Pseudomembranous croup

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SUMMARY During a 2-year period, 7 children were seen with a severe form of laryngotracheobronchitis associated with sloughing of the respiratory epithelium and profuse mucopurulent secretions. We have called this condition pseudomembranous croup. The children had severe upper airways obstruction, appeared toxic with high fever, and were older than the typical age group for viral laryngotracheobronchitis. Lateral x-ray films of the airways showed subglottic narrowing and often these suggested the presence of radio-opaque foreign material in the tracheal lumen. At endoscopy, in addition to pseudomembrane in the subglottic region and trachea, there was thick mucopus and debris, and in some cases these changes extended into the bronchi. An artificial airway was required in all except one, and even after intubation it proved difficult to maintain the airway. *Staphylococcus aureus* was the most common pathogen isolated from tracheal cultures but other organisms were grown.

Viral laryngotracheobronchitis (LTB) and epiglottitis are the most common causes of acute, infectious upper airways obstruction in children. In particular, we are reporting children with a distinct form of LTB which has been referred to by a number of terms—such as bacterial tracheitis¹ and membranous laryngotracheobronchitis.² There has been little information published on the condition and both Jones *et al.*¹ and Han *et al.*² regarded the syndrome as new, although we believe they were reporting a similar clinical entity, and one similar to that reported in the 1940s.^{3,4} This report concerns our experience of 7 children with this entity, which we believe is preferably termed pseudomembranous croup.

Subjects and methods

The 7 children were admitted to this hospital between July 1979 and August 1981. The patients were fairly evenly spaced throughout this period and did not cluster during epidemics of parainfluenza, influenza A, or other respiratory viruses. This syndrome had been recognised only rarely in this hospital before this time. Six of them had diagnostic laryngoscopy with or without bronchoscopy performed under general anaesthetic by an experienced paediatric endoscopist while the remaining child had laryngoscopy for intubation only, not for diagnostic evaluation.

The features from the literature^{1,2} and from our experience which we felt were suggestive of pseudo-

membranous croup were as follows: severe upper airways obstruction; age over 5 years; high fever and toxicity; and a lateral airways x-ray film showing subglottic narrowing and radio-opaque material in the tracheal lumen. We regarded the diagnosis as definite if, at endoscopy, we found thick mucopus and sloughed epithelium, forming a sheet-like structure which separated easily from the wall of the tracheobronchial tree.

Results

Table 1 summarises the features of the children, with details of age, gender, findings at endoscopy, lateral x-ray films of airways, tracheal culture, and type and duration of artificial airway.

All the children were immunised against diphtheria, and only one (Case 2) reported a previous episode of LTB. None had a history that suggested foreign body inhalation. Fever and toxicity were prominent clinical signs. Four had a temperature of greater than 38.5°C, and in 5 the admission notes made specific mention of the child's marked toxicity. Upper airways obstruction was severe, and urgent endoscopy under general anaesthetic was performed by a paediatric otorhinolaryngologist in 6 children. Four of the 7 children had a lateral x-ray film of the neck before endoscopy. Although we believe these x-ray films should be performed with great caution in the presence of severe infective upper airways obstruction, no immediate deterioration occurred

Table 1 Features of patients with pseudomembranous croup

Case	Age (years)	Sex	Lateral x-ray of airways	Endoscopic findings	Tracheal culture*	Artificial airway (duration)
1	7.4	M	Subglottic narrowing and possible mass	Subglottic swelling with thick yellow pus and crust	<i>S. aureus</i>	Intubation (4 days), tracheostomy (11 days)
2	6.3	F	Not done	Thick yellowish-green pus in trachea	<i>P. aeruginosa</i> <i>S. aureus</i>	Intubation (2 hours)
3	5.8	M	Soft tissue mass in subglottic region	Sloughed epithelium and pus in subglottis and trachea	<i>S. aureus</i> <i>S. pneumoniae</i>	Intubation (3 days)
4	12.3	M	Soft tissue mass in subglottic region	Sloughed epithelium and pus in subglottis and trachea	No pathogens isolated	
5	1.8	M	Not done	Subglottic swelling with slough and mucopus below cords	<i>S. aureus</i> <i>H. influenzae</i>	Intubation (4 days)
6	12.0	M	Not done	Tissue debris and mucopus in tracheo-bronchial tree	<i>S. aureus</i>	Tracheostomy (8 days)
7	1.2	M	Subglottic narrowing	Subglottic swelling with slough and mucous below cords	<i>H. influenzae</i> <i>S. pneumoniae</i>	Tracheostomy (4 weeks)

*At time of endoscopy or intubation.

as a consequence.⁵ The x-ray film was taken in these 4 children because the clinicians at the time were unclear as to the nature of the airways obstruction and were to be in attendance while the x-ray films were being performed. One child (Case 2) was intubated at another hospital by a paediatric transport registrar from our hospital and did not have diagnostic endoscopy. In all 7 cases the epiglottis was normal. Apart from Case 4, every child required an artificial airway (Table 1). In all cases in which the children were intubated, there was considerable difficulty in keeping the tube patent, since it tended to block with thick secretions and crust.

Blood cultures showed no growth in the 6 patients on whom these were performed. Nasopharyngeal aspirate for viral cultures was obtained from only 3 subjects and only one of these (Case 7) yielded a likely pathogen, parainfluenza virus type 3. Immunofluorescent techniques were used only during the respiratory syncytial virus season, and then only for respiratory syncytial virus. All 7 children received ampicillin and cloxacillin by the intravenous route and there appeared to be a clinical response to them as judged by decreased fever and toxicity and decrease in purulent secretions.

All children made a complete recovery. Lateral xeroradiograms were performed on 3, when they were completely well, but none showed a persistent abnormality.

Some case reports

Case 1. A 7.4-year-old boy was admitted with a 2-day history of fever and sore throat, and one day of stridor. He was fully immunised and had neither a history of previous LTB (croup) nor of recent

foreign body inhalation. He was toxic and febrile with severe upper airways obstruction. Lateral x-ray films of his airways showed subglottic narrowing with an irregular margin to the tracheal wall suggesting membrane formation. At endoscopy, a thick carpet of pus was present in the tracheobronchial tree as well as a sheet of yellowish-grey membrane. The epiglottis was normal (Figs 1 and 2).

Staphylococcus aureus was recovered from the tracheal aspirate and histology of the membrane showed an admixture of mucous and degenerate

Fig. 1 (Case 1.) Endoscopic appearance of the larynx showing the vocal cords clearly with sub-glottic oedema and the pseudomembrane.

Fig. 2 (Case 1.) Bronchoscopic appearance of lower trachea and carina, showing ulceration, generalised inflammation, and pseudomembrane.

purulent inflammatory exudate. Blood culture and initial chest x-ray films did not help. Ampicillin and cloxacillin were administered intravenously.

He was extubated after 4 days but severe airways obstruction recurred within an hour. At endoscopy, the subglottic region was narrowed by granulation tissue, which appeared to have formed secondary to trauma from the endotracheal tube. Therefore, his airway was maintained by tracheostomy. Eleven days later, a further endoscopy showed almost complete resolution of the granulation tissue, and he was successfully decannulated. His subsequent course was uneventful.

Case 2. This 6.3-year-old girl presented to a country hospital with a 3-day history of fever and a 2-day history of sore throat and croupy cough. At age 12

months she had had an episode of croup, and asthma had been diagnosed at age five. She was fully immunised. At first, her acute respiratory difficulty was thought to be a further attack of asthma but her condition deteriorated despite bronchodilators and steroids. When our transport registrar arrived, the child was febrile, cyanosed in oxygen, and restless, with evidence of upper and lower airways obstruction. At intubation, the epiglottis was normal but thick yellowish-green purulent material was aspirated from the trachea. There was striking clinical improvement and she was extubated. One hour later she required reintubation and 30 ml of this mucopus was sucked from the airway. After 45 minutes the endotracheal tube became blocked with a thick plug and she was extubated. She had a third episode of respiratory obstruction about an hour later.

In addition to bronchodilators and steroids, she was treated with ampicillin and cloxacillin. Tracheal aspirate yielded *Pseudomonas aeruginosa* and *S. aureus*. Chest x-ray films revealed generalised hyperinflation but there was no growth on blood culture. She made a complete recovery.

Discussion

Other workers have referred to this clinical entity^{1 2 6} and agree that pseudomembranous croup is distinct from both epiglottitis and the usual case of viral LTB (Table 2). The major distinguishing feature between pseudomembranous croup and acute epiglottitis is the longer duration of symptoms and the presence of the typical croupy cough in the former (Table 2). Most of the children had high fever and were toxic but the normal supraglottic structures excluded epiglottitis, while the history of adequate immunisation made diphtheria unlikely. Five were over 5 years, older than the peak incidence of croup which is in the second year of life,⁷ and only one had a history of croup. While great caution is required when performing lateral neck x-ray films in children with severe upper airways obstruction, in

Table 2 Clinical and laboratory features of viral laryngotracheobronchitis, pseudomembranous croup, and acute epiglottitis

Feature	Viral LTB	Pseudomembranous croup	Acute epiglottitis
History of viral LTB (croup)	Common	Uncommon	Uncommon
Peak age incidence	< 3 years	> 5 years	< 3 years
Duration of illness	Days	Days	Hours
Croupy cough	Present	Present	Absent
Fever	Low grade	High	High
Toxicity	Mild	Marked	Marked
Airway obstruction	Variable	Severe	Severe, progressive
Findings on lateral x-ray of airways	Subglottic narrowing	Subglottic narrowing with soft tissue mass	Epiglottic swelling with normal subglottic region
Endoscopic findings	Subglottic oedema	Mucopus and sloughed epithelium forming pseudomembrane	Swelling supraglottic structures, including epiglottis
Aetiology	Viral	?Bacterial especially <i>S. aureus</i>	<i>Haemophilus influenzae</i> type B

3 of the 4 cases in which such an x-ray film was taken, we found radio-opaque material in the tracheal lumen, which raised concern about a possible inhaled foreign body. This observation has also been made by Han *et al.*² and presumably represents the partly detached pseudomembrane and thick intraluminal secretions.

We regarded the endoscopic appearance as diagnostic with the airway blocked by thick mucopus and debris, which was membranous and extended into the bronchi. Unlike diphtheria this was a pseudomembrane which separated easily from the lining of the airway without bleeding. In all cases, suction of the airway resulted in a striking improvement. However, the benefit was temporary since either the endotracheal or tracheostomy tube often blocked despite meticulous attention to toilet.

In one extreme case, copious aspirate continued to pour out of the tracheostomy tube for over 3 weeks. Even with humidification of the airway, dry crusts were a problem. In contradistinction, in our experience blockage of the tube is an uncommon problem in viral LTB requiring intubation.

The tracheal mucopus yielded at least one possible bacterial pathogen in 6 of the 7 cases. *S. aureus* was the predominant organism and was recovered from 5 of the 7 children in our series, compared with 6 out of 8 in the report by Jones *et al.*¹ and 20 out of the 28 by Han *et al.*² It is difficult to be sure whether the staphylococcus is incidental or causal, since it is often isolated from the tracheal lumen of otherwise healthy children with artificial airways. Nevertheless, we believe that the bacteria which are isolated in pseudomembranous croup should be regarded as pathogens. Cherry⁶ supports this view and states that pseudomembrane obstruction is the result of secondary bacterial involvement in viral LTB. In one case, parainfluenza type III virus was isolated in a child with pseudomembranous croup. It is possible that some of the other cases were primary and not secondary bacterial infections.

Pseudomembranous croup is a more appropriate term than membranous croup. Han *et al.*² who used the latter term, performed microscopical examination of one specimen removed at endoscopy and found 'a pseudomembranous tissue with numerous neutrophils and cellular debris', a similar finding to our histology in Case 1. We recommend uniformity in referring to this clinical entity.

The recognition of pseudomembranous croup is important. The airway obstruction is severe and even with meticulous endotracheal toilet, we have experienced difficulty in maintaining the airway because of thick secretions and the tendency to form crusts. Management in a paediatric intensive care unit is mandatory, with humidification of the airway and frequent suctioning, as well as prompt recognition of an obstructed tube. Tracheostomy should always be considered in this illness, particularly if thick crusts are a problem and management of the endotracheal tube is difficult. Tracheostomy has the advantages of ease of suction and the presence of an inner tube which can be cleaned easily and regularly. Other reasons for recognising pseudomembranous croup are (1) repeat endoscopy is sometimes necessary to remove pseudomembrane, (2) appropriate antibiotic therapy may shorten the illness, and (3) the radiological findings may be confused with a foreign body.

Pseudomembranous croup is an uncommon but important cause of respiratory obstruction which appears to have been under-reported in the medical literature and is not simply the severe end of the spectrum of viral LTB.

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