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ETHER-CYCLOPROPANE ANAESTHESIA FOR THE PRIMARY REPAIR OF CLEFT LIP AND PALATE (A 20-YEAR EXPERIENCE)

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During the past 25 years, several papers have been published describing different anaesthetic techniques for use in the repair of cleft lip and palate (Davies and Danks, 1953; Norris and Saunders, 1955, Salanitre and Rackow, 1962, Black *et al.*, 1969). Modifications such as the use of hypothermia (Kilduff *et al.*, 1956) and acupuncture (Lu-Ch'ieu and Tao-Hsieh, 1960) have been used with varying results, while more recently, newer anaesthetic drugs such as methoxyflurane have been advocated (Black *et al.*, 1969). Ether has been the agent most commonly employed (Smith, 1968) and is traditionally regarded as the safest anaesthetic for maintenance (Woodfield-Davies, 1954). While cyclopropane is commonly used as an induction agent in children, the use of the ether-cyclopropane combination for maintenance of anaesthesia has declined in recent years. This is probably due to anxiety about the explosive and inflammable properties of both agents and the greater difficulty in learning this technique.

In this unit, ether-cyclopropane anaesthesia is used extensively, especially in the management of severe burns and the primary repair of cleft lips and palates.

This communication describes the Senior author's (E. J. D.) technique, which has been used for 20 years in over 1,000 cases of primary cleft lip and palate repair, and reviews a consecutive series of 500 cases.

TECHNIQUE

The infant should be admitted to the hospital 2 days before operation, to ensure careful preparation. A Hb. below 10 gm/100 ml, any evidence of sepsis or pyrexia or a body weight below 5 kgs are considered valid grounds for postponing the operation. Premedication consists of atropine sulphate 0.02 mg/kg intramuscularly and rectal thiopentone 40 mgm/kg given 20 minutes before coming to theatre. Induction of anaesthesia, using an infant set (Medical and Industrial Equipment Ltd) is achieved by administering 500 ml cyclopropane and 500 ml oxygen per minute via a closed circuit (Waters to-and-fro system). When the correct depth of anaesthesia is reached (stage 3, plane 2) as judged by absent laryngeal reflexes and centrally fixed eyes, the glottis and trachea are sprayed with 1 ml 4 per cent lignocaine using a Forrester spray.

For laryngoscopy, a selection of straight and curved blades is available, although the Oxford infant laryngoscope is usually successful. Intubation is achieved using a Magill Flexometallic tube, selected from the three available sizes. The pharynx is carefully packed about the shouldered portion of the tube with ribbon gauze dipped in liquid paraffin and squeezed dry before insertion. The tube is then fixed exactly in the mid-line of the mouth with adhesive tape, taking care to avoid distortion of the lips.

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Anaesthesia is maintained with a nitrous oxide, oxygen, ether and cyclopropane combination using an Ayre's T-piece. A total flow of 6 litres per minute (2 l. Oxygen, 4 l. nitrous oxide) together with a basal flow of 150-200 ml cyclopropane provides smooth anaesthesia. The ether concentration is gradually increased by advancing the control knob in the Boyle bottle a division at a time, taking care to keep below the coughing and breath holding threshold. The maintenance concentration is guided by the signs of anaesthesia and by the surgical requirements which, for primary repair of cleft lips and palates, is generally attained by keeping the plunger of the vapouriser level with the surface of the liquid (150-200 ml).

A stethoscope taped onto the chest wall is used to monitor the breathing and the heart rate. Care is taken to detect any respiratory obstruction by watching the open ended reservoir bag attached to the expiratory limb of the Ayre's T-piece and by listening frequently at the end of the expiratory limb for any obstructed breathing. Body temperature is recorded throughout the operation.

Blood loss is estimated by weighing the used swabs and measuring the blood collected in the suction bottle. Fluid infusion includes a maintenance regime of 3 ml/kg per hour, using 2·5 per cent dextrose, 0·45 per cent saline in addition to replacement of any excessive blood loss. Blood is replaced when the measured loss exceeds 10 per cent of the estimated blood volume (calculated on the basis of 85 ml/kg).

When draping the child for surgery, no impermeable mackintosh sheeting is used and the theatre temperature is maintained at a comfortable 68-72°F. (20-22°C). Infiltration of the palatal tissues with adrenaline solution is not considered necessary by the surgeon and may in fact be dangerous, by reducing the vascularity of the palatal and mucosal flaps. Bleeding points are ligated when necessary. On completion of the operation, the pharyngeal pack is removed and the pharynx and larynx carefully aspirated. Anaesthesia is discontinued and the infant is allowed to breathe 100 per cent oxygen for a few minutes. When respirations are regular, the Magill tube is removed with the infant on his side. The conscious child is returned to the ward in the semi-prone position and feeding resumes within 2 to 3 hours.

Review of Cases

Five hundred consecutive cases were reviewed for the period 1968 to 1977. The childrens' ages ranged from 6 weeks to 13 months for cleft lip repair (mean 3·5 months) and 6 months to 36 months for cleft palate repair (mean 12 months). Overall infant mortality was nil. The operation was postponed if the patient failed to satisfy the preoperative criteria, described earlier in this paper. This occurred in 10 per cent of the series and was largely due to streptococcal and pneumococcal throat infections. With appropriate antibiotic therapy, the infants were usually ready for operation within two weeks. Difficult intubation accounted for 2 per cent of the children whose operation was postponed and was usually due to such associated anomalies as microstomia, macroglossia, the Klippel Feil syndrome or the Pierre Robin syndrome. A second attempt 3 to 6 months later usually resulted in a successful intubation, although in one infant with a complete cleft palate and the Pierre Robin syndrome, the primary repair had to be deferred until the age of 36 months.

Other problems were encountered by junior staff learning the technique: intubation spasm occurred in 10 per cent of the cases and was due to an inadequate depth of anaesthesia at intubation. Extubation spasm occurred in 2 per cent of the infants and was due to mechanical stimuli with too light level of anaesthesia, irritants such as blood and mucus, and particularly, we believe, omission of or inadequate spraying of the glottis with 4 per cent lignocaine. Airway problems during the operation occurred in

10 per cent of the cases and included accidental extubation and endobronchial intubation. An incorrect size of Magill tube, excessive pharyngeal packing and incorrect siting of the pack were all contributory factors.

The recorded blood loss varied from 15 ml for cleft lip repairs (mean 31 ml S.D. ±5·75) and 45 ml to 253 ml for cleft palate repair (mean 66 ml S.D. ±25·76). A large proportion (94 per cent) of cleft palate repairs received blood, while only 8 per cent of cleft lip repairs required a blood transfusion. No single episode of hyperthermia or of convulsions occurred during or after operation and heart rate and rhythm remained within normal limits.

The condition of the infants in the postoperative period was excellent. Feeding was resumed within 2 to 3 hours of operation. Children with cleft lip repairs were fed with 50 per cent glucose in water for 12 hours, those with cleft palate repairs received the same solution for 48 hours.

Discussion

Most of the anaesthetic problems are associated with intubation, the endotracheal tube and immediately following extubation (Wylie *et al.*, 1972). The introduction of an endotracheal tube in a child with a cleft palate may be a difficult task, even in experienced hands. The fact that associated anomalies such as microstomia and macroglossia may be present may make intubation even more difficult and in our opinion relaxants to aid intubation are contra-indicated. Rapid induction is achieved with cyclopropane, particularly when administered using a closed circuit; breath holding and coughing are avoided and the thiopentone premedication produces basal narcosis which avoids the occurrence of excitement in the second stage of anaesthesia (Wood Smith *et al.*, 1978*a*). Barbiturates (Wood Smith *et al.*, 1978*a*) and ether (Coleman, 1978*a*) are also said to offer some protection against dysrhythmias produced by cyclopropane anaesthesia. Reflex resistance to intubation is abolished with 1 ml 4 per cent lignocaine applied to the glottis and trachea: this helps to avoid not only intubation spasm, but also extubation spasm.

A selection of straight and curved laryngoscope blades should be available and in our experience the Oxford infant laryngoscope is the most satisfactory. The overhang on the open side helps to prevent the lips obscuring vision, while the broad, flat lower surface is helpful when a marked degree of cleft palate is present. This difficulty may also be overcome by packing the cleft with gauze or bridging it with a spatula.

The Magill flexometallic tube is in our opinion the most suitable endotracheal tube. The bulge (shoulder) produced by the overlap of thin rubber is a useful safeguard against endobronchial intubation, while the proximal portion, with its inlying coil is completely flexible and collapse proof. Tight pharyngeal packing about the shoulder helps to avoid accidental extubation. Reported complications following the use of ether, including hyperthermia (Davies and Danks, 1953), convulsions and increased blood loss (Black *et al.*, 1969) have not presented problems in this series. The use of rectal thiopentone, low dose atropine, avoidance of heavy draping and the maintenance of a comfortable theatre temperature, together with a strict regime regarding any degree of sepsis, perhaps contributed to the absence of hyperthermia and convulsions. However, it should be added that children do have a greater propensity to develop convulsions than adults and this is presumably due to the lability of their central nervous system (Conway, 1978). Indeed convulsions occurring during anaesthesia are not confined to ether and have followed chloroform, trilene and other anaesthetics (Wood Smith *et al.*, 1978*b*).

The absence of tachycardia in these cases may be ascribed to the fact that while ether appears to increase sympathetic activity and block parasympathetic activity in

normal man, (Price, 1961), cyclopropane produces a slowing of the pulse (Coleman, 1978*b*). Regional blood flow measurements made during cyclopropane anaesthesia indicate substantial increase in splanchnic vascular resistance (Shackman *et al.*, 1953). The enhanced reactivity of the resistance vessels during cyclopropane anaesthesia is probably due to potentiation of the action of noradrenaline (Gravenstein *et al.*, 1960 and McArdle and Black, 1963). Increased blood loss following ether anaesthesia for cleft palate repair has been reported (Black *et al.*, 1969). While ether interferes with the ability of noradrenaline to constrict vascular smooth muscle, a light plane of ether anaesthesia causes a vasoconstriction (Atkinson *et al.*, 1977) and in our experience light ether anaesthesia in conjunction with light cyclopropane anaesthesia reduces the blood loss.

In conclusion, we feel that the ether-cyclopropane combination has many advantages. Cyclopropane provides a rapid pleasant induction and acts as a fine adjustment on the level of anaesthesia, while ether with its wide margin of safety and excellent analgesia provides a quiet and peaceful emergence from anaesthesia. In our view, both these features are highly desirable in an infant undergoing delicate lip and palate surgery.

* *Since this paper was accepted for publication, we were saddened to learn of the sudden death of the Senior author of this paper, Dr E. J. Delaney, in Dublin, on the 19th October 1979, after a short illness.*

Editor

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