical stabilization (Figs. 10-A and 10-B).

Seven patients (9.5 per cent) required surgical intervention during the years of this study (Table III). The indications in most patients were severe pain, neural deterioration to Grade III, and radiographic progression consistent with the clinical findings. In three patients, atlanto-axial subluxation alone was responsible for the deterioration. In the remaining four patients it was not until a sec-

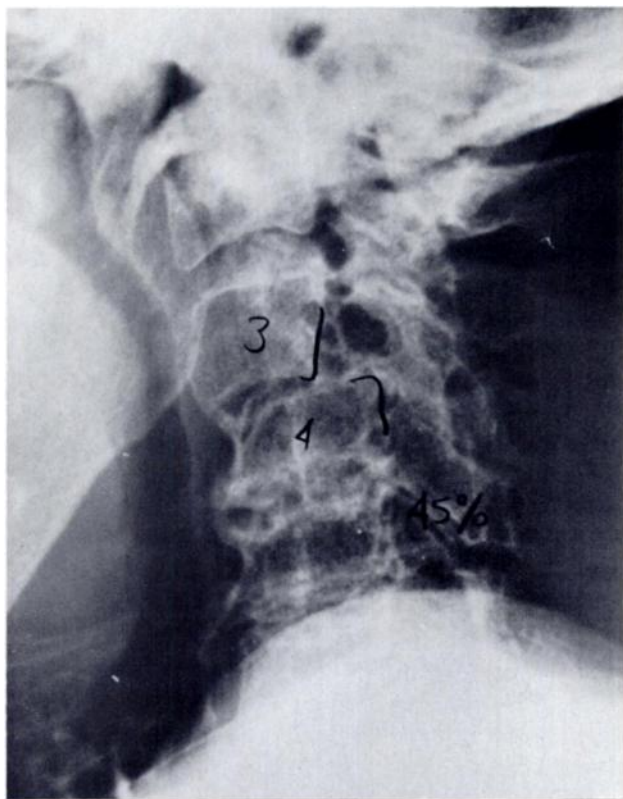


FIG. 9

Although the subluxation increased in this patient (see Fig. 2), the stabilization provided by spontaneous fusion resulted in lessened pain and improved muscle power.

TABLE II

TYPES OF RADIOGRAPHIC INVOLVEMENT

Type	No. of Patients	
	Initially	At Final Review
Atlanto-axial subluxation	28	41
Subaxial subluxation	5	10
Superior migration of the odontoid process	1	2
Atlanto-axial and subaxial subluxation	9	13
Atlanto-axial subluxation and superior migration of the odontoid process	3	5
All three types	0	3

ond problem intervened, either subaxial subluxation or superior migration of the odontoid process, that the neural status deteriorated.

At the conclusion of the study, three (7 per cent) of the patients with atlanto-axial subluxation alone had come to surgery, and two (15 per cent) of the patients with atlanto-axial and subaxial subluxation required surgery. One patient with atlanto-axial subluxation, subaxial subluxation, and superior migration of the odontoid process came to surgery. Finally, one of the patients with atlanto-axial subluxation and superior migration of the odontoid process required surgery.

Data also were collected on the thirty-two (30 per cent) of the patients in whom radiographic criteria of disease did not develop. Their other statistics did not differ significantly from those of the entire study group. Their average age was 54.5 years. The women outnumbered the men by a 7:1 ratio. The average duration of disease was 22.8 years, and the average follow-up was 5.3 years. Thus, we do not think that this group lacked radiographic involvement because it represents a different age group, duration of disease, or length of follow-up, but rather because it represents the incidence of rheumatoid involvement of the neck in this particular population.

None of the thirty-two patients without radiographic involvement had evidence of myelopathy, although nineteen (59 per cent) had Grade-I neck pain compared with sixty-one patients (82 per cent) in the group with radiographic involvement.

There also was a difference between the groups with and without radiographic involvement with respect to their American Rheumatism Association¹⁴ functional classification. Of the patients without radiographic involvement, 39 per cent were in Class II; 48 per cent, Class III; and only 13 per cent, Class IV. Only 12 per cent of the group with radiographic involvement were in Class II, while 61 per cent were in Class III and 27 per cent, in Class IV. It is apparent, therefore, that although the majority of patients were in Class III, the greater the involvement of the cervical spine the worse was the patient's functional classification.

Discussion

The thirty-two synovial-lined joints confined in close

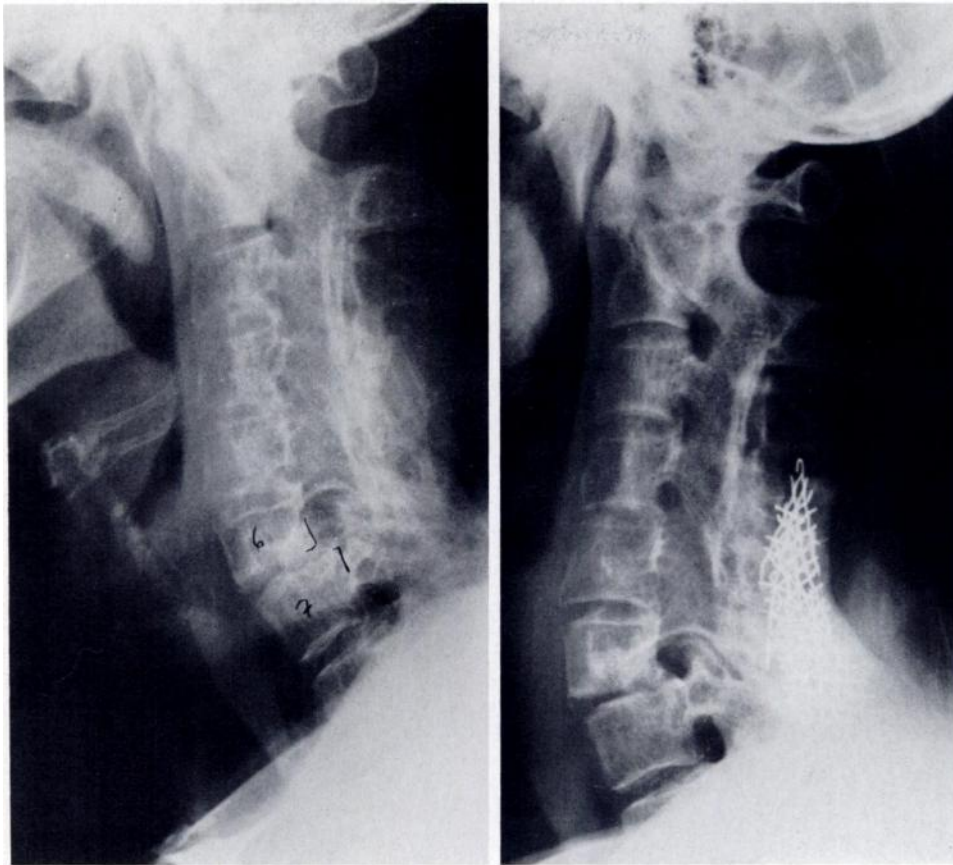


FIG. 10-A

FIG. 10-B

Figs. 10-A and 10-B: Case 3.

Fig. 10-A: Symptomatic subluxation below the spontaneously fused segment required stabilization.

Fig. 10-B: Wire mesh and methylmethacrylate provided immediate internal fixation to augment the bone graft and obviated the need for external immobilization.

proximity within the cervical spine make this region particularly susceptible to the ravages of rheumatoid arthritis. The radiographic abnormalities that were followed in this study — atlanto-axial subluxation, superior migration of the odontoid process, and subaxial subluxation — were present in seventy-four (70 per cent) of the patients at the time of final review. This figure would be higher if other radiographic criteria were included, such as disc-space narrowing; erosions of the vertebrae, apophyseal joints, and odontoid process; and osteoporosis.

Neck pain was the most common finding. Occipital pain was specific for disc disease at the interspace of the first and second cervical vertebrae. All of the patients with occipital pain were found to have either atlanto-axial subluxation or superior migration of the odontoid process, or both. The absence of occipital pain, however, did not preclude cervical disc disease.

It is clear from this study that radiographic evidence of severe disease may be present without symptoms, as 50 per cent of the asymptomatic patients had cervical subluxation and 50 per cent did not.

The time of onset of cervical involvement in the course of rheumatoid arthritis is variable. Contrary to the report of Isdale and Conlon, we did not find that involvement of the cervical spine occurs within fifteen years of the

onset of rheumatoid arthritis and then reaches a plateau. Its initial appearance may be delayed for as long as twenty-five years beyond the onset of the disease. Furthermore, patients whose disease apparently has reached a plateau may still deteriorate following a long stable period. This usually correlates with the superimposition of a second instability on a pre-existing one. Three of the seven patients who required surgery had a relatively stable atlanto-axial subluxation, but deteriorated when superior migration of the odontoid process or subaxial subluxation subsequently developed.

Progressive superior migration of the odontoid process may incorrectly appear radiographically as an apparent improvement in atlanto-axial subluxation. As the odontoid moves superiorly, its wider base and the body of the second cervical vertebra approach the level of the anterior arch of the first cervical vertebra, filling the space and thus apparently decreasing the arch-odontoid distance (Figs. 11-A and 11-B). This must not be misinterpreted as spontaneous resolution of the atlanto-axial subluxation, and it is imperative that the potentially dangerous superior migration be recognized.

Our experience agrees with that of Mathews, in that mutilating disease of peripheral joints is related to the severity of involvement of the cervical spine.

TABLE III
PATIENTS TREATED OPERATIVELY

Case	Sex, Age (Yrs.)	Duration (Yrs.)	Initial Presentation*	Progression*	Operative Procedure	Postop. Follow-up (Yrs.)	Result*
1	F, 64	13	1973 — asymptomatic; AAS, 4 mm	1975 — pain, Grade III; neurol., Grade II; AAS, 9 mm	C1-C2 fusion	4	Pain, Grade 0; neurol., Grade I; solid fusion; SAS, C3-C4, C4-C5
2	F, 50	26	1973 — pain, Grade I; neurol., Grade 0; AAS, 4 mm	1976 — pain, Grade II; neurol., Grade II; AAS, 6 mm; SAS, C4-C5, 30%	Myelogram demonstrated block C4-C5; fusion, C4-C6	3	Pain, Grade I; neurol., Grade I; solid fusion; AAS, 6 mm
3	F, 52	19	1968 — pain, Grade I; neurol. and radiog., Grade 0	1977 — pain, Grade II; neurol., Grade III; AAS, 5 mm; SAS, C6-C7, 20%	C4-T1 fusion (spontaneous fusion above C4); methylmethacrylate augmentation	2	Pain, Grade I; neurol., Grade II; methylmethacrylate removed; secondary infection
4	M, 55	24	1973 — asymptomatic; AAS, 11 mm	1977 — pain, Grade III; neurol., Grade III; AAS, 11 mm; SM above, 3 mm	Occiput-C2 fusion	2	Pain, Grade I; neurol., Grade II; solid fusion
5	F, 45	26	1974 — asymptomatic; AAS, 4 mm	1976 — pain, Grade III; neurol., Grade III; AAS, 9 mm	C1-C2 fusion	3	Pain, Grade 0; neurol., Grade 0; solid fusion
6	F, 61	19	1974 — asymptomatic; radiog., Grade 0	1978 — pain, Grade III; neurol., Grade III; AAS, 11 mm	C1-C2 fusion	1	Pain, Grade I; neurol., Grade II; graft resorbed, wires broken
7	F, 46	26	1968 — asymptomatic; AAS, 3 mm	1977 — pain, Grade III; neurol., Grade III; AAS, 7 mm; SM above, 5 mm; SAS, C3-C4, 25%	Occiput-T1 fusion	2	Pain, Grade 0; neurol., Grade 0; solid fusion

* AAS = atlanto-axial subluxation, SAS = subaxial subluxation, and SM = superior migration of the odontoid process.

Our findings do not support the concept that the diligent use of a supportive collar will alter the natural history of the disease. Virtually all of those patients who had progression of disease to severe neurological and radiographic grades had such progression while wearing firm collars.

Smith et al.¹² compared the mortality statistics of patients who had rheumatoid arthritis with and without cervical subluxation with those of the population at large. They found that beginning at the age of fifty, survival rates are much lower for patients with rheumatoid arthritis, and are not altered by the presence or absence of involvement of

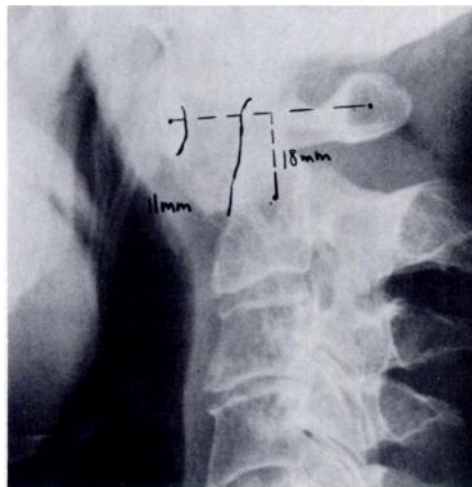


FIG. 11-A

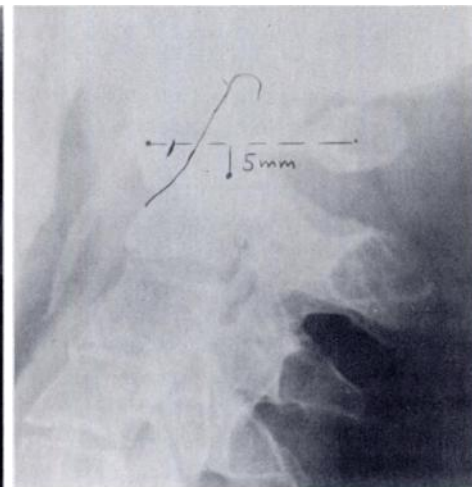


FIG. 11-B

Figs. 11-A and 11-B: Spurious improvement in atlanto-axial subluxation caused by superior migration of the odontoid process.

Fig. 11-A: The subluxation measures eleven millimeters and the pedicles of the second cervical vertebra are eighteen millimeters below the arch line of the first cervical vertebra.

Fig. 11-B: Three years later, the subluxation apparently is only three millimeters. However, note the superior migration, with the wider base of the odontoid process and the body of the second cervical vertebra now approaching the arch line of the first cervical vertebra.

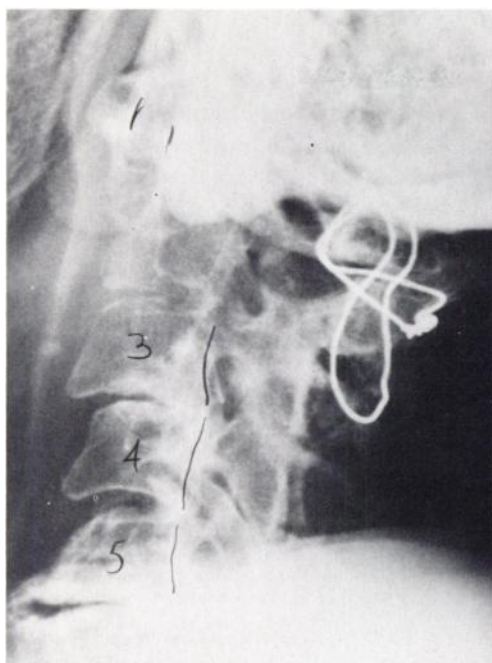


FIG. 12-A

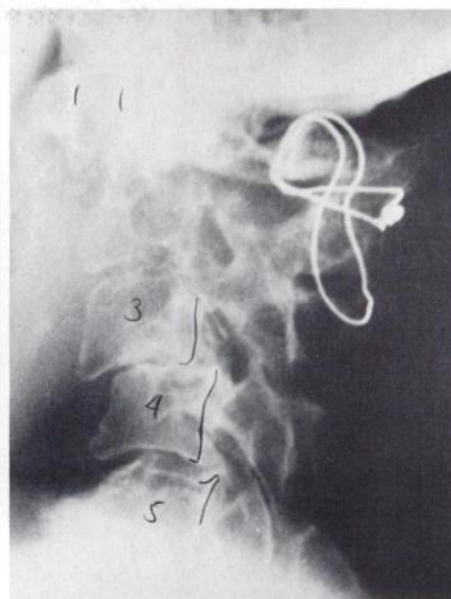


FIG. 12-B

Figs. 12-A and 12-B: Case 1.

Fig. 12-A: Solid fusion between the first and second cervical vertebrae.

Fig. 12-B: Subaxial subluxation at the third and fourth and at the fourth and fifth cervical vertebrae four years later.

the cervical spine. The twenty-one deaths in 124 patients who were followed in this study represents a mortality rate of 17 per cent over a five-year period. This is higher than the rate for the over-all population within the same age group by about 10 per cent but is lower by about 8 per cent than the statistics reported by Smith et al.¹² Thus, we would agree that the presence of rheumatoid involvement of the cervical spine does not appear to result in a shorter life-expectancy.

Spontaneous apophyseal fusion does occur, but its effect on the clinical picture is variable. A pre-existing instability may be improved if the spontaneous fusion bridges the unstable segments. However, if the fusion occurs only on one side of the unstable segments, a longer lever arm will result and may make the instability worse both radiographically and neurologically.

Similarly, subluxation may develop following surgical fusion in a different area of the cervical spine. In one patient in our series, two subaxial subluxations developed four years after a fusion of the first and second cervical vertebrae (Figs. 12-A and 12-B).

Conclusions

Although we examined the progression of rheumatoid involvement of the cervical spine in this group of patients, we have not defined the true natural history of the disease. Many of our patients were treated with supportive collars, and a large percentage were or had been treated with corticosteroids and other medications. Only by following untreated patients can the true natural history be determined.

Rheumatoid arthritis of the cervical spine is a progressive disease. Radiographic evidence of disease pro-

gresses to a greater degree than does neural involvement. Eighty-one per cent of our patients had radiographic deterioration whereas only 36 per cent had progressive neural abnormalities. On this basis we think that an attitude of conservatism is indicated. Fusion should not be recommended on the basis of radiographic abnormality or deterioration alone.

In this series, no patient was seen initially with Grade-II or III neural disease, although 19 per cent progressed to these levels of involvement. The potentially serious nature of this problem is further evidenced by the fact that seven patients (9.5 per cent) required surgery. If only the forty-six patients who had initial radiographic abnormalities are considered, the surgery rate increases to 13 per cent. Thus, while conservatism is the proper basic approach to the problem, it must not be substituted for by complacency. A constant awareness of the potential problems and a vigilant watch for their appearance must be maintained.

Based on our understanding of the progression of rheumatoid arthritis of the cervical spine, we recommend the following indications for operation: (1) intractable pain associated with any neural deterioration; (2) progression to Grade-II neural dysfunction when caused by superimposition of subaxial subluxation or superior migration on a pre-existing atlanto-axial subluxation; and (3) progression to Grade-III neural dysfunction.

The results of this study suggest that approximately 10 per cent of patients with radiographic evidence of disease risk deterioration to a level requiring surgery. Also, 10 per cent of patients who have a posterior arthrodesis of the cervical spine will further deteriorate neurologically¹¹.

Therefore, we do not routinely perform prophylactic arthrodesis for radiographic or neural evidence of disease that does not fall within the indications just mentioned. However, the patient with a Grade-II or III radiographic abnormality but no neural dysfunction must be made aware of the potential gravity of the problem. Our data suggest that 13 per cent of such patients eventually will require fusion. Some patients may elect to proceed with

surgery rather than risk neural deterioration. If not, these patients are treated with a firm cervical or Philadelphia collar, depending on the level of pain and their compliance. They are advised concerning the possible consequences of the disease and followed closely every two or three months for evidence of further deterioration.

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