THE DIAGNOSIS AND CONSERVATIVE TREATMENT OF BRONCHIECTASIS IN CHILDREN

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The title and purpose of this paper require some explanation. Its objects are to describe a method of bronchography in children, which has been tried at the Hospital for Sick Children, Great Ormond Street, and has been found to give an accurate picture of the bronchial tree. It also describes the conservative treatment by postural drainage, without, however, discussing the relative merits of conservative and operative treatment. It does not deal with the clinical diagnosis of bronchiectasis in children, which has already been described adequately in textbooks.

The authors feel, however, that postural drainage, whether used as a curative measure or in preoperative therapy, plays a most important part in the treatment of bronchiectasis in children. No apology is offered for calling attention to previous work, as many cases of bronchiectasis in children are being misdiagnosed and inadequately treated because this work has not been thoroughly understood.

The normal bronchial tree

Particular attention is called to the anatomy of the bronchial tree; for an intimate knowledge of this is essential to the production of good bronchograms that give a faithful picture of the nature and extent of the disease, upon which the correct postural drainage will depend.

Excellent diagrams of the bronchial tree in adults have been drawn by Nelson (1934), who has emphasized the importance of the anatomy both in the diagnosis and subsequent treatment of bronchiectasis. The anatomy of the bronchial tree is again discussed here. Contrary to many opinions the angles of the bronchi in children do not differ from those of adults.

Fig. 1 and 2 show:

1. That the right eparterial bronchus runs almost transversely, and then obliquely upwards.

2. That the right eparterial bronchus divides into three branches.

(a) **Apical**, running directly upwards.

FIG. 1.—Anteroposterior bronchogram of both sides.

A=apical. Ax=axillary. P=pectoral bronchi. M=middle lobe bronchus. V=ventral bronchus. AB=anterior basic. AxB=axillary basic. PB=posterior basic bronchi and AxAp=axillary apical bronchus.

FIG. 2.—Right lateral bronchogram.

Ap=apical bronchus. Ax=axillary bronchus. P=pectoral bronchus. D=dorsal bronchus. ML=middle lobe bronchus. PB=posterior basic bronchus. AxB=axillary basic bronchus. AB=anterior basic bronchus.

(b) **Pectoral**, running forwards, downwards and slightly outwards.

(c) **Axillary**, running backwards, upwards and outwards.

3. That the right hyparterial bronchus supplies the middle and lower lobes, and divides ultimately into five branches:—

(a) **The right middle lobe bronchus**, running forwards, outwards and very slightly downwards.

Note the similarity in direction to the pectoral bronchus.

(b) **The dorsal bronchus**, arising at the same level as the right middle lobe bronchus and running horizontally backwards.

(c) **The anterior basic bronchus**, running forwards, and slightly downwards, parallel to the right middle lobe bronchus.

(d) **The axillary basic bronchus**, running downwards and outwards towards the costo-phrenic angle.

(e) **The posterior basic bronchus**, running downwards and backwards parallel to the right border of the heart.

Fig. 1 and 3 show the bronchial anatomy of the left side. It will be noted that it differs from the right side in the following ways:—

1. **The upper lobe bronchus** arises lower down, and at a less acute angle than on the right side. It is a branch of the left main bronchus and runs slightly forwards giving off the following branches:—

(a) **The axillary and apical**, which arise together and divide higher up into separate branches running in similar directions to those of the right side.

(b) **The ventral**, which corresponds to the middle lobe bronchus on the right, and runs forwards, outwards and slightly downwards.

2. **The lower lobe bronchus** divides into the dorsal, anterior, axillary and posterior basic branches. These have the same course and direction as those on the right side.

FIG. 3.—Left lateral bronchogram.

AxAp=axillary apical bronchus. V=ventral bronchus. D=dorsal bronchus. PB=posterior basic bronchus. Ax B=axillary basic bronchus. AB=anterior basic bronchus. P=pectoral bronchus.

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Technique of bronchography

The technique used at Great Ormond Street follows that described by Erwin (1936), Ellman (1939) and others.

PREPARATION OF THE PATIENT. It is essential that the bronchi should be as empty as possible before introducing the oil. This is achieved by providing postural drainage eighteen hours daily for one week. If this is not sufficient, drainage is continued for a further two to three weeks, or until the amount of sputum becomes negligible. Too much reliance must not be placed on the volume of sputum in children, as most of the sputum is swallowed. The best guides are the general condition of the child and the presence or absence of moist sounds on auscultation. The injection of oil is carried out while the patient is fasting, whether local or general anaesthesia is employed. But in the latter case the administration of atropine is essential. Considerable difference of opinion exists between the respective merits of general and local anaesthesia. The authors, after experience of both methods, have come to the conclusion that local anaesthesia is only advisable after the age of ten years, and even then, only in isolated cases. When using local anaesthesia the complete co-operation of the patient is essential, for he must neither cough nor swallow.

GENERAL ANAESTHESIA. At Great Ormond Street, induction with ethyl chloride, followed by deep ether anaesthesia has proved very successful.

BASAL ANAESTHESIA. Various forms have been tried in children, but they do not abolish the cough reflex, neither are the patients sufficiently co-operative. Jacoby and Keats (1938) advocate premedication with avertin, followed by ether anaesthesia.

LOCAL ANAESTHESIA. If this is used the patient must be tested for cocaine sensitivity. If the patient is not sensitive to cocaine, the larynx is anaesthetized by running 2 to 3 c.c. of a 1 per cent. cocaine solution through the syringe into the nose, using the technique employed for introducing the oil, shortly to be described. A better anaesthesia is obtained if the child sucks a decaine sweet first. Two or three injections of cocaine are made over a period of twenty minutes to half an hour, the oil being introduced after a further interval of ten minutes. Jewesbury (1939) has suggested that laryngeal anaesthesia is unnecessary for bronchography, but it is impossible to obtain good results in children without it.

THE APPARATUS FOR INTRODUCING THE OIL. This is extremely simple, and consists of a tongue clip and a 10 c.c. record syringe to which is attached $1\frac{1}{2}$ inches of a $\frac{1}{16}$ -inch bore rubber tubing.

THE IODIZED OIL. The preparation used was oleum iodisatum, B.P. addendum 1936, supplied by British Drug Houses. The oil is thinner than that commonly used and consequently flows easily from the nose into the larynx and trachea, producing better bronchograms in children, as the bore of the bronchi is small. The oil is used cold. The amount used varies with age and size of the child. To avoid superimposition of images of the bronchial tree in the lateral view, only one side is filled at one sitting.

If gross saccular bronchiectasis is suspected, much more oil will have to be used. The x-ray should be taken with the patient sitting up in the case of basal bronchiectasis.

DOSAGE

Age of child (years)	..	..	2-4	4-8	8-12
Volume required to fill one lung (c.c.)	..	3-4	4-6	6-8	

Method of introduction of the solution. When the patient is fully anaesthetized, he is placed in the sitting position with the head held upright and chin forward. The patient's trunk should be inclined towards the affected side at an angle of 25 degrees to fill the right bronchial tree, and at 45 degrees for the left (fig. 4 and 5). The tongue is then grasped with a tongue clip applied 1 inch from the tip of the tongue and is held very firmly forwards. It is most important that the tongue should be held forward throughout, for if this is not

FIG. 4.—Position for filling the ventral, middle lobe and anterior basic bronchi.

done the aperture of the larynx is occluded by the base of the tongue and the oil merely runs into the oesophagus. The rubber catheter is then inserted for a half to one inch into the nostril of the side which it is required to visualize. $1\frac{1}{2}$ to 2 c.c. of the solution are introduced. The patient should be kept in this position for fifteen to thirty seconds until the typical gurgle of the solution is heard as it passes between the cords. The success of the bronchogram now depends upon an accurate knowledge of the bronchial anatomy.

Fig. 4 shows the position for filling the middle lobe and anterior basic bronchi on the right side. A similar position is adopted to fill the ventral bronchus on the left side. Note that the head in this position is held extended. The patient

is flexed in this position and a further $1\frac{1}{2}$ to 2 c.c. of the solution is introduced, and the position maintained for twenty to forty seconds. The patient is then returned to the sitting position (fig. 5) and $\frac{1}{2}$ to 2 c.c. again introduced. When this has been done the patient is placed for twenty seconds in the semi-recumbent position leaning towards the affected side, in order to fill the dorsal, posterior, axillary and basic branches.

In children under general anaesthesia, the upper-lobe bronchi usually fill spontaneously, but if it is especially desired to fill them, two further positions are required. For the right side, after the bases have been filled, it is sufficient to turn the patient on his right side and to raise the pelvis. The left upper lobe bronchus is more difficult to fill. This is best accomplished by raising the pelvis

FIG. 5.—The inclination requisite for preventing the lipiodol from flowing into the other lung and should be held throughout the procedure.

and laying the patient on the left side, so that the left nipple is nearly in contact with the table. This last manoeuvre is necessary because the upper lobe bronchus on the left side runs slightly forwards, and gives rise to the ventral bronchus. This position therefore ensures that the ventral bronchus is filled.

The foregoing positions were elaborated by Erwin (1936) and others at the Brompton Hospital, and although they appear complex in description are easy to carry out.

This method of introduction is more suitable than the crico-thyroid route. For in children the landmarks in the neck are poorly defined, and the trachea is so easily compressed, that the introduction and maintenance of the needle in situ are difficult. Also in small children there is a danger of passing the needle right through the compressed trachea.

The simplicity of the apparatus and technique make this method ideal for hospitals with little experience of bronchography in children. A note of warning should be sounded about the amount of solution used, and the time allowed in each position; for if either of these two points are neglected, the solution will run into the alveolar spaces and obscure the picture of the bronchi.

Postural drainage

Nelson (1934) has placed on a sound footing the technique of postural drainage in relation to the anatomy of the bronchi. Unless stereoscopic views of the chest are taken, the clinician is apt to regard the child's chest as being a

FIG. 6.—The *wrong* way to drain the middle lobe and anterior basic bronchi.

'slice' rather than a 'barrel.' In consequence the Nelson beds or tipping frames have been improperly used, for if a child is simply inverted on its face over one of these devices, the upper lobe, middle lobe and anterior basic bronchi remain undrained. Fig. 6 illustrates this. It is clear that it is useless to attempt to drain these bronchi against gravity.

Little attention has been paid to the rotation of the chest necessary for the optimum drainage of both middle and lower lobes. Wedges have been devised by one of us (B.E.B.) and are incorporated in a jacket in order to produce this effect: fig. 7, which shows a diagrammatic cross-section of a chest, makes this point clear. The maintenance of the position is the chief difficulty in securing postural drainage. If given the chance, children are seen happily straddling the tipping device during the day, or sleeping peacefully curled up at one or other end of the bed at night. The jacket into which the wedges may be inserted

allows some freedom of movement, while maintaining the necessary posture and rotation of the chest. Fig. 8 shows an ordinary strap jacket commonly used for keeping children in bed. To this have been attached two oblong pockets front and back, into which the wedges may be inserted. Two stock sizes of jackets and wedges are in use at Great Ormond Street, the sizes being given in the table below.

AGE (YEARS)				INCHES
2 to 6	..	..	..	7×4×2
6 to 10	..	..	..	9×5×2½

These are made of firm sponge rubber.

A strap like a martingale passes from the centre of the chest or back to the head of the bed, where it should be fastened so as to allow some freedom of movement. The feet should be tied loosely to the foot of the bed by straps attached to anklets of soft material.

Positions for drainage

1. THE UPPER LOBES in children can be drained by allowing them to run about; for it is difficult to keep the child in the 'Cleopatra position.'

2. THE MIDDLE LOBE, VENTRAL AND ANTERIOR BASIC BRONCHI. The child should be on its back on a flat bed with the chest raised by a wedge under the affected side. The foot of the bed should be raised eighteen inches to two feet. In this position it is essential that the feet be fixed to the foot of the bed by the method described.

3. THE AXILLARY BASIC, POSTERIOR BASIC AND DORSAL BRONCHI. To drain these bronchi the child should be placed on its face over a tipping device with the trunk at right angles to the legs. A wedge should be placed under the affected side. In this case it is essential to attach the martingale strap to the head, and the feet to the foot of the bed.

A word is necessary about the times required to drain the bronchi. The secretions are so viscous, that it is necessary for the patient to spend eighteen hours daily in the requisite postures while in hospital, and the entire night when at home. Should the basic and middle lobe or ventral bronchi be affected together, the time should be divided equally between the two postures.

Finally, it is always advisable to give a liquefying expectorant mixture during the course of postural drainage. Both the Brompton Hospital hot-water mixture

R Sodium bicarbonate 20 grains.
 Sodium chloride 3 grains.
 Emulsion of chloroform B.P.C. 5 minims.
 Syrup of anise B.P.C. 3 minims.
 Distilled water to 1 fluid ounce.

or the Hospital for Sick Children, Great Ormond Street, Mist. senegae ammon.

R Ammonium carbonate ½ grain.
 Spirit of chloroform 2 minims.
 Syrup 15 minims.
 Inf. of senega to 60 minims.

are efficacious.

SHOWING WEDGE MAINTAINING THE
BRONCHI TO BE DRAINED UPPERMOST

FIG. 7.

STRAP JACKET SHOWING
MARTINGALE AND WEDGE

FIG. 8.

Summary

1. The anatomy of the bronchi is discussed in relation to the technique of bronchography.
2. The technique of bronchography for children is given in detail.
3. Postural drainage in children is discussed, and particular attention is called to the methods of maintenance of posture.

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