Discussion

These cases, together with those already reported by other writers, show clearly that it is possible for ribs to fracture as a result of otherwise normal respiratory exercise. The occurrence must be a rare one, but is likely to be observed occasionally by those who see a sufficient number of chest radiographs, and it probably occurs more often than might be supposed. Cases are easily missed if chest radiographs are not carefully examined and the condition borne in mind.

The mechanism of such fractures is difficult to determine. Primary tuberculous osteitis of ribs is generally believed to be so uncommon that it is unlikely to be the basic cause. There was no evidence of it in my own cases, though it is conceivable that areas of bone rarefaction may occur in a rib adjacent to a cold abscess arising from a caseous tuberculous gland; and, so far as I have been able to ascertain, most reported cases, excluding those due to gross localized changes such as secondary malignant deposits or osteitis fibrosa, have occurred in tuberculous subjects, but the condition is not confined to them. Cough fractures of ribs have also been known to occur in elderly subjects, probably associated with increased fragility of bones associated with advancing age, and it would not be surprising if it occurred also, for example, in cases of rheumatoid arthritis, in which rarefaction of bones is sometimes found.

The apparently high incidence in tuberculous subjects suggests a possible constitutional effect on bone structure, but it must also be remembered that such subjects are repeatedly having their chests x-rayed and the lesion is therefore more likely to be discovered.

I have been unable to find any evidence to suggest that the ribs of a tuberculous patient are particularly liable to decalcification, except in so far that prolonged bed-rest may lead to some degree of this from diminished use. Certainly the blood calcium level remains remarkably constant in tuberculous subjects. Healing of the fractures has followed normally, and there does not appear to be any delay in callus formation and eventual union.

The most reasonable explanation of these fractures seems to be the violent and abnormal action, probably associated with asymmetrical posture producing uneven action on the ribs, occurring during the violent expiratory effort of a cough or sneeze. Diminished use of the thoracic musculature that occurs in a patient confined to bed for long periods may also lead to a mild degree of decalcification and be a contributory factor.

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The Mental Survey Committee of the Scottish Council for Research in Education has recently completed an investigation into the intelligence of Scottish children. The results were briefly described in *The Times* of Nov. 17, 1948, by Professor Godfrey Thomson, the chairman of the committee. The full results are to be published in a series of volumes, the first of which will appear in the spring. The main task of the investigators was to repeat a group intelligence test given in 1932 to 87,498 Scottish children whose eleventh birthday fell in that year. The same test was given to 70,805 children whose eleventh birthday fell in 1947, but on this occasion much additional sociological information was collected about each child. The possible score was 76 points, and in 1947 the mean score, 36.7, was higher than the mean score, 34.5, in 1932. The boys went up 1.3 and the girls no less than 3.2 points. At least as a first deduction this appears to show that no decline in intelligence is going on, but Professor Thomson thinks the rise may be due to the fact that children are now much more familiar with intelligence tests. The now common observation that intelligent children are more frequently found in small families than in large ones is confirmed. The average score obtained by the only children, 7,824 out of 70,805, was 42 points, and children of families of two averaged nearly as much. But for families of four the average score was 35.3 and for those of eight 28.8.

COUGH FRACTURE IN LATE PREGNANCY

BY

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Rib fractures due to cough alone, or with an added factor of shearing stress from simultaneous action of other muscles, have been recognized for many years (Gurlt, 1862; Tunis, 1890; Hawley, 1890; Skyrme, 1890; Bähr, 1894). In addition, sneezing, choking, vomiting, and straining at stool are recorded as causes among other varieties of expiratory effort. Numerous forms of exertion, such as a handspring or mounting a restive horse (Hilton, 1852; Seilin, 1917), have also been blamed, although here again associated grunting expiration through partly closed cords may have been responsible.

In recent years the number of cough fractures reported from sanatoria has tended to overshadow the non-tuberculous cases, which may be more numerous but have less chance of being diagnosed. Oechsli in 1936 found 77 cases of cough fracture in the literature to that time. He indicated that when a routine search was made in chest films the incidence of the condition was high. In his series of approximately 3,000 admissions to Olive View Sanatorium 22 cases with cough fracture were found. At the same time Richardson (1936) at Ray Brook Sanatorium reported 20 cases out of 1,903 tuberculous admissions. Osteoporosis in the late stage of phthisis has often been suspected as predisposing to cough fracture, but evidence that it is the chief cause is as yet unconvincing.

Tunis (1890), analysing 40 such stress injuries from muscular action, noted that more than 25% occurred in patients in whom bone fragility could be excluded as a factor, and Seilin (1917) supported this view. Reports since published do not suggest a different conclusion.

Kleiner (1924), quoting Tunis and bringing the literature up to date, found that of 57 cases (which included 14 by muscular action other than coughing) 28 were left-sided, 17 were right-sided, and the side was unrecorded in the remaining 12. There were more fractures of lower ribs than upper, the site of fracture on 19 occasions being the upper seven ribs and on 36 occasions the eighth, ninth, tenth, and eleventh ribs. (The apparent discrepancy is due to more than one rib being involved in some instances.) Kleiner's analysis was made before the papers on the large series of tuberculous cases had been published. In seven of eight patients with fracture of the eleventh rib reported by Tunis and Seilin this was the only rib affected. Multiple fractures appear to be more frequent when the higher ribs are involved.

The older writers (Tunis, 1890; Bähr, 1894) suggest that the preponderance of left-sided damage pointed to a cushioning action of the liver on the right side. Oechsli found no left-sided prevalence and was therefore sceptical of this theory, but the majority of his fractures were mid-thoracic and above liver level. Richardson in a similar series of tuberculous patients noted that the sixth and seventh ribs in the mid-axilla were the commonest sites.

In the literature there are six reports of this accident in pregnancy. Only one occurred during labour, and that in

a coughing fit (Ahern, 1894). Wahl (1926) remarked on the coincidence that four out of five cases described had occurred at the end of pregnancy; the duration of cyesis in the other was not recorded. These cases reported by different authors over many years, together with the four patients in the present series, appear to have features in common: (1) they occur late in pregnancy; (2) they tend to be left-sided; (3) lower ribs are chiefly involved; and (4) multiple fractures are the exception. The details are summarized for convenience in the Table.

Author	Patients' Age and Previous Pregnancies	Duration of Pregnancy	Site of Rib Fracture	Remarks
Hérard (1855) ..	22	7 months	Left 11th	Cough for 6 months
Benoit (Bähr, 1894)	—	In 9th month	Left 9th	Coughing fit (ch. bronchitis)
Chonery (Bähr, 1894)	23	—	—	Coughing fit
Dogadkin (1885) ..	27 multipara	In 9th month	Left 8th	" "
Blanc (1908) ..	—	At end of pregnancy	Multiple	Coughing
Ahern (1894) ..	—	In labour	Left 6th	Coughing fit (ch. bronchitis)
Pauley <i>et al.</i> ..	21 primipara	36 weeks	Left 10th	Coughing mildly
" " ..	25 multipara	38 "	Left 9th and 10th	" "
" " ..	36 "	40 "	Left 11th	Lifting and coughing
" " ..	25 primipara	29 "	Left 11th	Coughing after previous choking

Case Reports

Case 1.—Primipara aged 21. 36 weeks. No previous fractures. When seen on Jan. 12, 1947, gave a history for 14 days of sharp pain in the lower left chest posteriorly. A non-productive barking cough had been present for the same length

FIG. 1

of time. Physical signs suggested a small effusion at the left base and chronic bronchitis. X-ray film of chest was negative. Subsequent examination revealed a localized tender lump with crepitation over the tenth rib on the left side. Special views of this area confirmed diagnosis of rib fracture. Control films for bone density showed no osteoporosis. Serum calcium was 9.5 mg. per 100 ml. Serum inorganic phosphate was 3.8 mg. per 100 ml.

Case 2.—Multipara (one previous child) aged 25. 38 weeks. No previous fractures. Seen in antenatal clinic on Jan 7, 1948. In late November, 1947, began to cough and noted slight pain in left lower chest. In mid-December, 1947, three weeks before being seen, while coughing mildly felt a crack

FIG. 2

in same region, with exacerbation of pain. Pain had persisted. On examination, tender over left tenth rib in the posterior axillary line. Radiograph of this area confirmed fracture of this rib and of the ninth. Control films for bone density showed no osteoporosis. Serum calcium was 10.3 mg. per 100 ml. Serum inorganic phosphate was 4.6 mg. per 100 ml.

Case 3.—Multipara (four previous pregnancies, well spaced) aged 36. 40 weeks. Seen Feb. 14, 1948. Gave history of having had a cough for some time. Seven days previously coughing vigorously, and at the same time, when bending and lifting a child aged 3, experienced a sudden pain in the left side of chest and felt something "go." Thereafter unable to cough properly because of pain. Clinically, fracture of eleventh rib left side posterior axillary line with ecchymosis. A.P. radiograph of area confirmed fracture. Comparative control radiographs for decalcification revealed no abnormality. Serum calcium was 8.9 mg. per 100 ml. Serum inorganic phosphate was 4.5 mg. per 100 ml.

Case 4.—Primipara aged 25. 29 weeks. No previous fractures. Seen on Jan. 26, 1948, having had cough for three or four weeks. In early January had had a choking attack and subsequently noticed pain over the left lower chest. Two days before attending had gone out in the evening, and cold air in the street caused her to cough, which was followed by immediate sharp pain in the left side. Radiograph confirmed fracture of eleventh rib. Radiographs for bone density against control revealed slight osteoporosis present. Serum calcium was 10.8 mg. per 100 ml. Serum inorganic phosphate was 4.07 mg. per 100 ml.

A woman in late pregnancy was seen in April, 1946, with what was in retrospect a characteristic history. At the time pleurisy was suspected. A radiograph of the chest was negative and she was dismissed as having had an intercostal muscle tear. It is noteworthy that in her case the lesion was on the right side.

Two other probable cases have been seen, but the considerable administrative difficulties in the immediate antenatal and post-natal periods interfered with the necessary investigations.

The Clinical Picture

If the possibility of the condition is kept in mind a careful history will often give a pointer to the diagnosis. The sudden onset of severe sharp pain during a coughing fit is often supported by a story of something "giving" or "cracking." The four cases described, and the other three possibles, all occurred in the first quarter of the year, when hard unproductive coughs are prevalent and bronchitis are having their winter exacerbations. All the patients were in the last three months of pregnancy.

On examination there may or may not be some fever from the primary chest condition, and the respiration rate may be raised owing to pain on deep breathing. Movement and air entry are diminished at the affected base, and percussion is impaired because of poor aeration or a high diaphragm. Pleural rubs have been noted in some cases of cough fracture. The signs may suggest a small pleural effusion, but it must be stressed that postero-anterior and lateral chest films reveal no abnormality when the lower ribs are involved. If suspicion has not already been aroused it is now that a careful search should be made for a tender localized area on one or more of the ribs. Experience of these pregnancy cases suggests that the left ninth, tenth, or eleventh ribs are the most likely site. Antero-posterior and oblique views will be required to confirm a fracture with minimal displacement in or behind the posterior axillary line.

Discussion

Comparisons of bone density against controls of the same sex and age revealed slight osteoporosis in only one case. Blood calcium and phosphorus estimations were within normal limits. There was no history in any of the cases of previous fractures to suggest pre-existing bone fragility.

If calcium or phosphorus metabolism were a factor in late pregnancy patients one might expect a high incidence in the early puerperium, but so far there is no record of such a case.

If bone fragility can be excluded the remarkable incidence of fracture of lower ribs consistently left-sided and in late pregnancy could be due to a mechanical cause peculiar to the abdominal mass or compensatory lordosis.

It has already been shown that the mid-thoracic fractures occur along the line of interdigitation of the external oblique and serratus anterior (Oechsli, 1936), and are assumed to be the result of shearing stress. The likelihood of fracture is reported to be increased if the serratus is taut at the time of coughing, as it may be when the arm is raised or when the patient is resting on one elbow (Atkinson, 1898; Seilun, 1917; Oechsli, 1936).

In the group of cases in which fracture occurs in the lower ribs a different explanation must be sought. Expiration, normally passive, becomes forced on coughing, but there is some disagreement about which muscles are implicated. Mainland (1945) gives these accessory muscles as: (1) anterior abdominal muscles; (2) latissimus dorsi, but states that its mechanism is not clear; (3) the long back muscles, the lower parts of which are able to depress the ribs.

A study of the anatomy and fracture sites in the majority of pregnancy cases suggests that the shearing stress occurs along the line between the origin of the external oblique (from the lower four ribs) and the costal slips of the latissimus dorsi. This, however, ignores the long back muscles (sacrospinalis). In the pregnant stance the head and shoulders are thrown back; compensatory to this is a lordosis involving increased postural tone, and perhaps hypertrophy of the iliocostalis and longissimus portions of the sacrospinalis. Incoordination or action of more than normal violence might occur in this muscle in such circumstances. Thus forcible expiration, as in coughing with depression of the lower ribs by the iliocostalis, could provide conditions for a shearing stress sufficient to fracture a rib.

Another possible mechanism is that the uterine mass is driven backwards and upwards against the inner surface of the lower chest in coughing by contraction of the anterior abdominal muscles. The main force would be deflected to the left side by the liver on the right. Whether or not the protuberant abdomen is in any way responsible by altering the action or direction of pull of the external oblique must remain at present a matter for further consideration.

Although a fractured rib is a trivial injury it can produce extreme discomfort and insomnia, particularly in a patient who is coughing. That this is undesirable in late pregnancy is self-evident. It would appear from the literature quoted in this paper, and from the present series collected without propaganda in twelve months from two antenatal clinics, that the condition in late pregnancy is not a rarity, and its frequency is probably greater than hitherto appreciated.

The importance of wider recognition lies in the great relief of pain experienced by the patient with early diagnosis and adequate strapping of the chest. Almost equally important is the avoidance of tiresome confinement to bed and needless investigation, often in hospital.

Summary

A brief review of the literature of cough fracture is given, with particular reference to its incidence in late pregnancy.

The clinical picture usually found in this condition is described.

Brief histories of four cases are reported.

Suggestions are made about the mechanism of the condition.

A case is put forward for this rather trivial injury to be regarded more seriously, and a suggestion is made that its frequency may be greater than is generally recognized.

We wish to thank Drs. J. N. Pattinson, F. Pygott, and R. A. H. Kinch for their help, and Miss W. P. Cory and Miss D. Wrighton for secretarial assistance. We are grateful to Mr. J. S. MacVine for access to three of the cases, to Mr. F. Roques for access to the fourth case, and to Professor J. Kirk and Dr. E. W. Walls for advice on the anatomy.

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LYMPHOBLASTIC LEUKAEMIA TREATED WITH URETHANE

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The use of urethane in the treatment of lymphatic leukaemia is a fairly recent development, and was first recorded by Paterson *et al.* (1946) in 12 cases of chronic lymphatic leukaemia. Five of these patients were alive at the end of the observation period, but the single case of acute lymphoblastic leukaemia showed no response to treatment.

The following case is noteworthy for the dramatic initial clinical and haematological response to urethane in a child with acute lymphoblastic leukaemia.

Case History

A girl aged 14 months, weighing 24 lb. (10.89 kg.), was admitted to hospital on July 19, 1947, with one week's history of anorexia and fretfulness, associated with vomiting for the previous two days. The mother had recently noticed that the child bruised easily. The past history was one of normal physical and mental development, the diet was normal, and no drugs had been taken. The family history was negative.

On examination the patient was seen to be a well-developed but abnormally quiet child with a very pale, slightly jaundiced skin. Small ecchymoses were present on the limbs, though petechiae were not seen. There was uniform enlargement of the cervical glands, and those of the axillae and groins were easily palpable. The spleen was enlarged to three finger-breadths below the left costal margin and was soft in consistency. The liver could not be felt; the mucous membranes showed neither haemorrhage nor ulceration, and no further abnormalities were detected.

A blood count on July 21 showed: Hb, 42%; white cells, 27,700 per c.mm (polymorphonuclear leucocytes 2%, cells of lymphocytic series 98%). Blood film:—Red cells showed anisocytosis, but were well filled. There was no evidence of red-cell regeneration. The lymphocytic series was made up largely of lymphoblasts, but some degenerating "smudge" cells were also present. The granulocytes were of the early type. Platelets were few. The whole blood picture was highly suggestive of acute lymphoblastic leukaemia.

The count was repeated two days later, when the haemoglobin level had fallen to 28%. The clinical condition had markedly deteriorated, and the child was wretched with buccal ulceration