COUGH FRACTURE OF THE RIBS UNASSOCIATED WITH PULMONARY TUBERCULOSIS

BY

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Fracture of the ribs may be produced by frank trauma, or may follow local or generalized abnormalities of the bones, which reduce their ability to withstand the strain of normal muscular movement. A further type has been described and variously referred to as "stress," "cough," or "fatigue" fracture—a diversity of names which reflects the doubt still held concerning its cause. This article is concerned with the latter group of fractures, which, for the sake of clarity, must again be subdivided into those affecting the lower ribs—most commonly the sixth to the eleventh inclusive—and those affecting the first rib.

The Literature

Fracture of the lower ribs following cough or, less commonly, other muscular effort was first described by Graves in 1833, and has been reported at intervals since. Several theories have been held responsible for these fractures, but their constant association with cough or other expiratory effort undertaken with a closed or partially closed glottis must be emphasized. This form of stress is most probably present even in those cases which seem to follow muscular exertion alone. Disadvantageous posture at the moment of strain has also been described and may be a factor in many cases. Oechsli (1936) thought that the opposing action of two sets of muscles on the rib was necessary to produce them. He pointed out that the common site of fracture was along the line where the muscles of the shoulder girdle and anterior abdominal wall interdigitate, and that both groups may be tensed at the time of coughing.

Seilin (1917) maintained that contraction of the diaphragm was necessary as a contributory factor, but the site of the majority of fractures renders this hypothesis untenable. Richardson (1936) found cough fractures in 6.5% of patients with advanced pulmonary tuberculosis and in only 0.08% of those with incipient disease. He thought that there was evidence that softening of the ribs occurred in advanced tuberculosis. Bond (1945) was of opinion that continuous coughing caused a change in the ribs analogous to that which occurs in the "fatigue" fractures of weight-bearing bones. Paulley *et al.* (1949) thought that cough fractures in pregnancy might be partly due to the uterine mass being driven backwards and upwards against the inner surface of the lower chest on the left side.

Whatever their exact causation, cough fractures, confirmed radiographically, have been judged rare except when associated with pulmonary tuberculosis. But Cohen (1949), who reported seven cases, thought that these fractures were rare even when associated with pulmonary tuberculosis, though Oechsli (1936), with 21 cases, and Richardson (1936), with 27 cases, thought them not uncommon. Apart from tuberculosis 12 child-

ren with cough fractures complicating pertussis were described by Pospischill in 1921, but no series in adults has exceeded four in number (Cramer, 1943), and single cases are still being reported (Bodenheimer, 1948; Gelfand, 1949). Paulley *et al.* (1949), however, thought them to be relatively common in late pregnancy, though they were able to collect only six cases from the literature to add to the four they detailed.

Fracture of the first rib arises most often in those subjected to unaccustomed exertion, and is more common in men (Alderson, 1944; Garber, 1944). It has been reported in status asthmaticus (Ginsburg, 1947) and in patients without obvious cause. It has no relation to cough and, unlike fractures of the lower ribs, is usually asymptomatic. Though probably caused by the action of opposed muscles, it should not be classed as a cough fracture, but differentiated as a "stress" fracture. The term "fatigue" fracture (Hartley, 1943) should be reserved for those of weight-bearing bones.

Present Series

The histories of nine cases of true cough fracture of the ribs unassociated with pulmonary tuberculosis are summarized.

Case 1.—A woman aged 28 was six months pregnant when first seen on March 29, 1949. She complained of pain in the right chest that was made worse by coughing or deep breathing. This pain had appeared suddenly during a spasm of coughing about five weeks previously, at the start of a respiratory infection. Examination showed no abnormal signs in her lungs, but a tender localized area was present over the sixth rib anteriorly. On this date a postero-anterior (P.A.) radiograph of the chest showed slight elevation of the left side of the diaphragm accompanied by shadowing in the lower zone of the left lung suggesting pneumonia. A fracture with some displacement of the anterior part of the sixth right rib was obvious. No callus was observed round this fracture at any time.

Case 2.—A woman aged 28 was first seen on August 30, 1949, when she gave a history of having had cough and sputum for over six months and an aching pain in the left shoulder for about 14 days. There were signs of widespread bronchitis. A P.A. radiograph showed no evidence of disease of the lungs, but a linear fracture without displacement of the posterior third of the seventh left rib about 4 cm. from the tubercle was present, though it was not diagnosed until a further film on September 27, 1950, disclosed callus surrounding the fracture.

Case 3.—A man aged 56 was referred on January 12, 1950, for an exacerbation of bronchial asthma, which had been accompanied by stained sputum. On examination signs of bronchitis were found. A P.A. radiograph was normal. A further film taken on July 13 showed the callus of a fracture of the posterior third of the ninth right rib, 9 cm. from the rib tubercle. Direct questioning elicited the fact that he had had pain in the right chest posteriorly for over three months. He dated this pain to about four weeks previous to a radiograph taken on April 13, which showed no abnormality of the ninth right rib in the area later developing callus. It is of interest that his pain had never been of sufficient severity for him to mention it.

Case 4.—A man aged 73 was first seen at his home on January 26, 1950. He gave a history of chronic cough and sputum, which had been much increased for about seven days. During this time there had been pyrexia and a pain in the right chest posteriorly that was made worse by movement, coughing, and deep breathing. On examination the breath sounds were slightly weak over the right lower zone anteriorly and posteriorly, where a pleural rub was heard. On March 2 he was well, apart from his usual cough and the pain in the right chest. A P.A. radiograph on this date

showed shadowing in the right lung suggesting a resolving pneumonia of the posterior segment of the right upper lobe (confirmed by lateral film). A small indefinite shadow was also present in the outer part of the lower zone above the diaphragm. A further radiograph on March 16 showed some resolution of the shadow in the upper lobe. The shadowing in the lower zone was still present, but the inner part of this shadow had become denser and was now diagnosed as callus forming round a fracture of the posterior third of the tenth right rib about 9 cm. from the tubercle. Reference to the film of March 2 showed that part of the shadow in the lower zone was apparently the ninth rib, though no fracture line was apparent. Evidence of increased density localized to this area of the tenth rib was still present on September 21, the lung fields being normal.

Case 5.—A woman aged 28 first attended on March 21, 1950, complaining of pain round the lower part of the right chest and cough of about four weeks' duration. The pain had followed a spasm of coughing, which, with deep breathing, made it more acute. No abnormal physical signs were found in the lungs, but an area of tenderness was present over the anterior part of the seventh right rib. A P.A. radiograph was normal, as was a further film on April 18. On June 14 she was admitted to hospital with symptoms and physical signs of a right basal pneumonia. Pain was still present over the same area as previously. A radiograph on this date disclosed a fracture at about the junction of the middle and anterior thirds of the seventh right rib with callus formation as well as a basal pneumonia.

Case 6.—A woman aged 29 was first seen on June 6, 1950, complaining of a sore throat, cough, and pain in the right side of the chest, made worse by a deep breath. There was no history of sudden onset of this pain, which lasted about 10 days. Her lungs were normal on examination. A P.A. radiograph showed no abnormality of the lungs, but fractures of the anterior parts of the seventh and ninth right ribs were apparent, although not diagnosed until a further radiograph taken on July 4 disclosed the presence of callus round the fractures.

Case 7.—A man aged 45 was first seen on July 6, 1950, complaining of long-standing cough and sputum. During the previous week pain had been felt in the right chest posteriorly on coughing, but no history of sudden onset was obtained. A P.A. radiograph showed an irregular cystic appearance suggestive of bronchiectasis in the upper and middle zones of the right lung. A fracture of the middle third of the seventh right rib with slight displacement was also present.

Case 8.—A woman aged 28 was first seen on July 18, 1950. She complained of cough and sputum of about eight months' duration, but even on direct questioning she stated that she had not suffered from any pain in her chest. Examination showed weak breath sounds, diminished movement, and a few adventitious over the right lower zone posteriorly. A P.A. radiograph disclosed callus formation in the anterior thirds of the sixth and seventh left ribs. It is of interest to note that this patient had been referred to another hospital for radiographic examination because of pain and tenderness over the area of the seventh left rib. A P.A. radiograph on March 15, 1950, was reported on as showing a congenital abnormality of the seventh left rib. This film, when viewed, showed callus formation of the seventh left rib but no evidence of any lesion of the sixth rib. The latter fracture, therefore, presumably developed after March 15.

Case 9.—A woman aged 22 was first seen on October 24, 1950, when she complained of cough and pain in the right side. This pain had occurred suddenly while coughing three weeks previously, and was made worse by deep inspiration. On examination there were signs of widespread bronchitis and tenderness over the lower ribs on the right side. A P.A. radiograph showed no abnormality in the lung fields, but fractures in the anterior thirds of the ninth and tenth right ribs were present.

Analysis of Symptoms and Radiographic Findings

Among these patients there were six women and three men; the youngest was aged 22 and the oldest 73. Pain was present in all, but in only three was it described as of sudden onset. Two patients admitted pain on direct questioning only, and one, who denied having suffered any pain in her chest, had actually been radiographed four months previously for this symptom. Tenderness was demonstrated over the area of fracture in three. It therefore seems that these fractures, unlike those of the first rib, are usually accompanied by pain. Cough was present in every case, but there appeared to be no connexion between the cause of the cough and the liability to fracture. The right side was affected in seven patients and the left in two. This distribution is opposite to that most often found, but Oechsli (1936) thought that there was no bias towards either side. As in most previous reports, only the sixth to the eleventh ribs were implicated. Three fractures occurred in the posterior third of the rib, an unusually high proportion for this position.

The radiographic findings are important, as confirmation of the diagnosis can be obtained by this means alone. In no patient was any underlying abnormality seen in the ribs. Ordinarily a P.A. radiograph was available, other views, if necessary, having to be specially obtained. Three of these fractures were diagnosed when the first film was examined, one other was visible but was not recognized until a later film showed callus formation, and one was readily seen because of the presence of callus. No fewer than four (44%) were diagnosed on subsequent films because of the formation of callus, and reference to the first radiograph showed no evidence of fracture in this area. From these facts it may be seen that the diagnosis may offer considerable difficulty, and if only one radiograph is taken it may be impossible. Lateral or oblique views were secured in five cases but failed to reveal any fracture that was not obvious in the P.A. position. To exclude the diagnosis of cough fracture it is necessary to take a second radiograph after time has been allowed for the formation of callus.

Discussion and Conclusions

Nine patients suffering from cough fractures unassociated with pulmonary tuberculosis or abnormality of the ribs were found among 2,431 new patients referred for an opinion on the chest between March, 1949, and October, 1950. Such an incidence (0.37%) is not rare. Moreover, it is unlikely that every case of cough fracture was detected; first, because of the difficulty in seeing them, and, secondly, because the need for taking subsequent films in all patients who complained of pain in the chest was appreciated only during the last year of this review. Even during the latter period a considerable proportion of such patients were not recalled for a further radiograph. Unless an alternative cause can be found, the diagnosis should be entertained in every case of chest pain accompanying cough, particularly if there is a history of sudden onset following cough or other effort, and if the pain is made worse by deep inspiration. Dry pleurisy, Bornholm disease, and the chest pain that may precede pleural effusion (Sibley, 1950) must be excluded. The diagnosis is not, however, justified by a history of pain of sudden onset and localized tenderness

following cough unless there is radiographic confirmation. Several cases with these symptoms have been seen in which there was no evidence of fracture or subsequent callus formation, and which must therefore be presumed to be due to some injury of the soft tissues.

It is unlikely that these fractures have any definite relation to pulmonary tuberculosis or pregnancy. The former combination has cough of increasing severity with advanced disease as a constant symptom and no obvious bony changes in the ribs; the latter combination also has been observed only in the presence of cough. Therefore, unless a high incidence of these fractures is found in the future, it seems unnecessary to postulate any other than a fortuitous association, especially as the condition is commoner in women.

The recognition of these fractures is usually of little practical significance except that strapping will relieve the pain if severe. However, if the rounded area of callus lies over the lung field it may be taken for an intrapulmonary shadow more easily than is generally realized. I have come across two instances in which callus round a fracture in a rib was temporarily diagnosed as disease in the lung.

Summary

Nine cases of cough fracture unassociated with pulmonary tuberculosis are reported.

Attention is drawn to the relative frequency of these fractures and to the difficulty in detecting them other than by the presence of callus formation.

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During the last 35 years the Rockefeller Foundation has granted fellowships to over 6,000 individuals from 75 countries, and by the end of 1950 the amount of money expended for this purpose was roughly \$19,000,000. The Foundation has in addition made grants of about \$9,500,000 to other organizations for their fellowship programmes. The *Directory of Fellowship Awards for the Years 1917-1950*, recently issued by the Foundation, lists 5,026 recipients of fellowships who are traceable. Name, country of origin, date of birth, highest degree, address, present position, and other details are given, making the directory a valuable addition to current biographies of the medical sciences. Some idea of the distribution of fellowships can be gauged from the fact that in 1950 the international health division awarded 2,566 (including 689 to nurses), the medical sciences division awarded 1,263, the natural sciences division 1,219, the social sciences division 823, and the humanities division 471. The directory is published from the office of the Foundation at 49, West 49th Street, New York.

WESTERGREN AND WINTROBE METHODS OF ESTIMATING E.S.R. COMPARED*

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The present investigation was conceived as a result of the observation by one of us (A. J. S.) that in two cases of acute tuberculosis the erythrocyte sedimentation rate (E.S.R.) when estimated by the Westergren method was considerably raised, whereas by the Wintrobe method it was within normal limits. It was decided, therefore, to make tests on a series of patients, male and female, by both methods, to see what measure of agreement was obtained.

Technique Employed

Wintrobe Tubes.—Test-tubes (3 by $\frac{1}{2}$ in.—7.5 by 1.25 cm.) graduated with a mark at 2 ml. were coated with 4 mg. of Heller and Paul's anticoagulant mixture (three parts ammonium oxalate and two parts potassium oxalate) and stoppered with red rubber stoppers.

Westergren Tubes.—Similarly graduated (3 by $\frac{1}{2}$ in.—7.5 by 1.25 cm.) tubes containing 0.4 ml. of 3.8% sodium citrate solution were used. These tubes were stoppered with black rubber stoppers.

The tests were made as follows. Blood samples were taken by venepuncture, dry-heat sterilized syringes and needles being used. A rubber tourniquet was lightly applied in most cases. As soon as enough blood had been withdrawn, the needle was removed from the syringe and blood was delivered to the mark in the Wintrobe collection tube and then into the Westergren collection tube. The two tubes were at once stoppered and the contents mixed by gentle shaking.

The tests were put up as soon as possible after venepuncture—the great majority within 30 minutes from the time of taking the blood. Before filling the sedimentation tubes each blood sample was mixed by hand-shaking for approximately two minutes. Care was taken to see that the spirit levels of the Wintrobe rack were correctly adjusted, and in the case of the Westergren tests a plumb-line was used to assist in setting the tubes to a vertical position. Variations in room temperature were not considered sufficient to warrant recording, the temperature being fairly constant at about 20° C.

The E.S.R. value recorded was the length in millimetres of the column of plasma above the packed red cells, read at the end of one hour.

Although corpuscular volume determinations were made in all cases which showed a raised E.S.R. value, no correction for low C.V. values was applied to the figures quoted in this article; doubts about the merits of applying a correction to the Wintrobe E.S.R. reading have within recent years been expressed and discussed (Sinton, 1948; Terry, 1950). Had a correction been

*The work for this paper was done in Winson Green Hospital, Birmingham, while we were respectively the deputy medical superintendent and the chief technician of the hospital.