

## The value of radiological investigations in pre-endoscopic assessment of children with stridor

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### Abstract

The differential diagnosis of stridor in an infant depends on a careful history and examination, followed by radiological and endoscopic investigations. Currently a chest, lateral neck and antero–posterior, high kilovolt (Cincinnati) view radiographs in association with a diagnostic barium swallow are performed prior to the definitive diagnostic procedure of microlaryngobronchoscopy.

Our impression was that some of the routinely ordered radiological investigations were of limited value in the differential diagnosis. We undertook a retrospective audit study to determine the value of radiological investigations in the pre-endoscopic assessment of infants with stridor. The radiological and endoscopic information of 100 infants presenting over the three-year period 1991–1993 at Great Ormond Street Hospital, London (a tertiary referral centre) was collected.

It was found that only five out of 65 barium swallow investigations performed had consistent positive findings at diagnostic microlaryngobronchoscopy. The lateral neck and Cincinnati views identified many of the more gross pathologies of the larynx and trachea e.g. the space occupying lesions, which occur infrequently. The more common diseases e.g. laryngomalacia or subglottic stenosis are rarely identified radiologically.

Our results confirmed that radiology had a limited screening role and that in a child presenting with stridor the initial radiological assessment should be a chest radiograph with further imaging and a barium swallow only if an abnormality is found at microlaryngobronchoscopy.

**Key words:** Laryngoscopy; Bronchoscopy; Radiology; Respiratory sounds; Child

### Introduction

The management of an infant presenting with stridor requires the collection of a detailed history and clinical examination which are complemented by a radiological assessment. Microlaryngobronchoscopy under general anaesthesia currently plays a major role in the clinical assessment and documentation of all children with laryngeal and tracheal pathologies. It has previously been stated that chest, lateral and antero–posterior neck radiographs and a barium swallow examination are essential to delineate any defect prior to such endoscopy (Smith *et al.*, 1984).

Standard radiography serves as a primary screening study of the airway, neck, cervical spine and chest. These radiographs are readily available and can be performed quickly. The chest radiograph may identify some vascular malformations, such as a double aortic arch, by widening of the mediastinum, or indirectly as intermittent bronchial obstruction which may produce atelectasis or pneumonia.

Radiographic examination of the airway can be performed using a soft tissue (low kilovolt) technique in a lateral projection. The head is slightly

hyperextended to bring the larynx and upper trachea up from the retrosternal position. The antero–posterior or Cincinnati view is taken with a 1 mm copper filter attached to the overhead tube. The overfiltration of a high kilovoltage beam of radiation results in an attenuated beam made up primarily of high energy photons which interact with tissues to reduce the difference between photon absorption in bone, soft tissues, and air characteristic of the usual diagnostic range, thereby improving visualization of the airways in the neck and mediastinum. The Cincinnati view allows assessment of the whole airway from the hyoid to the main bronchi (Weber and Grillo, 1992).

The pharyngoesophagogram or 'barium swallow' investigates any structural or functional abnormality from the oral tract to the gastro-oesophageal junction (Low and Rubesin, 1993). It provides a dynamic investigation of deglutition and the protective sphincteric action of the larynx. Laryngopharyngeal incoordination, aspiration, cricopharyngeal spasm and gastro-oesophageal reflux can be detected and quantified by this modality. In cases of stridor, the primary indication for a barium study is to look for

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the presence of a vascular ring or sling causing tracheo-oesophageal compression. Vascular anomalies, such as those of the fourth branchial arch, causing compromise of the upper aero-digestive tract are rare, and, by virtue of tracheo-oesophageal compression are usually manifest during the first year of life. The diagnosis can reliably be made by barium swallow (Figure 1).

Microlaryngoscopy is performed under general anaesthesia. A purpose built table is placed over the chest of the patient and an operating microscope is fitted with a 400 mm objective lens to provide a magnified view of the laryngeal structures. A specially designed series of laryngoscopes are



FIG. 1

Barium swallow examination showing vascular compression of the oesophagus.

attached by a ratchet mechanism to the chest piece, thus freeing the surgeon's hands. The tracheobronchial tree may then be further evaluated by rigid bronchoscopy. These two procedures combined are used in the investigation of stridor-microlaryngo-bronchoscopy.

### Patients and methods

All the work for this study was carried out at Great Ormond Street Hospital, London, which is a tertiary referral centre. The study covers the three-year period 1991–1993 and includes data collected from 100 cases. It is a retrospective analysis of information taken from radiological investigation reports and operative records.

Any child aged under 20 months, undergoing diagnostic investigations for suspected upper airway obstruction, with inspiratory, expiratory or biphasic stridor, was included. The age range was two weeks to 20 months and the mean age was seven months.

The reports of the routinely ordered, pre-operative, radiological investigations were collected. These were plain films of the chest, lateral neck, an antero-posterior filter view of the trachea (Cincinnati), and a barium swallow. The data was collected from the radiological records of all children having most, or all, of the selected investigations who subsequently underwent microlaryngobronchoscopy (MLB).

Findings at MLB were collected from the operative records in the Department of Otolaryngology. The number of each radiological investigation performed was tabulated. The findings at barium swallow were then compared directly to the findings at MLB and the plain radiology films were analysed similarly. The diagnoses encountered at MLB were ranked in order of frequency and the role the radiological investigations had played in the diagnosis of each pathology was assessed.

### Results

The number of subjects who actually underwent the recommended radiological investigations is shown in Table I. It can be seen, for example, that of the 100 infants who underwent diagnostic MLB only 65 had a previous barium swallow, 95 had a previous chest radiograph and 92 had radiological assessment of their airway prior to the endoscopy.

#### *Barium swallow examinations*

Sixty-five barium swallow examinations were performed, 32 were reported as normal (Table II), three of these also had a normal MLB. Twenty-nine cases, therefore, had a normal barium study with pathology seen at MLB. These cases included 19 of laryngomalacia, three of subglottic stenosis, two of each tracheomalacia and subglottic haemangioma and single cases of laryngeal cleft, stove-pipe trachea and laryngeal cysts.

Sixteen of the barium swallow examinations showed the presence of gastro-oesophageal reflux.

TABLE I  
NUMBER OF SUBJECTS UNDERGOING DIFFERENT COMBINATIONS OF RADIOLOGICAL INVESTIGATIONS

	Number of radiological investigations performed pre-endoscopy					
MLB	+	+	+	+	+	100
Barium swallow	+	-	+	+	-	65
Cincinnati/Lateral neck	+	+	+	-	+	92
Chest X-ray	+	+	-	+	-	95
No. of cases	53	34	4	8	1	100

One barium swallow showed a constant posterior impression on the oesophagus consistent with a vascular ring and the chest X-ray in this case showed an enlarged aortic arch, the lateral neck and Cincinnati views showed no evidence of upper airway obstruction and the microlaryngobronchoscopy was essentially normal.

Five barium swallow reports commented on an abnormality in the size of the trachea. They all had comparable findings at MLB as shown in Table III.

#### *Lateral neck and Cincinnati radiographs compared to MLB findings*

Ninety-two of each of lateral neck and antero-posterior neck views were performed in the subject group and they were reported together so the results represent 'pairs' of radiographs. Forty-seven 'pairs' were reported as normal, five of these also had a normal MLB.

The number of each pathology identified at MLB and the number of each that was identified on lateral neck and Cincinnati view are represented in Figure 2. The dark shading illustrates the endoscopic findings and the pale shading the radiographic findings.

Forty-three 'pairs' of neck films were reported as 'abnormal': 65 per cent of these 'abnormals' had a comparable finding at MLB; 33 per cent, however, suggested a different diagnosis to the endoscopic finding. As the MLB is the accepted definitive diagnostic procedure, these represent falsely positive radiological results.

The diagnoses made at microlaryngobronchoscopy were ranked in order of frequency and compared with the number of individuals in each pathological group accurately diagnosed on neck radiographs. The results are shown in Table IV.

TABLE II  
REPORTED FINDINGS AT BARIUM SWALLOW

Barium swallow diagnosis	No.
Normal	32
Gastro-oesophageal reflux	16
Overspill into bronchial tree	9
Vascular ring	1
Poor peristalsis	1
Pharyngeal 'ballooning'	1

#### Discussion

The aim of the study was to determine the value of routinely ordered radiological investigations in the pre-endoscopic investigation of infants with stridor. To undergo an endoscopic examination an infant must have a general anaesthetic, in a child with stridor, a chest radiograph is considered mandatory by most anaesthetists to identify any major pulmonary or vascular malformations. Thus, the information from the chest radiographs, although collected, has not been presented in the paper.

Table I shows that only 53 of the 100 subjects underwent all the recommended investigations and 43 had all except a barium swallow. In the sample group 65 barium swallows were performed. This discrepancy between actual investigations performed and the number expected from the recommended investigation procedure, may arise as often an urgent microlaryngobronchoscopy is required and it is not recommended that a barium study and an upper airway endoscopy are performed within the same 24-hour period and as a consequence the contrast examination may be omitted.

Sixty-five barium swallow investigations were performed (Table II): 32 were reported as normal (three of which also had normal endoscopy); the remaining 29 had a variety of abnormal findings on MLB. Of the 16 barium swallows which showed gastro-oesophageal reflux, two cases were found to have oedema of the glottis or subglottis at endoscopy. This reflux may be the cause of, or contribute to, stridor in the two cases showing oedema at MLB. The reflux may also be a secondary effect of the airway obstruction, as the increased negative intrathoracic pressure may cause stomach acid to be refluxed. Five of the barium reports commented on an abnormality of the size of the trachea, all had consistent findings at MLB (Table III).

The diagnoses made at MLB are ranked in order

TABLE III  
COMPARISON OF MLB FINDINGS AND THE REPORTS OF THE BARIUM SWALLOW EXAMINATIONS WHICH SPECIFICALLY COMMENTED ON TRACHEAL SIZE

Barium swallow report	MLB diagnosis
Tracheal stenosis	Subglottic stenosis
Trachea narrow	Subglottic stenosis
Trachea narrow	Primary cleft
Trachea collapsing	Tracheomalacia
Trachea narrow on inspiration	Laryngomalacia

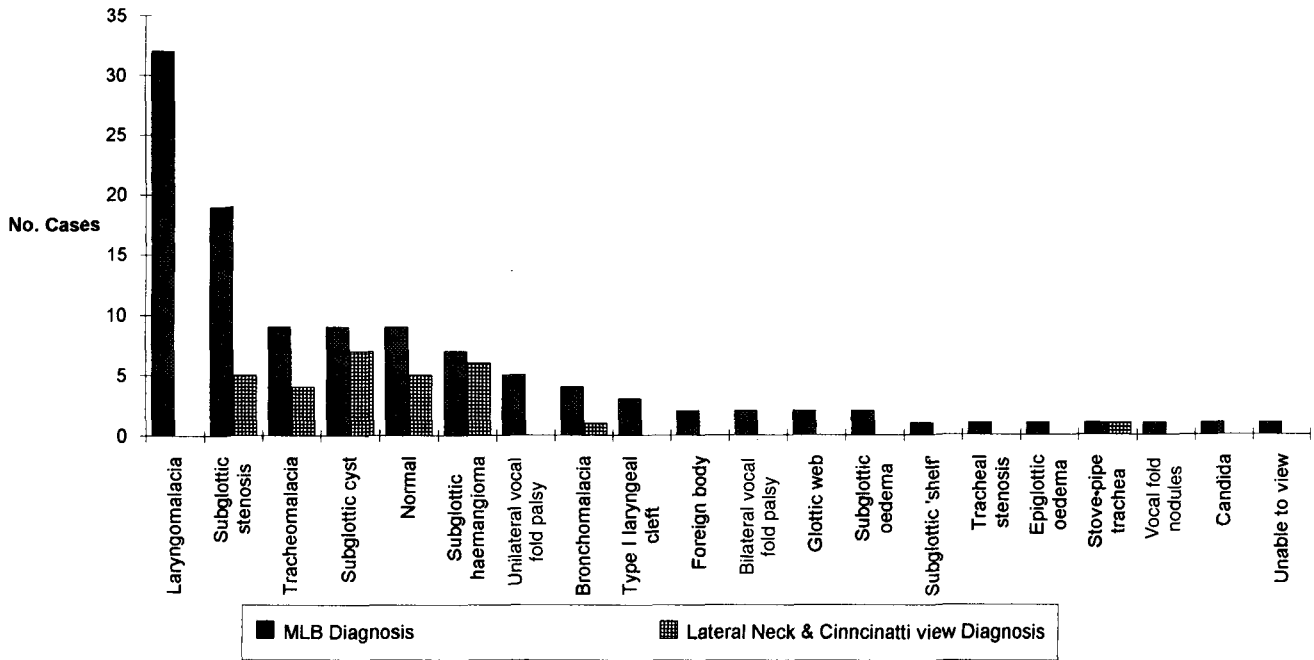


FIG. 2

The number of cases of each pathology in the series comparing MLB findings and neck radiological findings.

of frequency in Table IV. This Table compares these findings with the number of each pathology that was accurately suggested on the neck lateral and antero-posterior films. The most common diagnosis at MLB in this series was laryngomalacia followed by subglottic stenosis. Eliachar and Lewin (1993) quote laryngomalacia as the most common upper airway anomaly found in young children followed by vocal fold paralysis or fixation and thirdly congenital

subglottic stenosis. Of the 32 cases of laryngomalacia it can be seen from Table IV that 26 had normal plain radiographs. Of the six cases with abnormal radiographs none suggested the diagnosis of laryngomalacia, but four cases of tracheal narrowing were reported, one case of widening of the pharynx and one of a mass in the retropharynx. However these findings were not reproduced at endoscopy. To summarize, none of the cases of laryngomalacia were identified radiologically. This is not an unexpected finding as malacia is a dynamic phenomenon and the radiographs present a static picture. However, its importance is to emphasize that the most commonly occurring pathology is not identified radiologically.

TABLE IV

DIAGNOSES MADE AT MLB IN RANKED ORDER AND THE NUMBER OF EACH CASE THAT WAS IDENTIFIED ON THE LATERAL NECK AND CINNICINATTI VIEW X-RAYS

MLB diagnosis	No.	X-ray diagnosis
Laryngomalacia	32	0
Subglottic stenosis	19	5
Tracheomalacia	9	4
Subglottic cyst	9	8
Normal	9	5
Subglottic haemangioma	7	6
Unilateral vocal fold palsy	5	0
Bronchomalacia	4	1
Type 1 laryngeal cleft	3	0
Foreign body	2	0
Bilateral vocal fold palsy	2	0
Glottic web	2	0
Subglottic oedema	2	0
Subglottic shelf	1	0
Tracheal stenosis	1	1
Epiglottic oedema	1	0
Stove-pipe trachea	1	1
Vocal fold nodules	1	0
<i>Candida spp.</i>	1	0
Unable to view	1	0

Nineteen cases of subglottic stenosis were identified at MLB, eight had lateral neck and Cinninatti X-rays reported as normal. Therefore, only a quarter of cases of the second most commonly occurring pathology were identified radiologically. Nine cases of tracheomalacia were found, four had normal plain films. Of the four with abnormal radiological findings all had the correct diagnosis. Therefore, half of our series of eight tracheomalacia cases were identified on X-ray. Nine cases of subglottic cyst were included, 88 per cent of which were identified on plain film as space-occupying lesions. The cysts are thus readily identified but present very rarely even in a tertiary referral unit.

Seven normal endoscopies were performed: five of these cases also had normal neck radiology but two had false-positive radiological findings. Seven cases of subglottic haemangioma were in the study group: six had compatible radiological findings but one was false negative. This is again an extremely rare disorder. Five unilateral and two bilateral vocal fold palsies were included, none were seen on X-ray,

as would be expected. A quarter of the cases of bronchomalacia were also diagnosed radiologically.

Those cases not identified on plain film were epiglottic oedema, type 1 laryngeal cleft, glottic web, foreign body, subglottic shelf, vocal fold nodules and *Candida spp.* One very rare case of stove-pipe trachea was however clearly diagnosed radiologically.

To summarize, the barium swallow investigations in the group studied did not, in general, help in the differential diagnosis of upper airway disease. We recommend that it is more appropriate to study only selected patients in this way. The neck and filter views were useful in identifying abnormalities in tracheal size, but poor at assessing the more common disorders. Therefore it would seem that negative radiological findings should not be used as an indication not to endoscope the child as they may well be false negatives.

We conclude that radiological assessment of the airways is good for mass lesions but poor for the more common causes of airway obstruction. We recommend that all children have a pre-micro-laryngobronchoscopy chest X-ray which will detect some of the vascular rings and rare conditions e.g. stove-pipe trachea and foreign bodies. Further radiological imaging should then be selected accord-

ing to the endoscopic findings. This would also limit the X-ray exposure to a vulnerable area in the child.

The radiologist and surgeon must be aware of the potential pitfalls involved in each imaging technique. The advantages and limitations together with cost effectiveness should be discussed in every case.

#### References

- Smith, R. J. H., Smith, M. C. F., Glossop, L. P., Bailey, C. M., Evans, J. N. G. (1984) Congenital vascular anomalies causing tracheoesophageal compression. *Archives of Otolaryngology* **110**: 82–87.
- Low, V. H. S., Rubesin, S. E. (1993) Contrast evaluation of the pharynx and oesophagus. *Radiologic Clinics of North America* **31**: 1265–1291.
- Weber, A. L., Grillo, H. (1992) Tracheal lesions - assessment by conventional films. Computerized tomograms and magnetic resonance imaging. *Israel Journal of Medical Science* **28**: 233–240.
- Eliachar, I., Lewin, J. S. (1993) Imaging evaluation of laryndotracheal stenosis. *Journal of Otolaryngology* **224**: 265–277.

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