

# Bronchography in Children

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A bronchogram of satisfactory standard is a prerequisite of surgery for bronchiectasis. In adults, bronchography is normally performed under local anaesthesia and consistently good results are not difficult to achieve. In children, general anaesthesia is obligatory and the results are more variable. The quality of a bronchogram is determined by the extent of bronchial filling. If the mechanism of filling that operates during local anaesthesia can be preserved under general anaesthesia, equally reliable results can be obtained. The forces available for bronchial filling will first be reviewed and then a technique for bronchography under general anaesthesia described.

The course of the radiographic oil can be divided into three stages. (1) Introduction to the trachea; (2) selective distribution to the bronchial orifices by gravity; and (3) outlining (filling) of the bronchial tree. This last stage is brought about by one of two main forces: the suction force of inspiration when the patient breathes spontaneously, or the blowing force of positive pressure ventilation when the patient is paralysed by a relaxant.

Gravity does little more than present the oil to whatever main orifices are made lowest by posturing; it is weak as a filling force but very useful as an aid to distribution. The suction effect of inspiration is indispensable to reliable bronchography. The uniformity and extent of filling characteristic of a good bronchogram can only be produced consistently under conditions of vigorous spontaneous respiration. When filling is effected by positive pressure blowing, the result is likely to be patchy and uneven: some areas may be overfilled to 'alveolar' level while other areas may be quite unfilled. Open ether anaesthesia has been used for many years for bronchography in children. Ether allows steep posturing with safety and promotes vigorous respiration: the principle of gravity-distribution and suction-filling can be exploited to the full.

The child is admitted to hospital two days in advance. Extensive postural coughing sessions are

begun at once; it is useless and dangerous to attempt bronchography in a child whose bronchial tree is flooded with mucopus. The sputum is sent for bacterial culture and antibiotic sensitivity tests. Hb estimation is important in that some degree of anoxia is inseparable from the performance; the lower the Hb level the more serious is the significance of cyanosis. Bronchography should be postponed if the haemoglobin level is below 10 g./100 ml. Finally, a chest radiograph is taken.

Premedication is with minimal omnopon-scopolamine or pethidine-atropine. Thiopentone-sodium intravenously is followed by succinyl choline. The total amount of respiratory depressants must be kept low, or a level of ether anaesthesia deep enough to suppress the cough reflex is difficult to reach and maintain; in addition the respiratory stimulant effect of ether will be neutralized and subsequent bronchial filling impaired. The bronchial tree is cleared out by bronchoscopy, taking care to avoid bruising the mucosa; bruised areas lower the threshold of the cough reflex. A full-sized plain endotracheal tube is passed, and the lungs are gently inflated with a weak ether-N<sub>2</sub>O-O<sub>2</sub> mixture until spontaneous breathing returns; a transfer to open ether is now made. When Plane 2 to 3 is reached, 0.5 to 1.0 ml. of 4% lignocaine is injected down the tube and the child is taken to the x-ray department.

The dose of propylidone oily suspension (Dionosil, Glaxo) is based on the age of the child, with due allowance for size: 1.25 ml. per year of age, for the right lung, 1.0 ml. likewise, for the left lung. The right lung is always filled first. Gravity produces good distribution if the bronchial tree is simply regarded as having anterior and posterior branches. Posturing is therefore confined to two manoeuvres for each side.

Right side. (1) With the trunk raised 60° to the horizontal and inclined well to the right, half the calculated dose is injected—in fractions—into the open end of the endotracheal tube. At the completion of injection, 15 breaths are allowed for the oil to be inspired. (2) The child is placed in the right semiprone position, with head and shoulders raised

on pillows so that the trunk is at an angle of 30° to the horizontal. The remaining half dose is injected as before, and followed by 20 breaths. The anterior branches are longer and fill more slowly than the posterior branches; the right middle lobe is commonly the most difficult lobe of all to demonstrate. A right lateral radiograph is taken during the pause following expiration. If the radiographer has trouble in timing the exposure because of irregular breathing, respiration can be temporarily inhibited by connecting an oxygen reservoir bag to the endotracheal tube and squeezing (Hering-Breuer reflex). The left side is dealt with in similar manner, but using smaller dosage and a left lateral position for anterior branch filling. The right lateral radiograph is checked before proceeding to fill the left side. In the event of either side not being filled properly a second attempt is made: one-quarter of the dose is repeated, using gravity to direct the oil to the unfilled area. Third attempts at filling are seldom successful and do not warrant the risk involved. Adequate indication of gross bronchiectasis is given by partial filling—complete filling is neither necessary nor often possible (the affected lobe is usually collapsed and adynamic). With good technique the bronchogram should be completed on three films—right lateral, left oblique, antero-posterior. At the conclusion the bronchial tree is thoroughly sucked out, the child is turned on to his side with the best lung uppermost and the endotracheal tube is removed; he is kept under close observation until consciousness returns.

In the dosage described, gurgling noises follow each fractional injection; these diminish and often disappear as the oil is inspired. If at any time gurgling noises persist, the indication is that the bronchi—in that area of distribution at least—have reached saturation point; to inject further oil is futile and dangerous. High efficiency suction apparatus and equipment for oxygen inflation of the lungs must be instantly available throughout.

The ether mask must be replaced promptly after each injection of oil or the anaesthesia will lighten and coughing begin. Apart from a ruinous effect on the bronchogram, coughing spasms quickly worsen the anoxia that is an inherent part of the procedure.

Since ether is a bronchodilator, it is sometimes suggested that bronchography performed under ether anaesthesia might lead to a wrong diagnosis of early bronchiectasis. This idea is false. Ether may conceivably widen the calibre of normal bronchi but it does not alter their taper. Loss of taper, not arbitrary increase in calibre, is the earliest radiographic evidence of bronchiectasis.

## Complications

The most serious complication is oedema of the larynx. The passage of a bronchoscope or tube through a larynx awash with mucopus presumably causes minute abrasions through which bacteria enter. The trauma need not be overt: in the few instances seen with this complication there had been a singular absence of obvious trauma. The subglottic swelling is occasionally visible on a plain radiograph. Appropriate antibiotic therapy should be begun without delay.

Spread of lung infection is not common. When it occurs it is largely due to inadequate preparation of the patient.

An unusual complication was seen recently. A boy aged 7 years was referred to this unit for treatment of a tension pneumothorax on the left side following bronchography on the right side. A relaxant and vigorous positive pressure ventilation had been used.

## Discussion

There is nothing new in the technique described here. The only justification for presenting it in detail is to assert its position as the best method at present available for bronchography in children. The first-time success rate is high: this in itself is a contribution to safety in that the need to repeat a serious investigation is reduced. A considerable proportion of the children referred to this unit for bronchography have been sent because of failure of other techniques elsewhere. The main objection to the use of ether for bronchography is the hazard of explosion: this can be minimized.\* It should, however, be emphasized that ether must not be used in an x-ray department unless alterations, approved by the Ministry of Health, have been made to minimize this risk.

## Summary

The mechanism of filling of the bronchi with radiographic oil is considered. It is concluded that the force in operation during spontaneous respiration affords the best results. A technique based on the use of open ether is described.

I should like to thank Drs. E. Joan Millar and R. G. Sykes, who first introduced me to the technique described here; and Miss J. Hill and Mrs. I. Banks for their services in the x-ray department of this hospital.

\* By forced ventilation, antistatic flooring, and flash proofing of the x-ray unit. Absolute safety cannot be guaranteed but 'certain limited standards of safety' have been set out by the Ministry of Health (R. L. Wake, Regional Engineer, Newcastle Regional Hospital Board, personal communication, 1957). Unfortunately flash proofing is costly and must be done by the manufacturers of the unit at their factory.