Acta Paediatrica Academiae Scientiarum Hungaricae, Vol. 10 (2), pp. 93—98 (1969)

Cough Fracture of Ribs in Infants with Dyspnoea

By

I. KOPCSÁNYI, A. LACZAY and L. NAGY

Children's Hospital, Pécs

(Received October 17, 1968)

Seven cases of serial cough fracture in young infants are reported. The fracture developed in the course of episodes of grave dyspnoea and cough caused by various respiratory diseases. The pathomechanism of costal fractures is discussed; they aggravate the primary disease so that their recognition on the evidence of X-rays is of clinical importance. Cough fractures are facilitated by distrophy and rickets.

Stress fractures were defined by SCHMITT [11] in the following terms: "Die sog. schleichenden Frakturen kommen durch die schnell und dauernd sich wiederholenden Biegungsbeanspruchungen zustande. Man vermutet, dass es zunächst zu feinsten, röntgenologisch nicht nachweisbaren Knochenrissen kommt, denen dann bei Fortdauer die röntgenologisch nachweisbare Fraktur folgt." Stress fracture of the ribs is a rare phenomenon; its occurrence in adults has nevertheless repeatedly been reported [1, 2, 7, 12, 16, etc.].

WULLSTEIN and WILMS [15] write that "Die biegsamen Rippen der Kinder brechen nur ausserordentlich selten", a statement particularly applicable to infants. Textbooks on radiological diagnostics [3, 5, 10, 13, 14] deal but briefly with spontaneous rib fractures and generally attribute them to paroxysms of whooping cough in early childhood. Reputed textbooks of paediatrics [4, 8] do not refer to costal fracture as a complication of cough. Serial rib fractures in infants have also been described [6, 9].

Whooping cough has become rare in Hungary since the introduction of mass immunization. There are, however, numerous other factors which may induce grave, prolonged dyspnoea and cough in infants and result in costal fractures. Partly for this reason and partly on account of their rarity, data regarding seven cases of cough fracture are presented below. One of the cases is discussed in more detail since it afforded opportunity to follow the entire development of serial costal fractures in the course of treating a case of dyspnoea.

CLINICAL OBSERVATIONS

Rib fractures were observed in 7 premature babies, 2 males and 5 females. The fractures were registered around the age of 3 months. The primary disease was plasmocytic pneu-

monia in 3 cases, spastic bronchitis with subglottic oedema in one, bronchiolitis with mediastinal emphysema in one, congenital lobar emphysema in one, and a congenital heart defect with spastic bronchopneumonia likewise in one patient. All these patients were dystrophic, and four of them displayed signs of rickets. A typical case is reported in some detail.

F. F., the male offspring of young and healthy parents, was admitted on February 4, 1968, at the age of 3½ months, with a diagnosis of spastic bronchitis, with dyspnoea and tachypnoea. At admission the moderately developed infant was restless and dyspnoeic, displaying perioral cyanosis, superficial breathing at a rate of 70/min, crepitation in the right axillary line, and diffuse harsh rales with prolonged expiration. The heart rate was 140/min. The lower extremities and the sacral region were oedematous, the abdomen was distended, the liver enlarged. Serum Ca was 11.5 mg per 100 ml; P, 5.5 mg per 100 ml; serum alkaline phosphatase, 12.3 Bodansky units; Sulkowitch's test, negative. Urinary P was 580 mg per 100 ml; tubular reabsorption of P, 69%; tubular reabsorption of water, 97%.

X-ray of the thorax on February 5th revealed an enlarged middle shadow slightly displaced to the right, a bronchopneumonic focus in the right upper lobe, and emphysema in the left lung (Fig. 1a).

On penicillin, cortisone, strophanthin and oxygen therapy there was some improvement, but a sudden aggravation of the condition occurred on the 8th day of treatment, with marked tachypnoea and decreased respiratory excursions of the left half of the chest. X-rays (Fig. 1b) made at this time revealed an oblique fracture (without dislocation) of the left sixth rib in the posterior axillary line.

As vigorous treatment resulted in moderate improvement, X-rays were again taken on the 21st of February (Fig. 1c); now serial fractures of the left sixth to ninth ribs were revealed.

Four days later considerable improvement was registered and the patient was discharged practically without complaints on 22nd March when the X-rays (Fig. 1d) showed intensive calluses around the fractures with wide gaps between the broken ends.

Costal fractures supervened in every patient when dyspnoea had lasted from one to three weeks. Both sides were involved in two, only the left side in four cases, and only the right side in one case. The number of broken ribs was 2 to 6 in unilateral, 2 to 3 in bilateral fractures. The bones showed signs of hypomineralization, a phenomenon presumably due to dystrophy and rickets. The blood calcium level was approximately normal, that of phosphorus low. There was no question of congenital or postnatal hypophosphatasia in any of the cases: the values of alkaline phosphatase were high (12 to 15 Bodansky units). Sulkowitch's test was invariably negative. All the relevant data are shown in Table I.

Discussion

Wynn-Williams [16] described two causes of rib fractures: (a) direct trauma; (b) local or generalized abnormity of the bones which weakens their resistance to muscular traction. The second factor is not sufficient in itself and leads to fracture only together with strong or repeated muscular traction. Certain authors [7, 16] regard costal fracture as the result of

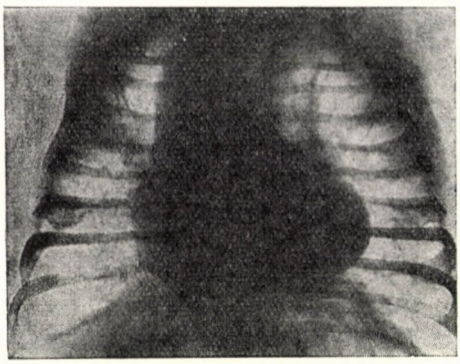

FIG. 1a. F. F.; male; age 3½ months. Congenital heart defect; rickets; grave spastic bronchitis. X-ray (February 5): enlargement of heart, slightly displaced to right; bronchopneumonia in right, emphysema in left lung

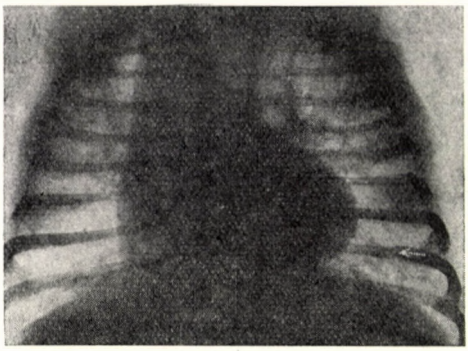

FIG. 1b. X-ray (February 12): oblique fracture of left sixth rib in the posterior axillary line (arrow). No dislocation

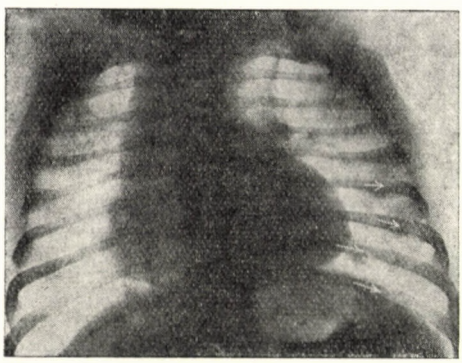

FIG. 1c. X-ray (February 21): serial fracture of 6th to 9th ribs on left side

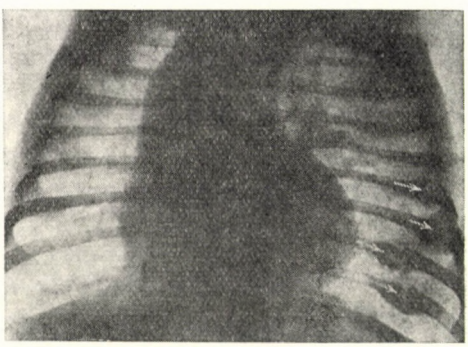

FIG. 1d. X-ray (March 22): intensive shadow of callus around the wide gaps between the broken ends

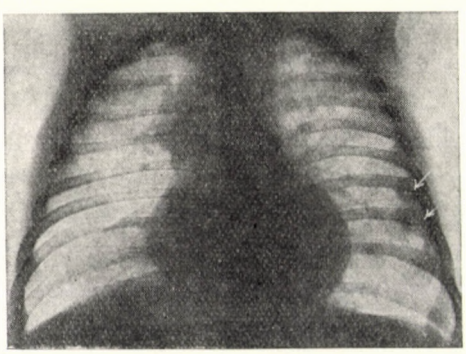

FIG. 2. B. T.; female; age 3 months. Congenital emphysema of right central lobe; dystrophy; dyspnoea of 4 weeks duration, with periodic aggravations; tachypnoea. X-ray: fracture of left 7th and 8th ribs in the posterior axillary line. Note reorganization by spindle-like callus

TABLE I

Name	Sex	Diagnosis	Age at costal fracture, months	Side and number of broken ribs	Duration of dyspnoea before fracture, weeks	Period of gestation, months Birth weight, g	State	Rickets
F. F.	♂	Congenital heart defect. Bronchopneumonia	4	left 6—7—8—9	3	9 2100	Dystrophic	+
E. F.	♀	Bronchiolitis. Mediastinal emphysema	2½	right 6—7—8	3	6 1800	Atrophic	+
E. C.	♀	Interstitial pneumonia	7 weeks	left 6—7	2	8 2050	Dystrophic	—
A. B.	♀	Spastic bronchitis, subglottic oedema	2	left 2—9	1	8 2300	Dystrophic	—
C. K.	♂	Interstitial pneumonia	4	right 6—7 left 6—7	2	7 2000	Dystrophic	+
B. T.	♀	Congenital emphysema of right central lobe	3	left 7—8	4	9 2100	Dystrophic	—
L. D.	♀	Interstitial pneumonia	3	right 5—6—7 left 6—7	3	8 1950	Dystrophic	+

opposite tractive forces, those exerted by the anterior serratus muscle in the one and by the external oblique muscle of the abdomen in the other direction; they observed in adult patients rib fracture along the line between the insertion of the said muscles. Others [12, etc.] consider a change in the tonicity of the respiratory muscles an important pathogenic factor of cough fractures.

All fractures in the present cases occurred in the posterior axillary line between the respective insertions of the two muscles, in the middle third of the ribs. This localisation was presumably due to the construction of the ribs. Curvature with reference to edge, surface and axis is most pronounced in the middle third of the ribs; their diameter is, moreover, the second shortest after that of the neck

so that resistance is weakest in this segment. The major inspiratory and expiratory muscles pull the anterior third of the ribs upwards and downwards, respectively. The peak of the curvature, acting as a one-armed lever, transmits this tractive force to the rotation axis which traverses the head of the rib in order to effect the necessary expansion and contraction of the thoracic cavity. Be it on account of expiratory or inspiratory dyspnoea that the tractive force of the respiratory muscles is increased, the rapidly repeated torque induces structural rupture at this point, and it is here that the zone of reorganization is formed.

We share the view [5] that, in addition to dyspnoea and cough, porosity of the bones is another pathogenic factor of fractures, although LEBEDA [6] found no hypomineralization in his four premature patients.

Unilateral costal fractures in the present material occurred on the side of the intact lung, a phenomenon pointing to its compensatory function.

It has been emphasized in reports on adult cough fractures [1, 2, 12, 13] that local pleural pain before or after the fracture should be regarded as a significant warning. Objective signs of this local thoracic pain become subsequently manifest, such as elevation of the dome of the diaphragm or accumulation of pleural fluid. CAFFEY [3] suggests that costal fracture should be looked for if children complain of pleural pain following episodes of cough. Infants do not notify such pains but, by way of defence, respiratory excursion will decrease on the affected side. Respiration thus becomes still more superficial and more rapid, the degree of hypoxia increases [9] so that the patient's general condition deteriorates despite adequate and careful treatment.

In clinical practice, suspicion of costal fracture arises if the infant's dyspnoea, cyanosis, tachypnoea and tachycardia fail to improve despite a causal treatment of the primary disease or if the respiratory excursion is arrested or reduced on one side. Suspicion is usually verified by the X-rays, although the initially indistinct lesion may escape the roentgenologist's notice. Still, X-rays made a week later may already reveal the fracture of several ribs. Giving rise to paradoxical respiration, serial fractures may become fatal [9]. Costal fractures of both adults and infants are sometimes recognized only several weeks after the coughing fit, at a time when the X-rays already show the shadow of a fairly dense callus (Fig. 2).

In the present cases, the possibility of a traumatic origin of the fractures could be disregarded as the first examination showed no traces of fracture attributable to postnatal resuscitation, and artificial respiration had not been mentioned in the history of any of the patients.

CONCLUSIONS

(i) Cough fractures may occur in young infants, being induced by grave protracted dyspnoea or cough of any

origin. Rib fractures are facilitated by hypomineralization which in the present material was due to dystrophy and rickets.

(ii) Rib fractures may be bilateral or unilateral; the latter usually occur on the side performing compensatory function.

(iii) According to the anatomical conditions and to muscular traction, the fracture line or the zone of reorganization develops in the middle third of the rib.

(iv) The primary disease is aggravated by cough fractures so that their recognition is of high importance. Sedation, inhalation of oxygen or mechanical ventilation prevent costal fractures or, at least, mitigate their noxious effect on the primary disease.

References

1. Balgairies, E., Amourdon, C.: Fractures de côtes spontanées chez les silicotiques. J. Radiol. Électrol. **38,** 1112 (1957).
2. Belayew, D., Meersseman, F., Swartenbroekx, F.: Cinq cas de fracture "spontanée" de la première côte. J. Radiol. Électrol. **38,** 1109 (1957).
3. Caffey, J.: Pediatric X-ray diagnosis. Year Book Publishers, Chicago 1961.
4. Fanconi, G., Wallgren, A.: Lehrbuch der Pädiatrie. Schwabe and Co., Basel 1967.
5. Köhler, A., Zimmer, E. A.: Grenzen des Normalen und Anfänge des Pathologischen im Röntgenbilde des Skelettes. Thieme, Stuttgart 1953.
6. Lebeda, D.: Spontanni fractury zeber "z unavy" u kojencu. Čs. Pediat. **16,** 667 (1961).
7. Mitchell, J. B.: Cough fracture. Brit. med. J. **2,** 1492 (1951).
8. Nelson, W. E.: Textbook of Pediatrics. W. B. Saunders, Philadelphia 1964.
9. Pintér, A., Kustos, Gy., Antalovics, M.: Paradox légzést okozó csecsemőkori sorozat-bordatörés. Gyermekgyógy. **19,** 70 (1968).
10. Schinz, H. R., Baensch, W. E., Friedl, E., Uehlinger, E.: Lehrbuch der Röntgendiagnostik. Georg Thieme, Stuttgart 1952.
11. Schmitt, W.: Allgemeine Chirurgie. J. A. Barth, Leipzig 1960.
12. Starke, O.: Hustenfrakturen (Ermüdungsbrüche) der Rippen. Fortschr. Röntgenstr. **80,** 191 (1954).
13. Teschendorf, W.: Lehrbuch der röntgenologischen Differentialdiagnostik. Georg Thieme, Stuttgart 1958.
14. Wolf, H. G.: Röntgendiagnostik beim Neugeborenen und Säugling. W. Maudrich, Wien 1959.
15. Wullstein, L., Wilms, M.: Lehrbuch der Chirurgie. Gustav Fischer, Jena 1951.
16. Wynn-Williams, N.: Cough fractures of the ribs unassociated with pulmonary tuberculosis. Brit. med. J. **2,** 1494 (1951).

Dr. I. Kopcsányi
Nyár utca 8.
Pécs, Hungary