Incidence and Outcome of Scoliosis in Children With Pleural Infection

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Summary. Aims: To ascertain the incidence and outcome of secondary scoliosis associated with parapneumonic effusions/empyema. Methods: Retrospective review of case notes of children with pleural effusions over a 3-year period. Review of digitalized erect chest radiographs by two observers with serial measurements of Cobb angles. Scoliosis defined as lateral curvature of the spine $\geq 10°$. Results: Of 122 children (median age 4.3 years), 103 (84%) required chest drains of whom 83/103 (81%) received urokinase; 5 (4%) required surgical decortication. On admission, 56 (46%) had a scoliosis, 68 (62%) on the 2nd radiograph, and 68 (59%) at discharge; overall 87 (71%) had a scoliosis at some stage. In all cases, there was a single thoracic curve with the direction towards the side of the effusion. There was no association between scoliosis and size or type of effusion, nor inflammatory markers. There was a statistically significant but small effect from duration of illness prior to admission. At follow-up, 6 (5%) had a mild residual scoliosis but all subsequently resolved. Intraobserver variability for measurement of Cobb angles was $\pm 4.6°$ and interobserver variability was $\pm 5.8°$. Conclusions: Scoliosis was common but always resolved so therapy is unnecessary; follow up is recommended to exclude coincidental idiopathic scoliosis. **Pediatr Pulmonol. 2007; 42:221–224.** © 2007 Wiley-Liss, Inc.

Key words: empyema thoracis; scoliosis; children.

INTRODUCTION

Scoliosis is a lateral curvature of the spine, and when secondary, the vertebrae are structurally normal, with neither spinal rotation nor truncal asymmetry. The recent UK guidelines on childhood pleural infection stated that "secondary scoliosis noted on chest radiograph is common but transient; no specific therapy is required but resolution must be confirmed."[1] However, this was a grade D recommendation, based on the clinical experience of the guideline committee, as there was little published evidence. Five case series of pediatric empyema have mentioned the presence of scoliosis and given incidences ranging from 4 to 86%; combining these series gives an overall reported incidence of 30% (71/240 cases).[2–6] None of these series indicated the degree of scoliosis, nor how it was measured. Another article reported scoliosis in 27/61 (44%) children, but they defined it as a curvature of $\geq 5°$; since $\geq 10°$ is the standard cut-off, some of their cases should be regarded as normal.[7] Outcome was reported in only one small series, in which 12/14 children had scoliosis, and it had resolved in all of them by 6 months.[5] We wished to ascertain the incidence and outcome of scoliosis during admission for parapneumonic effusions and empyema. The hypothesis was that scoliosis was common but would resolve.

METHODS

The setting was a tertiary pediatric respiratory center in London. All children (aged up to 16.0 years) admitted over a 3-year period (April 2002–April 2005) with a diagnosis of pleural infection (parapneumonic effusion or empyema), were retrospectively identified from the hospital's computerized coding system. Medical records were then reviewed to confirm the diagnosis (pneumonia with fever, pleural effusion on ultrasound and chest radiograph, and raised inflammatory markers), and to extract clinical data. Signs and symptoms indicative of pneumonia were fever, cough, difficulty breathing, and raised respiratory rate, combined with chest radiographic confirmation. We did not use microbiological criteria to define pleural infection since pleural fluid and blood cultures were usually negative; and we do not routinely measure biochemical markers in pleural fluid, as per the BTS guideline recommendations.[1] Patients were excluded

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from the study if they had a pre-existing scoliosis or if the effusion immediately followed cardiac surgery.

Chest radiographs (digitally acquired images) were then reviewed on a Siemens Sienet MagicView 300 workstation (Siemens AG, Erlangen, Germany). Patients were excluded if the initial radiograph was taken in the supine position or if there was no follow-up radiograph available. The first erect chest radiograph (posteroanterior and less often anteroposterior) taken after admission, and all subsequent erect chest radiographs were independently assessed by two trained observers for the presence of thoracic scoliosis. A line was drawn across the proximal endplate of the superior tilted vertebra and the distal endplate of the inferior tilted vertebra, and perpendicular lines were drawn on both of these lines. The angle at the intersection of the two perpendicular lines is the Cobb angle and determined the degree of curvature (see Fig. 1), a perfectly straight spine has an angle of 0°. It was measured using the Siemens angle measurement tool (Siemens AG, Erlangen, Germany), and the mean of the measurements made by both observers was taken. A diagnosis of scoliosis was made if the lateral curvature of the spine was $\geq 10°$ as measured by the standard 1948 Cobb method on a standing radiograph (as per the Scoliosis Research Society definition, www.srs.org). If present, the direction of the convexity and severity were recorded.

Initially, intraobserver variability was assessed using a Bland Altman plot, with independent measurements of the Cobb angle made twice on the same radiograph in 56 cases.[8] Interobserver variability was similarly assessed, by comparing the mean difference and assessing the 95% limits of agreement of the observed difference, from the measurements made by both observers on the initial radiographs from all cases.[9] Multiple stepwise linear regression was used to determine whether the presence of scoliosis (using the Cobb angle as a continuous outcome) was related to the independent clinical variables—duration of illness, depth of effusion, and inflammatory markers (analyzed as continuous variables); a Mann–Whitney test was used to assess the influence of the type of effusion determined by ultrasound
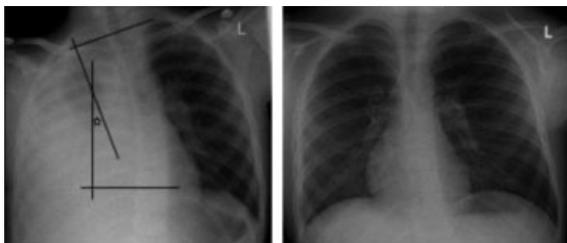
grade. Statistical analyses were performed using Statistical Package for Social Sciences (SPSS version 12.0, SPSS, Inc., Chicago, IL).

The study was approved by the Hospital Ethics Committee who felt parental/patient consent was unnecessary.

RESULTS

There were 148 children admitted with parapneumonic effusion/empyema and 26 were excluded—pre-existent scoliosis (n = 2), effusion post cardiac surgery (n = 6), initial radiograph in supine position (n = 8), and no follow-up radiograph available (n = 10). Clinical parameters of the 122 assessed in the study are given in Table 1. There were 73 boys and 49 girls of median age 4.3 years (range 4 months to 15.8 years). All children received intravenous antibiotics, and chest drains were inserted in 103/122 (84%) using general anesthesia in all but one child. Intrapleural urokinase was given to 83/103 (81%) children with chest drains. Five children required a surgical decortication (representing a 4% failure rate of initial medical management), 2 in the 1st year, 3 in the 2nd, and none in the 3rd year. Two cases were complicated by hemolytic uremic syndrome (one with *Haemophilus influenzae*, the other with *Streptococcus pneumoniae*). Pleural infection was secondary in eight cases—chicken pox (n = 3), post appendicectomy (n = 2), staphylococcal abscess from insect bite, stab wound to chest, and severe herpes infection. Pre-existing conditions were present in six cases (non-specific neurodevelopmental delay, hyper-IgE syndrome, Duchenne muscular dystrophy, Marfan's syndrome, pulmonary valve stenosis, and repaired ventricular septal defect with partial anomalous pulmonary venous drainage). New diagnoses were made in three children (coarctation of the aorta, CD40 ligand deficiency, and thoracic primitive neuroectodermal tumor).

The initial radiograph was taken within 24 hr of admission (median, interquartile range (IQR) day 1 (1–1); the 2nd radiograph was taken at median day 3 (IQR 2–4) of admission; the discharge radiograph within 24 hr of discharge (median day 6 (IQR 4–9) of admission).

On admission, 56/122 (46%) patients had a scoliosis, 68/109 (62%) on the 2nd radiograph, and 68/115 (59%) at discharge (Table 2). Of the 47/115 free of scoliosis at discharge, 15/47 (32%) had one noted earlier in the admission whilst 32/47 (68%) never had one. Overall, there were 87/122 (71%) children with a scoliosis at some stage during the admission. In all cases, there was a single thoracic curve with the direction of scoliosis towards the side of the effusion and the curve apex on the side of the unaffected lung (example in Fig. 1). There was no association between the presence of scoliosis and age, gender, size of effusion on ultrasound, type of effusion

Fig. 1. Admission (A) and 3-month follow up (B) erect chest radiographs of a 7-year old boy with right-sided pleural effusion. Shown are lines inserted for measurement of Cobb angle (asterisked), which was 21° on admission and 0° at follow-up.

TABLE 1—Clinical Details of the 122 Patients Assessed

Duration of illness pre-admission, median (IQR) days	10	(7–14)
White cell count on admission, median (IQR) $\times 10^{-9}$/L	16.7	(13.1–21.8)
Platelet count on admission median (IQR) $\times 10^{-9}$/L	583	(412–800)
C-reactive protein on admission, median (IQR) mg/L	185	(108–218)
Side of effusion—left:right	59:63	
Depth of effusion on ultrasound, median (IQR) cm	3	(2.5–4.9)
Ultrasound appearance, simple versus fibrin strands $\pm$ loculations	40:82	
Length of hospital stay, median (IQR) days	7	(5–10)

IQR is interquartile range.

(simple vs. fibrin strands $\pm$ loculations), nor inflammatory markers (total white cell count, platelet count, and C-reactive protein). There was a statistically significant effect ($P < 0.05$) of duration of illness, but the effect was so small (adjusted $r^2 = 0.03$) as to be clinically irrelevant. Follow-up radiographs were taken at a median of 44 days post discharge (IQR 34–64 days). There were 6/122 (5%) who still had a mild residual scoliosis (Table 2) with Cobb angles of 10.7°, 10.8°, 10.8°, 11.0°, 11.4°, and 13.0°. Subsequently, these resolved in 4/6, whilst the parents of the other 2 patients declined further follow-up. Intraobserver variability for measurement of Cobb angles was $\pm 4.6°$ and interobserver variability was $\pm 5.8°$.

DISCUSSION

A significant proportion of children admitted for treatment of pleural infection have a scoliosis (defined as a Cobb angle $\geq 10°$), with 71% having one at some stage during the admission. It was always thoracic and always directed towards the side of the effusion. Generally, the scoliosis was mild, with 93% measured at 10°–19°, 7% at 20°–30°, and none above 30°. Prognosis was excellent with 95% resolved at initial follow up, and essentially 100% with subsequent follow up (accepting the two children who did not have further radiology). No-one was diagnosed with a structural (idiopathic) scoliosis, although two patients were excluded from the study as they were already known to have one. Our incidence is

higher than all but one of the case series, but ours is the only publication that systematically looked for and measured the degree of scoliosis; furthermore, this is the only publication to formally monitor the outcome. Both intraobserver and interobserver variability is low and in keeping with that expected.[9,10]

The cause is said to be due to pleuritic pain from the infection/inflammation, and discomfort from chest drains.[1] In our study, we can not say whether the presence of a drain itself was relevant, as 84% of children had a drain inserted, and those without a drain tended to have an insignificant effusion (hence we would be unable to ascribe any significance to the drain itself). The drain cannot be the only factor however, since scoliosis is often noted prior to drain insertion. We also cannot say whether drain size was important, as only small drains (8–12 FR) were used. Our previous (anecdotal) experience with large drains (20–24 FR) prior to 2000, however, is that they were more painful and many children sat in bed hardly moving, with a marked scoliosis. Whilst pain from pleuritic irritation or a drain may be an important factor, it can not be the only one, since the children receive major analgesia, including oral morphine and non-steroidal anti-inflammatory drugs for most or all of the time their drain is in place. It is likely that the cause of scoliosis is multifactorial with the factors assuming different degrees of importance in individual patients. Other reasons would include the child adopting a "protective posture" due to the mere presence of the

TABLE 2—Number of Patients (%) Categorized by Their Cobb Angles Measured on Admission, the 2nd Radiograph, Discharge From Hospital, and Outpatient Follow-up

	Admission radiograph	Second radiograph	Discharge radiograph	Follow up radiograph
n	122	109	115	122
0°	24 (20%)	14 (13%)	26 (23%)	105 (86%)
1°–9°	42 (34%)	27 (25%)	21 (18%)	11 (9%)
10°–19°	52 (43%)	60 (55%)	66 (57%)	6 (5%)
20°–30°	4 (3%)	8 (7%)	2 (2%)	0
>30°	0	0	0	0
Median	9.0°	11.6°	10.5°	0°
IQR	3°–12.7°	7.1°–15.1°	2.6°–13.3°	0°–0°

Scoliosis was defined as presence of Cobb angle $\geq 10°$. Also shown are medians and interquartile ranges (IQR).

drain and also to stop the drain stitches pulling on the skin, significant lobar atelectasis, and inflammation and contraction of the pleura itself.

We did not find an association with severity of the illness as measured by depth or type of effusion, or inflammatory markers. We do not routinely measure protein levels in the effusion so can not categorically say whether exudate versus transudate was a factor, although this is unlikely, given the lack of association with the ultrasound grading. However, in a series of 61 children with parapneumonic empyema, it was found that whilst overall 20% cases were managed with antibiotics alone, all children with a scoliosis required a chest drain; furthermore, decortication (which was carried out on 43% of all cases) was required in 80% of the children with a scoliosis >10°.[7] Of the five children requiring surgery in our study, only three presented with a scoliosis of which two were minimal (Cobb angle 10.1° and 10.4°).

In our study, duration of illness prior to admission was the only variable associated with scoliosis, but only to a very minor degree. Others have suggested that this is important, with Hoff et al.[7] reporting patients presenting with a scoliosis had been ill for an average of 7.3 days compared with 5.9 days in those without one. Another study which classified patients into ''fibrinopurulent'' or ''chronic'' based on pleural biopsy, found an increased incidence of scoliosis in the chronic ones (15/42, 36%) compared with the fibrinopurulent (4/36, 11%).[6] It is likely the degree of pleural thickening is the main factor associated with scoliosis in chronic empyema. Finally, one study suggested that scoliosis was a complication of significantly delayed thoracotomy, but our study does not support this, and furthermore their data are unusual since they only detected scoliosis in 4% patients (2/47).[4]

Outcome was excellent in all cases with resolution of the scoliosis, which in one-third cases was before discharge. Therapy is not necessary for the in-patients, although attention to posture should be encouraged. We agree with the BTS recommendation that resolution needs to be confirmed on follow up to ensure the child does not have an idiopathic scoliosis as a chance finding,[1] and since a repeat chest radiograph is inevitable, this does not present a problem. It seems reasonable though that further follow up and radiography is not required if the scoliosis has not completely resolved at initial follow up. Suspicion of a primary scoliosis should be raised if the scoliosis is severe or has the curve apex on the same side as the effusion.

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