EFFICACY OF THE LARYNGEAL REFLEX DURING OXYGEN–NITROUS OXIDE SEDATION (RELATIVE ANALGESIA)

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SUMMARY

The efficacy of the laryngeal reflex during dental treatment in two groups of children was tested using propyliodone 10 ml. In 25 children not specially afraid of dental treatment there was no aspiration of radiopaque dye into the larynx or chest. A similar group of 25 anxious children treated using oxygen–nitrous oxide sedation (relative analgesia) were examined in the same way; there was no aspiration of radiopaque dye.

The use of oxygen and nitrous oxide mixtures (relative analgesia) in dental practice to achieve sedation and analgesia, frequently supplemented by local analgesia, has led to queries regarding its safety for use by the single operator. There has been concern at possible depression of the laryngeal reflex and aspiration of debris from the oral cavity (Pleasants, 1971).

Cleaton-Jones (1976) reported that during “relative analgesia” (50% nitrous oxide in oxygen) the laryngeal reflex remained functional, there being no aspiration of radiopaque dye in adult volunteers. That experiment, however, was carried out 1800 m above sea level where blood saturation of nitrous oxide would be less than at sea level.

Rubin and others (1977) repeated the experiments at sea level. Adult volunteers received 50% nitrous oxide in oxygen as “relative analgesia”. Two of 10 volunteers (20%) aspirated contrast medium (Dionosil) to the lungs. It was concluded that the inhalation of 50% nitrous oxide in oxygen differs little from other commonly used anaesthetic techniques with respect to suppression of pharyngeal and laryngeal reflexes (Rubin et al., 1977).

The above studies, whilst showing changes under carefully controlled conditions, are sufficiently different from the circumstances prevailing during clinical practice to justify a study in patients undergoing dental treatment. There are two important differences between “experimental” and “clinical” conditions. First, in the clinical technique of relative analgesia it is considered important to determine the concentration of nitrous oxide in oxygen most suited to each patient by careful titration (Roberts, 1979). This optimum level of sedation is achieved and maintained by assessing the patient’s general demeanour, level of consciousness and the ability to maintain an open mouth and verbal contact (Langa, 1976).

Second, it is believed by many clinicians that the response of frightened patients undergoing dental treatment is likely to be different from that of calm volunteers.

It has been shown in adult volunteers that heart rate, arterial pressure, and respiratory rate increased during the administration of oxygen in nitrous oxide (Everett and Allan, 1971). Similar assessments in anxious children showed a slight decrease in arterial pressure, heart rate, and respiratory rate during dental treatment involving local anaesthetic injections and use of the drill (Roberts et al., 1979, 1982).

We have conducted a further assessment of laryngeal competence in anxious and non-anxious children undergoing dental treatment.

PATIENTS AND METHODS

The study was approved by the ethics committee of the Royal Dental Hospital. Anxious patients referred to the Children’s Department were assessed and those requiring oxygen and nitrous oxide sedation were included in the experimental group. The age range of the children was 4–18 yr, and they were matched in the groups for age, sex and the dental treatment required. No child selected had any coexistent medical problems. Consent was obtained from the parents and agreement obtained from the child.

The induction procedure was as follows (Roberts,
The mixture dial was set to 100% oxygen and the patient settled in the dental chair. The nasal mask was positioned and the patient encouraged to breathe gently through the nose. The flow of oxygen was increased until it matched the patient's tidal volume. At this point the patient was reassured and advised of the sensations likely to be experienced and the mixture dial turned to 10% nitrous oxide and held there for 60 s. Reassurance and encouragement was continued throughout induction. The mixture dial was then turned to 20% nitrous oxide for a further 60 s and if necessary to 30% nitrous oxide for 60 s more. Above this concentration increments of 5% were sometimes used. Satisfactory sedation was judged by the patient's demeanour, reported symptoms such as tingling, and a willingness to accept the needle and the drill. At the end of treatment we administered 100% oxygen for 2 min.

It is crucial to the success of the technique that the amount of nitrous oxide administered to the patient is assessed by careful titration of the nitrous oxide concentration to the patient's individual needs. Care was taken to obtain close adaptation of the nasal hood to the patient's face. During treatment the back of the mouth was observed to confirm that a posterior oral seal was achieved. Patients who exhibited mouth breathing were not included in the study.

All patients were treated in the supine position. Before the start of drilling a sufficient quantity of propylidone aqueous B.P. (Diosol Aqueous, Glaxo Laboratories, Greenford, Midd'x) was deposited onto the tongue until the patient swallowed the dye. This was repeated halfway through the operative procedure, and again at the end of dental treatment. The total amount of dye swallowed was in excess of 10 ml. In patients receiving oxygen and nitrous oxide sedation recovery was not started until the third increment of propylidone had been swallowed. During dental treatment oral suction was carried out only to remove water and saliva. No suction was present when the propylidone bolus was being placed on the tongue.

Immediately after treatment was completed we obtained a lateral x-ray view of the larynx and throat. The x-ray exposure factors, 7.5 mAs 60 kV, produced a film which showed the soft tissues of the larynx and pharynx (fig. 1). The patient then attended the Radiology Department when a postero-anterior view of the chest was taken (fig. 2). To minimize radiation dose a high speed screen-film combination was used in the radiography of both the neck and chest.

A follow-up questionnaire designed to determine the occurrence of complications after operation, particularly respiratory problems, was returned to one of the investigators. The radiographs were examined by one of us (BKW) who was unaware of the treatment group.

Details of patient's age, sex, treatment time and amount of treatment carried out were recorded for each patient.

RESULTS

Fifty children aged 4–18 yr were studied, 25 unsedated and 25 sedated with nitrous oxide. These two groups were similar as regards average age, (13 yr 2 months unsedated; 12 yr 9 months sedated). In each group there were 13 males. The amount of treatment, limited to simple fillings, was similar, being 2.52 relative value units for the unsedated and 2.60 relative value units for the sedated, as was the
treatment time—21 and 20 min respectively.

The sedated group received treatment using concentrations of nitrous oxide which varied from 20% to 65% (table I).

<table>
<thead>
<tr>
<th>Nitrous oxide (%)</th>
<th>No. of patients</th>
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<tbody>
<tr>
<td>20–24</td>
<td>4</td>
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<tr>
<td>25–29</td>
<td>7</td>
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<td>60–64</td>
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The questionnaire revealed that, in the days and weeks following treatment, there was no apparent increase in respiratory problems or general illness.

DISCUSSION

The results demonstrate that anxious children receiving dental treatment with nitrous oxide sedation and non-anxious children receiving dental treatment with local anaesthesia do not inhale propyliodone during dental treatment.

The use of propyliodone deposited on the posterior third of the tongue has been used frequently as a test of laryngeal incompetence (Tomlin, Howarth and Robinson, 1968; Wise et al., 1969; Healey, Robinson and Vickers, 1970; Taylor and Towey, 1971; Cleaton-Jones, 1976; Allen, Ricks and Jorgensen, 1977; Rubin et al., 1977). All of the above studies have been carried out on adults in whom it has been shown that 10 ml of propyliodone is needed as a single bolus to avoid false negative results (Taylor, Towey and Rappaport, 1972). Examination of these papers reveals a number of methodological differences, some authors placing a single bolus on the dorsal third of the tongue in anaesthetized patients and allowing it to trickle down into the pharynx and on into the larynx (Taylor and Towey, 1971).

In patients sedated with i.v. diazepam a single bolus of propyliodone was placed on the tongue and each patient instructed to swallow (Healy, Robinson and Vickers, 1970). Volunteers sedated with 50% nitrous oxide in oxygen had 10 ml of propyliodone deposited onto the dorsal third of the tongue as a single bolus and were instructed to swallow (Cleaton-Jones, 1976). In the study of Rubin and colleagues (1977) a total of 15 ml of propyliodone was placed on the back of the tongue over a period of 2 min and swallowed by the subjects.

It is clear from the work of Taylor, Towey and Rappaport (1972) that sufficient volume of propyliodone must be used to avoid false negative results. For adults this volume appears to be 10 ml in a single bolus. In the preliminary stages of the present study it was apparent that a single bolus of 10 ml was too large for many of our patients as swallowing was initiated when the bolus reached a critical size for each patient. For this reason the total amount of dye for each patient varied slightly as different children were obliged to swallow at differing times. All patients swallowed at least 10 ml divided into three separate aliquots, some in excess of this total volume. From a practical point of view it
is important that the volume of propylpolidone is sufficient to avoid a false negative. In the patients under study the laryngeal reflex was challenged three times in each patient with a volume of 3.3 ml or more. Whilst this volume differs from the 10 ml used in adults, it is assumed that for children a reduced volume would be needed to challenge the laryngeal reflex effectively. From our attempts to place a bolus on the dorsal third of the tongue it was clear that the response—the first stage of swallowing—limited the size of each bolus. For this reason a smaller bolus than previously reported (Taylor, Towey and Rappaport, 1972) was used. From a practical point of view the crucial factor would appear to be that the largest bolus tolerated by the patient would be a sufficient challenge to the laryngeal reflexes.

Previous work showed that the laryngeal reflex was not depressed below a critical level in student volunteers undergoing simulated dental procedures (Cleaton-Jones, 1976). This was challenged by Rubin and others (1977) because Cleaton-Jones' work was carried out at 1700 m above sea level and therefore the degree of saturation would be only 80% of that at sea level. Rubin and others (1977) showed that experimental "relative analgesia" using a fixed concentration of 50% nitrous oxide in oxygen resulted in two of 10 volunteers inhaling propylpolidone.

Whilst the use of volunteer subjects under carefully controlled conditions has an important role to play in the preliminary evaluation of techniques, and provides a useful means of carrying out a study simulating the conditions prevailing during clinical practice, such laboratory studies can never be a complete substitute for properly designed clinical studies.

The present study has extended the work of Cleaton-Jones (1976) and Rubin and others (1977) by comparing the efficacy of the laryngeal reflex in sedated and non-sedated patients receiving dental treatment.

The unique features are: the use of anxious patients undergoing dental treatment using nitrous oxide sedation with or without local analgesia; the provision of a level of sedation appropriate to the needs of each patient; the comparison of anxious patients receiving nitrous oxide sedation with non-anxious patients receiving local anaesthesia; the use of a lateral view of the larynx in an attempt to detect laryngeal soiling as distinct from bronchial soiling.

From the evidence presented we conclude that the nitrous oxide sedation (relative analgesia) did not put our patients at risk from depression of the laryngeal reflex.

ACKNOWLEDGEMENTS

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REFERENCES

On a testé l'efficacité du réflexe laryngé au cours de soins dentaires dans deux groupes d'enfants, en utilisant de la propyléodone 10 ml. Chez 25 enfants qui n'étaient pas particulièrement effrayés par les soins dentaires, il n'y avait pas d'inhalation de la substance radio-opaque dans le larynx ou le thorax. Un groupe comparable de 25 enfants anxieux, traités par une sédation au protoxyde d'azote dans l'oxygène (analgésie relative), a été examiné de la même façon. Il n'y a pas eu d'inhalation de colorant radio-opaque.