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A comparison of Entonox and Nitrous Oxide for inhalation sedation in dentistry

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SUMMARY

It has been shown that inhalation of nitrous oxide/oxygen mixtures in a concentration greater than 50 per cent may produce general anaesthesia. Inhalation sedation in dentistry, carried out by a single operator/sedationist, requires that no loss of consciousness must occur. It has been suggested, therefore, that the use of Entonox/oxygen mixtures which ensure that the inhaled nitrous oxide concentration will be less than 50 per cent, might increase safety. A single blind trial was performed on 29 subjects to determine whether a 50 per cent maximum concentration of nitrous oxide in oxygen using Entonox would satisfy a dentist's clinical requirements. Analysis of the subjective and objective responses showed that nitrous oxide in the form of Entonox satisfied the dentist's clinical requirements under these experimental conditions.

OPSOMMING

Dit is al bewys dat die inasem van distikstofoksied/suurstof mengsels in 'n konsentrasie van meer as 50 persent algemene narkose kan veroorsaak. Inhalasie sedasie in tandheelkunde wat deur 'n enkele persoon toegedien word, vereis dat daar geen verlies van bewussyn mag plaasvind nie. Dit word dus voorgestel dat die gebruik van Entonox/suurstof mengsels wat verseker dat die distikstofoksied wat ingeasem word minder as 50 persent is, groter veiligheid mag verseker. 'n Enkele blinde proefneming is op 29 persone onderneem om vas te stel of 'n 50 persent maximum konsentrasie van distikstofoksied in suurstof in die vorm van Entonox aan die kliniese benodighede van die tandarts sal voldoen. 'n Analise van die subjektiewe en objektiewe reaksies het getoon dat distikstofoksied in die vorm van Entonox aan die behoeftes van die tandarts voldoen onder hierdie eksperimentele toestande.

INTRODUCTION

Nitrous oxide sedation during dental surgery is used widely. The safety of the technique depends on the guaranteed delivery of mixtures containing at least 30 per cent of oxygen and the avoidance of levels of nitrous oxide that produce anaesthesia. An earlier study showed a high prevalence of anaesthesia at both sea-level and 1 700 m when mixtures in excess of 60 per cent nitrous oxide were inhaled (Cleaton-Jones, Moyes and Whittaker, 1979). It was suggested that Entonox, a mixture of 50 per cent nitrous oxide with oxygen, which provides guaranteed oxygen levels, and nitrous oxide concentrations not greater than 50 per cent, be used instead of nitrous oxide/oxygen. The study was undertaken to compare the clinical effects of Entonox/oxygen and nitrous oxide/oxygen mixtures.

MATERIALS AND METHODS

Twenty-nine adult subjects were studied in the trial. The subjects had all experienced the use of nitrous oxide during their regular dental treatment and had given informed consent in terms of a protocol approved by the Committee for Research on Human Subjects of the University of the Witwatersrand. All were adjudged Category 1 in the American Society of Anaesthesiologists system of classification (Jastak and Paravecchio, 1975). The study was undertaken in a conventional dental surgery, in Johannesburg, at an altitude of 1 700 m. A specialist anaesthetist was present throughout and comprehensive resuscitation equipment was available.

Standard gas cylinders of oxygen, nitrous oxide and Entonox were available in an adjacent store room. The cylinders were arranged such that either nitrous oxide or Entonox could be delivered to the patient via a nitrous oxide rotameter and oxygen via an oxygen rotameter. A conversion chart was available to compensate for the error of reading when Entonox was delivered through the nitrous oxide ratameter. The rotameter was not visible to the subjects. The drawing of lots was used randomly to assign subjects for first exposure to either Entonox or nitrous oxide, the other gas being used on the second exposure, the two occasions being separated by at least 48 h.

The subjects were settled comfortably in the supine position in a dental chair. The gases were delivered via

a loop to a Dupaco nosemask, on which the air entrainment valve was closed. The mask was placed on the subject's nose and adjusted to provide minimal leakage.

Each subject then breathed a mixture of nitrous oxide/oxygen or Entonox/oxygen which was adjusted until the subject felt the usual therapeutic level had been achieved, and then breathed this mixture for 10 min. Subjective and objective clinical observations were made. The subjects then breathed 100 per cent oxygen for 5 min. After this they were asked to assess their subjective feelings. The results were recorded on computer coding sheets.

Subjective responses were evaluated by direct questioning. A Digilog pulp tester was used to measure response to electrical stimulation. The response to vibration was gauged by the use of an amalgam burr on an existing filling. Tolerance to a turbine water spray was recorded as positive or negative. A negative was graded as poor, fair or good. Suggestion was tested by inferring that the dental turbine sounded like an aeroplane engine. If the subject did not respond positively he was asked to state what it sounded like. An answer related to dentistry was taken to mean that the subject still felt he was in the dental invironment.

A dental mirror was placed at the postero-dorsal aspect of the tongue and the gag response noted. Tongue pressure and resistance were assessed to gauge whether or not this would affect access to undertake dental procedures.

Objective determinants were assessed by the degree of relaxation of the orbicularis oris muscle. The eye expression was regarded as dreaming, vacant stare, or hard angry look. Pupil size was recorded as dilated, medium or pin-point. Response to verbal command was taken as positive if the subject carried out the command. A Cavitron scaling was undertaken to determine the degree of analgesia achieved.

Statistical evaluation was achieved by analysing the data as a cross-over experiment, testing separately for a learning effect (the difference between the responses on the first and second visits) and a treatment effect (the difference between the responses on Entonox and on nitrous oxide). For the continuous data (nitrous oxide concentrations) the test was based on the Student's t-distribution while the test on the discrete data (clinical observations) was based on the Binomial distribution. The details are available on request from the author. The critical statistical significance level chosen was $p<0,01$.

RESULTS

The ages of the 29 subjects studied ranged from 20 to 69 yr; 16 were male and 13 were female. Twenty subjects (12 male and 8 females) received nitrous oxide on their first visit and Entonox on their second, whilst 9 (4 males and 5 females) received Entonox first and subsequently nitrous oxide. Random allocation to the groups was responsible for the disparity in group size. There was no significant difference in the age analysis between the two groups. The mean nitrous oxide concentrations are shown in Table I.

TABLE I: Mean percentage nitrous oxide flow on rotameter

Group 1	Treatment 1 Nitrous Oxide	Treatment 2 Entonox
n	20	20
mean	48	43
s.d.	15	10
Group 2	**Entonox**	**Nitrous Oxide**
n	8	8
mean	41	55
s.d.	10	10

TABLE 2: Summary of clinical responses. The percentage of positive responses is listed. In group 1 n = 20 and in group 2 n = 9 except *n = 19, **n = 8. The headings used are those on the computer coding sheet

	Group 1		Group 2	
Criterion	Nitrous oxide	Entonox	Entonox	Nitrous oxide
Relaxation	100	85	100	100
Sleepy	40	40	33	56
Concern	15	25	0	11
Numb	75	45	56	56
Finger	45	50	22	56
Toe	50	50	33	44
Lips (+)	50	30	0	67**
Teeth	100*	100	100	100
Spray	85	75	100	78
Intolerance 1	15	20	0	22
Intolerance 2	30	40	11	33
Intolerance 3	55	35	89	44
Plane	40	20	44	33
Sound	65	80	56	67
Mouth 1	80	60	44	67
Mouth 2	60	65	33	56
Soft Palate	50	65	33	67
Vibration 1	30	20	33	22
Vibration 2	65	70	56	78
Orbicularis	35	50	44	44
Dreamy (++)	70	85	67	100
Vacant	5	5	22	0
Angry	15	0	0	0
Dilated	10	5	22	11
Medium	70	85	67	78
Pinpoint	20	10	11	11
Fidget	10	15	89	0
Clench	15	20	11	11
Verbal	90	95	67	67
Pain on scaling	16*	40	22	33

(+) = significant treatment effect – $p < 0,01$
(++) = significant learning effect – $p < 0,01$

TABLE III: Summary of observations after 5 minutes oxygenation. The percentage of positive responses is listed. In group 1 n = 20 except *n = 19, and in group 2 n = 9.

	Group 1		Group 2	
	Nitrous oxide	Entonox	Entonox	Nitrous oxide
Enjoyment	80	80	67	89
Recommend	95	90	89	89
Concorde	5	0	0	0
Bus	0	0	0	0
Airplane	95	85	100	78
Drill	25	10	11	22
Relaxation	89*	85	89	100
Swallow 1	16*	25	22	11
Swallow 2	25	10	22	11
Swallow 3	70	55	56	78
Fatigue	5	5	0	0

Some evidence (significance level $p < 0,05$) was found for a learning effect, indicating that patients tend to require higher concentrations on their second visit, and a highly significant ($p < 0,001$) treatment effect was found, indicating that patients on nitrous oxide require higher concentrations than those on Entonox. This may be related to differing sample sizes in the two groups.

The clinical observations are noted in Tables II and III. Of the 31 types of observations recorded, only two significant learning effects were noted, in that tingling of the lips and dreamy look were both significantly increased on the second visit.

DISCUSSION

The safety of nitrous oxide was confirmed. No subjects lost consciousness and no untoward happening occurred during the trial. No hallucinations, paranoia, or sexual phenomena were recorded which may be a reflection of the nitrous oxide concentrations being less than 50 per cent.

The lack of statictically significant differences between the nitrous oxide and Entonox groups for 28 of the 31 observations supports the contention that the chemical effect is one of nitrous oxide irrespective of the source. This supports the suggestions of Parbrook and Kennedy (1964), Cleaton-Jones et al (1979) and Jastak and Paravecchio (1975) that Entonox provides a suitable alternative to nitrous oxide.

The significant learning effect noted regarding an increased prevalence of a dreamy look at the second visit may be the result of a more relaxed attitude towards the study. The significant treatment effect concerning lip tingling is bizarre and cannot be explained.

This study has shown that Entonox provides a good substitute for nitrous oxide and gives adequate sedation conditions for dentistry. Since the oxygen content of Entonox prevents hypoxia, less elaborate equipment is required which may reduce the cost of apparatus considerably.

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