

Rib erosions in rheumatoid arthritis

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Defects in the superior margin of ribs, of an erosive nature, appear to be uncommon, the chief causes being poliomyelitis (Bernstein, Loeser, and Manning, 1958), hyperparathyroidism (Noetzli and Steinbach, 1962), rheumatoid arthritis (Alpert and Feldman, 1964), scleroderma (Keats, 1967); other rarer causes have been summarized by Boone, Swenson, and Felson (1964), Gayler and Donner (1967), and Sargent, Turner, and Jacobson (1969).

Eighteen patients with rheumatoid arthritis have been found to have these rib erosions, similar to those previously described in the literature.

Clinical features

All eighteen cases were personally observed and followed over a period of time by at least one of us in a rheumatology clinic. They all satisfy the A.R.A. criteria for classical rheumatoid arthritis, all being seropositive and all but one having rheumatoid nodules.

These patients are severely affected by the disease, being classified either into anatomical Stage III (with joint deformity due to cartilage and bone destruction) or Stage IV (with fibrous or bony ankylosis) and into functional Class III (limited to only a few items of daily self care) or Class IV (totally dependent on others).

Destructive joint changes could be found in most joints examined, but some features were considered to be particularly common:

(1) All eighteen patients have atlanto-axial joint disease, five having erosive changes, and the others atlanto-axial subluxation. Posterior subluxation of the atlanto-axial joint is extremely rare, only three cases having been reported in the literature (Isdale and Corrigan, 1970), but in this series two patients have this posterior subluxation.

(2) A dorsal kyphosis is an almost constant finding.

(3) Shoulder changes are also commonly seen, the usual change being a markedly eroded gleno-humeral joint, with an upward subluxation of the humeral head.

(4) The acromio-clavicular joint also shows erosion, often with dissolution of the outer end of the clavicle. The clavicular attachment of the coraco-clavicular ligament is commonly eroded in this series.

One patient has an erosion of the lateral border of the scapula, and another erosion of the iliac crest.

The rheumatoid arthritis had been present from 8 to 46 years (mean of 20.5); one patient had rheumatoid arthritis at the age of 6 years, with nodules and a positive Waaler-Rose test.

The clinical features of each case are shown in Table I (opposite).

In all cases, the other causes of rib erosions were excluded. Investigations were performed in particular for L.E. cells, serum calcium, alkaline phosphatase, and uric acid, but all were negative.

The atlanto-axial disease and dorsal kyphosis produced a characteristic posture. This deformity was so constant that the presence of rib erosions on the chest x ray could often be predicted clinically.

Radiological features

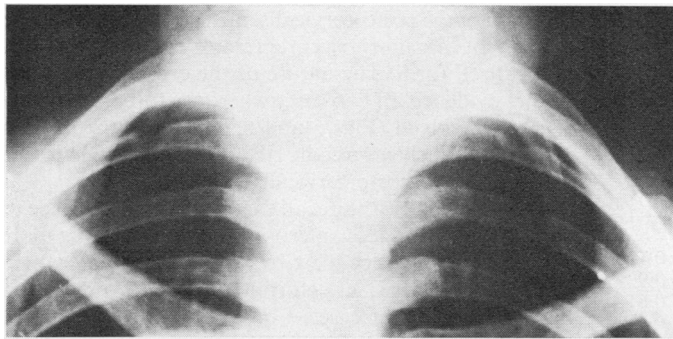
The erosions shown in Fig. 1 are typical of those found in all but three cases, being localized defects in the superior aspect of the upper ribs towards their posterior ends. There is a tendency for this lesion to occur symmetrically (Fig. 2) and to involve each particular rib at a constant distance from the costo-vertebral joint.



FIG. 1 Typical localized defect in the superior rib margin. The defect is clear cut, but lacks a cortical edge

Table I Clinical features of eighteen cases

Case no.	Age (yrs)	Sex	Duration of R.A. (yrs)	Ana-tomical stage	Func-tional class	Sub-cutaneous nodules	Latex-Rose test	Waal-er-Rose titre	Hb (G _m)	E.S.R. (mm./hr)	AT/AX subluxation (mm.)	Dorsal kyphosis	Steroids within 2 yrs
1	69	F	19	IV	III	Yes	+ve	1/256	12.5	63	Eroded	Yes	No
2	69	F	24	IV	III	Yes	+ve	—	12.6	70	4	Yes	No
3	39	F	16	IV	III	Yes	+ve	1/64	12.4	40	6	No	No
4	57	M	17	IV	III	Yes	+ve	1/1024	10.3	84	Posterior	Yes	No
5	52	M	8	IV	III	Yes	+ve	1/256	11.0	35	7	Yes	No
6	56	M	12	IV	III	Yes	+ve	—	11.8	48	6	Yes	Yes
7	58	F	24	IV	III	Yes	+ve	1/512	12.0	34	6	Yes	No
8	82	F	46	III	IV	No	+ve	1/512	12.2	42	5	Yes	No
9	59	M	23	IV	IV	Yes	+ve	1/1024	12.8	66	7	Yes	No
10	55	F	18	IV	II	Yes	+ve	—	11.8	42	4	Yes	No
11	60	M	20	III	III	Yes	+ve	1/1024	11.6	24	7	Yes	Yes
12	58	M	25	IV	IV	Yes	+ve	1/512	11.3	77	Posterior	Yes	No
13	58	M	19	III	III	Yes	+ve	1/1024	13.0	36	6	Yes	No
14	54	F	20	III	III	Yes	+ve	—	11.0	48	4	Yes	No
15	48	M	14	III	III	Yes	+ve	1/64	13.0	24	6	No	No
16	58	F	21	IV	IV	Yes	+ve	1/512	11.3	96	Severe	Yes	Yes
17	32	F	26	III	III	Yes	+ve	—	13.0	28	Eroded	No	No
18	60	M	18	IV	IV	Yes	+ve	1/512	11.8	73	Eroded	Yes	Yes

**FIG. 2** Both 3rd ribs are eroded symmetrically 1.5 cm. from the costo-vertebral joint. The 4th rib on the right is also eroded

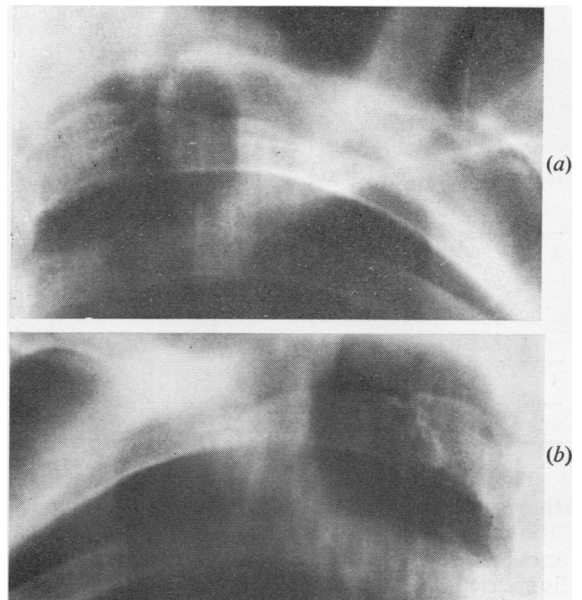
Ribs 2 to 6 inclusive were involved in all cases, the erosions appearing as rounded defects with well-defined borders, but lacking a cortical margin. However, in three cases (Fig. 3a, b), the upper margins of the ribs are more diffusely eroded over a few centimetres, but again the edges are clear-cut, unlike the bone resorption seen in hyperparathyroidism or bone destruction by metastatic malignancy.

To attempt to assess the incidence of rib erosions, the chest x rays of 100 rheumatoid patients were reviewed and no additional cases were found.

Review of the literature

Noetzi and Steinbach (1962), in a discussion on subperiosteal erosion of the ribs in hyperparathyroidism, made reference to a patient with long-standing rheumatoid arthritis with similar erosions of the superior margins of the upper ribs.

At an international symposium held at Amsterdam in 1963, Martel (1964), in a discussion on erosions occurring at 'non synovial' sites, referred to erosions in ribs towards their posterior ends. Dixon (1964) also recalled seeing well-delineated notches with good cortical margins in the upper

FIG. 3a, b Tomography of the 3rd ribs in Case 9 demonstrates diffuse erosion of their superior borders

edge of ribs in patients with far advanced rheumatoid arthritis. He suggested recumbency or rheumatoid involvement of the gliding plane behind the scapula as possible causes.

Alpert and Feldman (1964) reported eight patients with severe long-standing rheumatoid arthritis who had erosions of the upper margins of the 3rd, 4th, or 5th ribs posteriorly. The erosions were frequently symmetrical. Cup-shaped excavations were described as characteristic, but localized flattening of the superior contour and extensive destruction were also seen. Histological studies were not performed and the pathogenesis remained uncertain, but was thought to represent a rheumatoid granulomatous process.

Further cases were reported by Keats (1967), Sargent and others (1969), and Johnson, Kersley, and Airth (1970). The aetiology of the erosions remained unknown.

Discussion

The two striking features of this series are the constant anatomical site of the erosions (Table II) and the relationship of the rib erosions and atlanto-axial disease.

Table II *Site of erosions in eighteen cases*

Rib no.	Case no.	Distance from costo-vertebral joint (cm.)		Erosion diameter (cm.)	
		Right rib	Left rib	Right rib	Left rib
2	4	1.0	—	1.0	—
3	17	0.8	—	0.8	—
	1	2.0	2.0	0.6	0.7
	3	1.5	1.5	0.9	0.9
	4	1.25	1.25	0.75	0.6
	5	—	1.75	—	0.5
	6	Diffuse	Diffuse	Diffuse	Diffuse
	7	—	1.1	—	0.4
	9	—	Diffuse	—	Diffuse
	10	—	2.5	—	0.4
	11	—	1.5	—	0.6
	12	—	1.3	—	0.4
	13	Diffuse	—	Diffuse	—
	14	Diffuse	—	Diffuse	—
15	1.5	1.5	0.7	0.4	
16	—	2.5	—	0.7	
17	—	1.5	—	0.4	
18	2.5	—	1.0	—	
4	2	—	2.0	—	0.5
	3	2.5	—	0.6	—
	4	—	1.75	—	1.0
	8	—	2.0	—	0.4
	17	2.0	—	0.9	—
5	4	3.5	—	1.0	—
6	4	4.5	—	0.75	—

The site of the erosions relates well to the angle of the ribs, from which arises the costo-cervicalis muscle. The costo-cervicalis, a section of the sacro-spinalis group, arises from the angle of the upper six ribs and is inserted into the transverse process of the 4th, 5th,

and 6th cervical vertebrae. The origin from the rib is marked by a bony ridge running obliquely across the external surface at the angle. Fig. 4 (opposite) is an x ray of articulated spine and ribs with wire marking the site and obliquity of these ridges.

In Table III the distance of the origin of the costo-cervicalis from the costo-vertebral joint is compared with the average site of the rib erosions. It would

Table III *Distance of erosion from costo-vertebral junction*

Rib no.	Average distance of erosions from costo-vertebral junction (cm.)
2	0.9
3	1.7
4	2.05
5	3.5
6	4.5

seem reasonable to suggest that these erosions may be caused by rheumatoid inflammatory process at the origin of the costo-cervicalis muscle. The more diffuse type of erosion may represent extension of the localized form. The nature of the erosions adds further evidence. In two cases where the full width of the rib is involved (Figs 5 and 6, opposite), the erosion runs obliquely across the rib at a similar angle to the origin of the costo-cervicalis.

It is of interest to recall that the internal surface of the upper ribs faces antero-inferiorly, this being more marked the higher the rib. This is accentuated by a dorsal kyphosis, a deformity which is present in seventeen of our cases. Consequently, although the erosions appear to excavate the superior rib margin on an antero-posterior or postero-anterior radiograph, it is the external surface of the rib that must be involved.

In Fig. 7 (overleaf), a groove has been excavated along the region of the costo-cervicalis muscle. It can be seen that, with the rib lying in an anatomical position (Fig. 7b), the groove appears as an erosion in the superior rib margin, although the excavation involves only the external surface.

The significance of the erosions occurring in patients with atlanto-axial disease is hard to assess. There are three possible explanations:

(1) Both rib erosions and atlanto-axial subluxation are co-existing manifestations of severe rheumatoid disease.

(2) The abnormal posture with dorsal kyphosis that accompanies cervical spondylitis brings the rib erosions into profile. It may be that the erosions are common but not often seen.

(3) With cervical spondylitis an abnormal load is placed on the costo-cervicalis, a postural muscle of the neck, acting powerfully to retain the erect position in normal people.

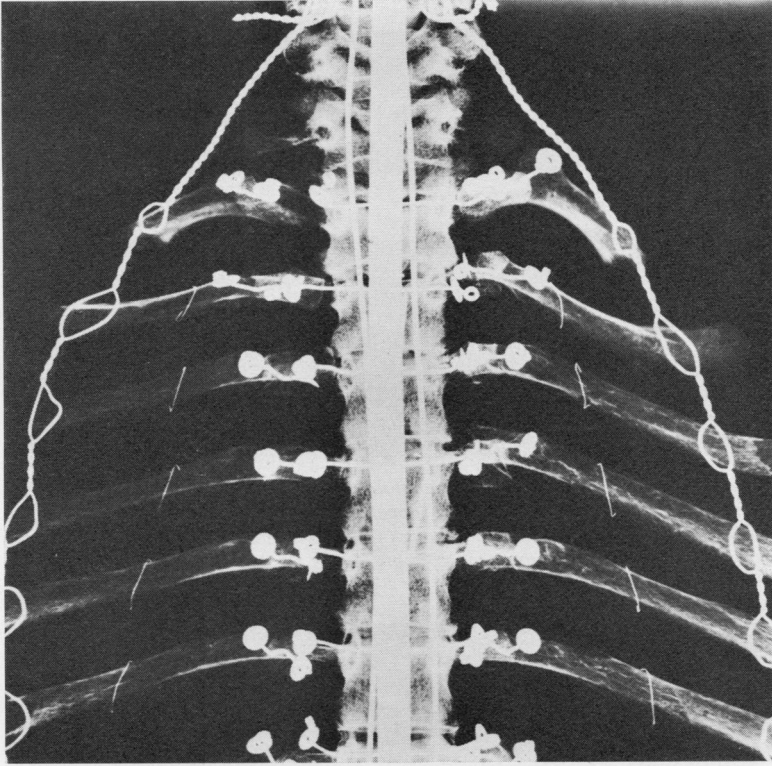


FIG. 4 Wire marks both the origin and obliquity of the costo-cervicalis from ribs 2 to 6

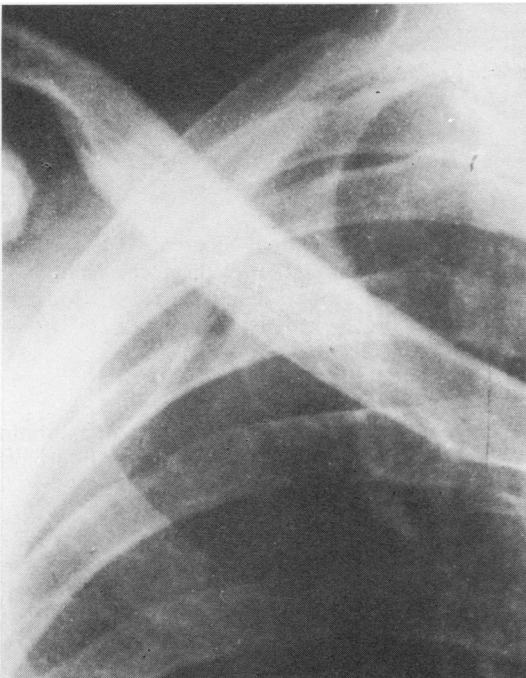


FIG. 5 Erosions of ribs 2, 3, 5, and 6 are in an oblique line, with the erosion of rib 5 involving the width of the rib in the same obliquity (compare with Fig. 4)

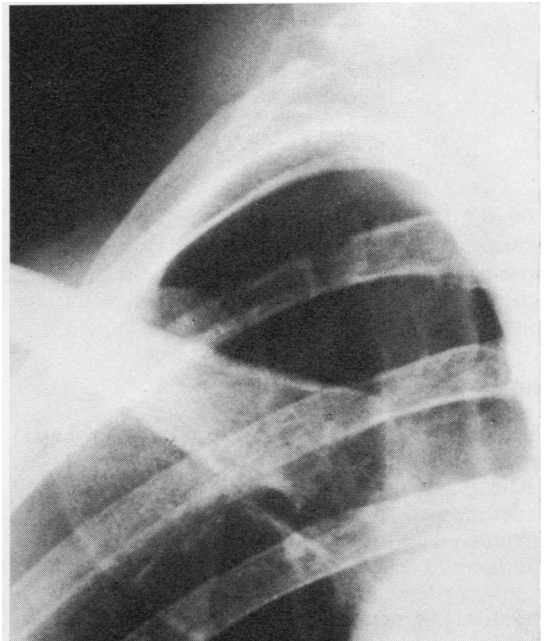
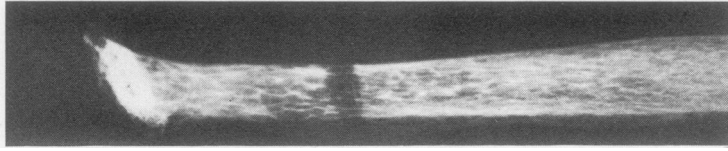


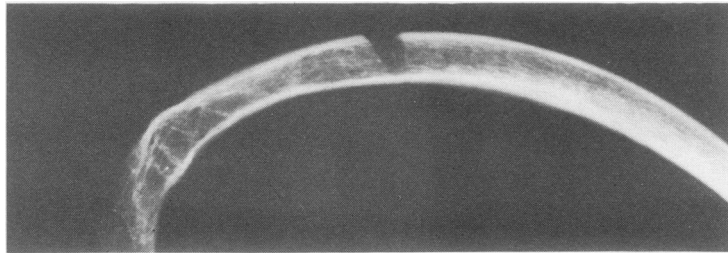
FIG. 6 The full width of right rib 4 is eroded, demonstrated by an oblique film. Compare the appearance of this erosion with Fig. 7c



(a) *The rib lies flat on the film*



(b) *The rib is now rotated into an anatomical position with the internal surface facing antero-inferiorly as do the upper ribs. The erosion is now seen as a defect in the superior margin, although the excavation across the full thickness remains evident. This appearance is present in right rib 5 in Fig. 5 and right rib 3 in Fig. 6*



(c) *The lateral aspect of the rib is elevated to produce an oblique projection similar to that in Fig. 6. The appearance of the erosion changes to become comparable with that in Fig. 6*

FIG. 7 *An erosion has been artificially created in a rib by excavating along the origin of the costo-cervicalis*

One of the patients in the series died suddenly from influenza, and although only a very limited *post mortem* examination was allowed by the relatives, sections taken from a biopsy in the region of the erosion showed lymphocytic infiltration of muscle.

Differential diagnosis

The differential diagnosis of the localized cup-shaped erosion found in this series is limited.

Rheumatoid arthritis is the only condition in which rib defects were found at the constant anatomical sites previously described. It is just conceivable that similar defects could be found as an anatomical variant, after trauma, or through pressure from a retractor post-operatively. A neurofibroma, while causing a defect, would also widen the rib space and affect the under-surface of the adjacent rib.

The more diffuse form of erosion has a wider differential diagnosis, including hyperparathyroidism,

poliomyelitis, scleroderma, Sjögren's disease, lupus erythematosus, coarctation of the aorta, irradiation, and such congenital conditions as Marfan's syndrome and osteogenesis imperfecta.

Summary

Eighteen cases of rheumatoid arthritis all exhibiting erosions of the superior aspect of upper ribs are presented.

Two forms of erosions are seen.

One is a localized rounded defect involving ribs 2 to 6 inclusive. These erosions tend to occur symmetrically and appear to occur at the angle of the rib, on the external surface at the origin of the costo-cervicalis. It is suggested that the cause of the erosions is rheumatoid inflammatory process at the origin of the costo-cervicalis muscle. This may develop as a part of a severe erosive arthritis or may be provoked by excessive strain on this muscle by atlanto-axial

involvement, which is a constant finding in this series. The erosions may become more obvious when thrown into profile by a dorsal kyphosis.

The second type of erosion is a more diffuse lesion of the superior margin of the rib and may represent a more extensive involvement.

We should like to thank the Radiology and Rheumatology Staff at The Royal North Shore Hospital, in particular Drs John Hunt, Ray Robinson, and John Webb, for help in gathering these cases, Frank Quealey for radiographic assistance, and Ruth Atkinson for secretarial help.

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