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RESEARCH ARTICLE

LEVEL OF SEDATION IN ADULTS UNDER NITROUS OXIDE FOR ORAL SURGICAL PROCEDURES

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ABSTRACT

Background and objectives: Few studies have addressed the level of sedation achieved by using nitrous oxide as a single sedation agent in adults. Our aim was to report the level of sedation reached by adult patient receiving 70% nitrous oxide for minor oral surgical procedures. We also aimed to examine differences in the level of sedation relative to the patient's age or gender and relative to the type or duration of the procedure.
Methods: A historical chart review was conducted and included the charts of 226 patients from the practice of a single oral and maxillofacial surgeon. Only the deepest level of sedation reached by the patient was recorded in addition to the patient's age and gender. Data related to the surgical procedure included the type, number of surgical sites per procedure and number of surgical procedure.
Results: There was a statistically significant gender difference with more females reaching a deeper level of sedation. There was another statistically significant difference for the type of surgical procedure as patients undergoing dental implant placement reached deeper levels of sedation.
Conclusions: When 70% nitrous oxide is administered as a single sedative agent, adult female patients reach a deeper level of sedation. Adult patients undergoing oral surgical procedures with mild stimulation also reach deeper levels of sedation compared to other types of minor oral procedures.

INTRODUCTION

Nitrous oxide (N2O) is an anesthetic gas that can achieve different levels of sedation at different concentrations. At 50% concentration or less, N2O produces minimal sedation.(1, 2) However, at concentrations more than 50%, the likelihood of moderate or deep sedation increases and the recommendations for monitoring become more stringent.(1)In addition to its anxiolytic properties, N2O also has analgesic properties and many advantages such as not requiring a fasting regimen for an extended period of time and ease of administration. It is also fast acting, immediately reversible and has a low incidence of adverse effects.(3, 4)

Many studies have addressed the safety of N2O delivered at a fixed concentration of 70% but few have addressed the level of sedation achieved at this concentration.(5)Even less are the studies that have addressed this issue of level of sedation in adult patients especially when administered for oral surgical procedures.

The current study investigates the level of sedation achieved by a fixed concentration of 70% N2O in adult patients undergoing minor oral surgical procedures. We hypothesize that patients will experience a variety of levels of sedation depending on many factors such as the patient's age and gender and the type and duration of the surgical procedure.

METHODS

After ethical approval was obtained, a historical chart review was conducted and included the charts of all adult patients seen at the outpatient clinic of a single oral and maxillofacial surgeon from January 2013 through December 2014. Patients under the age of 18 years were excluded from this study.

Any sedation procedure carried out by this oral and maxillofacial surgeon is preceded by an assessment that determines suitability for sedation. The surgeon carries out both the assessment and the sedation administration. N2O is usually administered using a dental nasal hood connected to a continuous flow meter that allows titration of N2O between 0% and 70%. The flow meter is equipped with a fail safe that terminates N2O flow if oxygen flow stops and a scavenging apparatus to minimize occupational exposure. All adult patients are instructed to present to their appointments with a minimum fasting period of four hours. During the procedure, N2O is titrated to a concentration of 70%. In addition, a local

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anesthetic is given via a regional block using 4% Articaine with 1:100,000 epinephrine. The sedation depth is recorded using the Ramsay scale for level of sedation (Table 1).(1). The score is determined by observing the patients' response to the most intense stimulus which most often corresponds to the time of local anesthetic injection, tooth luxation and/or bone removal. Oxygen saturation is monitored continuously via a pulse oximeter during the surgical procedure and for fifteen minutes after the procedure or until the patient returns to his/her baseline level of alertness. After the surgical procedure is complete, 100% oxygen is administered for five minutes. End tidal concentration of N2O was not measured because of the difficulty of accurately recording it using anasal hood.

Table 1 The Ramsay scale for level of sedation.(1)

Score	Level of sedation	
6	Inadequate	Anxious, agitated, in pain
5	Minimal	Spontaneous awake without stimulus
4	Drowsy	Eyes closed or open but easily aroused to consciousness with verbal stimulus
3	Moderate-deep	Aroused to consciousness with moderate tactile or loud verbal stimulus
2	Deep	Aroused slowly to consciousness with sustained painful stimulus
1	Deeper	Arouses but not consciousness with painful stimulus
0	Anesthesia	Unresponsive to pain stimulus

Data collected included basic demographics such as patient's age and gender in addition to the type of surgical procedure, the number of surgical sites per procedure and the number of procedures. For the purposes of this study, each patient received only one sedation score that corresponded to the deepest level of sedation reached at the most intense surgical stimulus during the procedure.

Statistical analysis was performed using SPSS 22.0 (SPSS, Chicago, IL). This included descriptive statistics to define the characteristics of the study variables in the form of counts and percentages for the categorical and nominal variables and in the form of means and standard deviations for the continuous variables. To compare two group means and more than two groups, an independent t-test and One-way ANOVA, with Least Significant Difference (LSD) as a post hoc test, were used respectively. These tests were done with the assumption of normal distribution. Otherwise, Welch's t for two group means and Games Howell for multiple group means were used as an alternative for the LSD test. A conventional *p*-value <0.05 was the criteria used to reject the null hypothesis.

RESULTS

Two hundred and twenty six patients were included in the study, most of which had only one procedure requiring N2O sedation. However, 16 patients underwent more that one N2O administration for multiple procedures at different time points. The age range was 18 years to 94 years with a mean of 40.7 years. There was no statistically significant difference in the level of sedation among the three age groups (younger than 40 years, 40-59 years, and 60 years or older). There were 141 female patients (62.4%) and 85 males (37.6%).

The different levels of sedation are presented in Table 2. The type of procedure varied from minimally stimulating procedures such as dental implant placement to more provoking procedures such as complicated dental extraction. The duration of the procedure also varied according to the number of surgical sites involved. No adverse effects were recorded for any of the cases included in this chart review. None of the patients desaturated below 94% spO2.

Table 2 Frequency of patients according to level of sedation reached

Level of sedation	Number of patients	Percentage of patients
6	11	4.9
5	29	12.8
4	47	20.8
3	75	33.2
2	63	27.9
1	1	0.4
0	0	0

A statistically significant difference in the level of sedation was found between males and females (p = 0.02) where females were found to reach a deeper level of sedation. A similar difference was found for patients undergoing dental implant placement (p = 0.04), these patients on average reached a deeper level of sedation compared to patients undergoing other types of surgical procedures. Interestingly, there was no significant difference in the level of sedation for patients undergoing lengthier procedures involving more than one surgical site, nor was there a difference for patients undergoing more than one procedure. These results are summarized in Table 3.

Table 3 Frequency of patients according to the type of oral surgical procedures, duration of the procedure and number of surgical procedures.

Variables		Level of Sedation n (%)	Min	Max	Mean (SD)	*p*-value
Type of surgical procedure						
Extraction	No	18(8.0)	2	6	3.4(1.3)	0.64
	Yes	208(92.0)	1	6	3.3(1.2)	
Exposure & bonding	No	221(97.8)	1	6	3.3(1.2)	0.59
	Yes	5(2.2)	3	5	3.6(0.9)	
Biopsy	No	222(98.2)	1	6	3.3(1.2)	0.76
	Yes	4(1.8)	3	4	3.5(0.6)	
Incision & drainage	No	217(96.0)	1	6	3.3(1.2)	0.23
	Yes	9(4.0)	2	6	3.7(1.4)	
Implant placement	No	211(93.4)	1	6	3.3(1.2)	0.04
	Yes	15(6.6)	2	6	2.7(1.2)	
TMJ injection	No	225(99.6)	1	6	3.3(1.2)	0.15
	Yes	1(0.4)	5	5	5.0(0.0)	
Number of surgical sites						
One site		142	2	6	3.2 (1.1)	0.17
Two sites		49 (21.7)	1	6	3.5(1.4)	
Three sites		12 (5.3)	2	5	3.5(1.2)	
Four sites		23 (10.2)	2	5	2.9 (0.9)	
Number of surgical procedures						
1 procedure		210 (92.9)	1	6	3.3 (1.2)	0.48
2 procedures		16 (7.1)	2	6	3.1 (1.1)	

significant using Independent *t*-test at p<0.05 level.

DISCUSSION

Dentists have used nitrous oxide for decades to achieve sedation and analgesia in their patients. Yet, there is very little in the dental literature regarding the level of sedation reached by these patients. The paucity in data is partially due to the fact that most dentists use N2O in combination with other sedation drugs and rarely as a single sedation agent.(1, 6)The reason dentists practice in this manner is because N2O must be administered via a nasal hood so that the oral cavity is unobstructed; this however results in a lower concentration of

N2O as was found by Klein *et al*. They found that the concentration of N2O in the nasal mask is approximately 31% less the flow meter setting and this concentration decreases by another 19% in the nasopharynx.(7)Hence the practice of combining sedation drugs, which in turn carries the risk of inadvertently reaching deeper levels of sedation than that intended.(8)Moreover, dentists always administer local anesthetic agents in addition to sedation drugs when performing surgical procedures. This could have affected the level of sedation in this study.

The current study presents novel findings on the level of sedation reached by adult patients undergoing minor oral procedures when 70% N2O is administered as a single sedative drug. Interestingly, a statistically significant difference was found between males and females with the females reaching a deeper level of sedation. One plausible explanation for this observation is that progesterone is believed to have anesthetic properties.(10)As such it can be assumed that the females that reached deeper levels of sedation in this study had higher levels of progesterone. Further studies are needed to investigate the correlation of sex hormones levels with the sedation levels.

Another significant difference in the level of sedation was found for patients undergoing dental implant placement. This is most likely related to the level of stimulus during the procedure, which is considered mild in dental implant placement procedures and more provoking in other procedures such as complicated dental extractions. The duration of the procedure did not have a significantly effect on the level of sedation. This finding is in accordance with other publications such as Zeir *et al*.(1)

In conclusion, N2O administered singularly achieved adequate levels of sedation in most adult patient undergoing minor oral surgical procedures. A difference was noted between male and female patients. Deeper sedation levels where achieved by females and by patients undergoing surgeries with mild stimulation. Future directions should include an observation of the level of sedation in adults when multiple sedatives are administered. It would also be interesting to relate the pre-surgical level of anxiety to the level of sedation reached during the procedure using N2O as a single agent and combined with other agents.

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