

USE OF NITROUS OXIDE RELATIVE ANALGESIA IN CHILDREN

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تستعمل عبارة التخدير للإشارة إلى زوال حس الألم، دون فقد الوعي أو حس اللمس. وقد أدخلت عبارة التخدير النسبي من قبل غوديل عام ١٩٣٧م. وقد شرح المراحل المختلفة للتخدير بالاستنشاق. المرحلة الأولى للتخدير قد قسمت إلى مرحلتين أيضا، التخدير النسبي والتخدير العام. إن حس الألم ينخفض بشكل كبير وذلك قبل فقد الوعي والنقطة التي تصل إلى فقد الوعي تعرف بالتخدير العام. وعلى الرغم من أن الأطفال في العيادات السنية متعاونين إلا أن خوفهم المنعكس على سلوكهم يشكل عتبة أمام المعالجة السنية. ولإنهاء المعالجة السنية لدى الأطفال يجب على الطفل أن يقبل المعالجة ويكون متعاوناً. وقد أظهرت الدراسات أن سوء التعامل إضافة إلى خوف الأطفال قد يؤدي إلى تجنب الأطفال للمعالجة السنية حتى بعد أن يصبحوا كباراً. لذلك فإن النجاح بالتعامل مع خوف الأطفال ليس أساسياً فقط للحصول على سلوك متعاون للتمكن من إنهاء المعالجة السنية. ولكن ضرورياً لإرساء قواعد قبول المعالجة السنية على المدى الطويل. معظم الأطفال الذين وُضِح لهم الإجراء السني قبل المعالجة تم ارتياحهم وتعاونهم باستعمال طريقة الإخبار- الإظهار- المعالجة. والأقلية من الأطفال يظلون غير متعاونين، عند هؤلاء الأطفال يجب استعمال بعض الأدوية المهدئة قبل العلاج. مثل استعمال أوكسيد الأزوت مع الأوكسجين استنشاقاً وأصبحت هذه الطريقة كثيرة الشيع حديثاً. وإن سهولة وسرعة استعمالها وسرعة استعادة الوعي دون ترك أي أثر ضار جعل هذه الطريقة شائعة الاستعمال ومناسبة لطب الأسنان.

على أي حال يجب ملاحظة واتخاذ الحيطة ضد التعرض المهني المديد لأوكسيد الأزوت إذ يسبب زيادة في حوادث الإجهاض ويقلل من النسل لدى الإناث إلا أنه لم تؤكد هذه العلاقة. إن استعمال تركيز منخفض من أوكسيد الأزوت مع تركيز مرتفع من الأوكسجين يحدث الاسترخاء ودرجة من التخدير، واستعمال التخدير النسبي لدى المرضى الذين يخافون من المعالجة السنية يجعلهم يتقبلون العلاج السني بثقة وبارتياح. وبهذا النوع من التخدير يبقى المريض صاحبياً ومتعاوناً ومنعكساته منضبطة، ويشعر بسرور. وكتيجة ترتفع عنده عتبة الألم وفي كثير من الحالات لا يحتاج إلى تخدير موضعي.

ومن فوائد التخدير النسبي للمريض:

- ١) يقلل من خوف المريض، ومن الألم.
 - ٢) يساعد المريض على الاعتماد على زيارة الطبيب بشكل منتظم مما يساعد في الحصول على معالجة سنية جيدة.
 - ٣) يجعل المريض مرتاحاً قبل وأثناء وبعد العلاج.
 - ٤) إذا احتاج المريض تخدير موضعي فإن المريض لا يلاحظ استعمال الإبرة ولا يخاف منها.
 - ٥) الأوكسجين المعطى بكمية أكبر مما يتوفر في الجو يفيد المريض.
 - ٦) وبمراقبة المريض لمدة ١٥ دقيقة إلى نصف ساعة تبين أن المريض يمكن متابعة أعماله المعتادة مباشرة.
- أما فوائد التخدير النسبي للطبيب فهي:
- ١) استرخاء المريض التام يساعد الطبيب على إنجاز المعالجة بشكل جيد.
 - ٢) يمكن إجراء المعالجة الطويلة بسهولة دون أن يشعر المريض بالتعب.

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- ٣) يقلل من تعب الطبيب لأنه يعالج مريض مسترخي وغير خائف لاسيما عند معالجة الأطفال .
- ٤) يمكن أن يتم التخدير بمدة وجيزة .
- ٥) أوكسيد الأزوت يتوافق مع جميع الأدوية مما يساعد على إعطائها بكميات قليلة .
- ٦) أوكسيد الأزوت ليس له رائحة كريهة أو محرشة .
- ٧) يمكن تطبيق التخدير الموضعي عند الحاجة دون خوف المريض .
- ٨) ثمنه رخيص .
- ٩) التخدير النسبي يشجع المريض لزيارة العيادة ويساعد على استقدام مرضى جدد .

Introduction

The term "analgesia" implies the loss of the sense of pain, without loss of consciousness or the sense of touch. The term "relative analgesia" was introduced by Cuedel (1937)¹ in relation to ether. He described the different stages (Table 1) of inhalation anaesthesia. The first stage "analgesia" was subdivided into two sub-stages, "relative analgesia" and "total analgesia". Pain sense is depressed progressively and is abolished just before consciousness is lost. The point of pain abolition is known as "total analgesia" and the approach to this as relative analgesia (Table 2).^{1,2}

Although children in the surgery generally are co-operative, their fear-related behaviors have been acknowledged widely as an obstacle to dental treatment.^{3,4} To complete treatment, children must co-operate, or at least passively accept treatment. Studies have shown that the inappropriate management of the fears of children may lead to long-term avoidance of dental care when the children become adults.^{5,6,7} Therefore, successful management of a child's fear is not only essential for co operative behavior and the completion of dental procedures, but is also important for laying the foundation for acceptance of dentistry.

The majority of children introduced to dentistry become relaxed and co-operative by the use of methods like Tell-Show-Do, Reinforcement, Desensitization and Modelling. A minority still remains unco-operative. If fear persists despite carefully conducted introductory appointments, some form of pre-medication could be used. Sedation by inhalation of nitrous oxide and oxygen is becoming increasingly popular in recent years, pioneered principally by Langa.⁸ The ease and rapidity of induction and quick recovery with no after-effects and the flexibility of controls have

rendered nitrous oxide/oxygen analgesia particularly suitable for dentistry. However, one must recognize and guard against the high level occupational exposure to nitrous oxide which has been reported as associated with increased rate of spontaneous abortions and reduced fertility in females.^{9,10} Although a definite cause and effect relationship has not been confirmed,¹¹ yet adequate scavenging measures should be instituted to prevent any possible harmful effects.^{10,11,12}

Definitfon

The term "relative analgesia" refers to the use of low concentrations of nitrous oxide with high concentrations of oxygen to produce sedation and a degree of analgesia. By using relative analgesia patient's fear and anxiety is replaced by a feeling of well-being and confidence – a state of euphoria. The patient remains conscious and co-operative, with the protective reflexes fully maintained. He also experiences a pleasant, floating, detached sensation. As a result, the pain threshold is raised and in many cases no local anesthetic may be necessary, but can be given readily when required, usually without any realization from the patient.

Signs and Symptoms of Relative Analgesia

A patient under relative analgesia is conscious and his facial expressions are those of a conscious person. The patient may report a mild sensation of drowsiness, detachment from his immediate environments or of euphoria. These sensations are generally regarded as pleasant. The pupils are normal and they contract normally to light. Eyelids become heavy and wink slowly when touched. Facial muscles are relaxed and face may become expressionless. Respiration is normal. Muscles are relaxed. The pulse rate, blood pressure and colour of the skin are normal. A patient may feel a tingling

Table 1. Guedel's classical stages of anaesthesia.

Stage I	Analgesia
Stage II	Excitement
Stage III	Surgical anaesthesia
Stage IV	Respiratory paralysis

Table 2. Various classifications of analgesia.

GUEDEL	LANGA	ROBERT
	PLANE I	Moderate sedation and analgesia
Relative analgesia	PLANE II	Dissociation sedation and analgesia
Total Analgesia	PLANE III	Total Analgesia

sensation in the finger tips, toes or tip of the tongue as well as tingling and numb sensations at the lips. All these symptoms indicate that the patient is under light analgesia. All these symptoms are not always present at each administration and a patient may go into a deeper stage without clearly distinguishing them, so it is advisable to commence treatment on the patient. Since we are working on a conscious patient, his verbal or physical reactions will indicate the degree of sedation. At this stage of relative analgesia the patient's threshold to cold, warmth and light touch is also raised.⁸

At a higher level of analgesia the sensations of drowsiness, detachment and euphoria become more marked. The patient has a feeling of lethargy. Very often he experiences a humming, droning or vibratory sensation throughout his body. At this stage the patient may describe a feeling of drowsiness. His voice becomes throaty and loses its natural resonance. The patient under analgesia knows that something is going on around and about him but he is unconcerned with what is taking place. He experiences a feeling of relaxation, of well-being, of safety and euphoria. He feels warm and comfortable. Sound is distinct but distant. A sudden loud noise may bring him out of his pleasant, euphoric state. His arms and legs may feel very heavy if he attempts to lift them. Conversely, he may feel very light or floating. He may engage himself in philosophical thoughts and attempts to solve some of the world's problems.^{8,13,14,15}

Benefits to the Patient

1. Relative analgesia reduces fear, anxiety, apprehension, discomfort and pain to a degree. A state of euphoria can be experienced.
2. It helps to develop the habit of early and regular visits resulting in better dental health.
3. Fatigue is reduced and the patient is more relaxed before, during and after the appointment.
4. If local anaesthesia is required it is rarely noticed by the patient.
5. The higher than atmospheric oxygen concentration is beneficial to the patient.
6. After an observation period of about fifteen minutes to half an hour at the conclusion of the procedure, most of the patients are able to resume normal activity.

Benefits to the Dentist

1. The relaxation and increased co-operation from the patient assist directly in all procedures.
2. Long dental procedures can be carried out unhurriedly without risk of the patient's discomfort or fatigue.
3. The dentist experiences less fatigue because he is treating relaxed patients. This benefit is particularly important while treating children.
4. The required sedation level can be produced in a very short time.
5. Nitrous oxide is compatible with all other drugs and usually allows reduced dosages.
6. Nitrous oxide has no unpleasant odor or irritation.
7. Local anaesthesia, if required, can be administered with the patient being only vaguely aware of the procedure.
8. Running costs are very low.
9. Relative analgesia is a good practice-builder due to the patient making earlier and more frequent visits and preparing others to become new patients.

Indications

The indications of relative analgesia include apprehension related to previous negative experience of a medical or dental treatment, fear of needles, contraindication to local analgesia (bleeding disorders), pronounced gag reflex and

treatment requiring sedation such as prolonged surgical procedures. Relative analgesia eliminates the fear, anxiety and apprehension associated with dental procedures. When the fear is eliminated and the child is relaxed, a high proportion of pain involved in dental procedures is eliminated. Very young or mentally handicapped children present special problems but sedation can sometimes be successful if their attention and interest can be gained.¹⁶⁻¹⁹

Contraindications of Relative Analgesia

There is no absolute contraindication to the use of nitrous oxide relative analgesia when adequate oxygenation is assured. There is, in fact, no situation where the proper use of these gases can cause death. However, as a dentist usually does not treat matters of life and death, it is wise to dispense with the use of analgesia under certain circumstances.

1. Cardiac Conditions

Patients suffering from cardiac diseases are usually hypertensed and nervous. They are not the type of individuals who look forward to dental treatment. Making such a person more tense and apprehensive is contraindicated. Thus, the use of analgesia solves this problem. Still, it is wise to discuss the case with the patient's physician and divide the responsibility.^{8,13,20}

2. Pregnancy

Analgesia is often used during labour with no harm to the mother and child. However, since all but the most urgent work can be deferred when necessary, it should be used with a physician's permission.^{9,21,22,23}

3. Common Colds

Poor and ineffective analgesia results from inability to breathe easily through the nose. There is also a possibility of nasal or pharyngeal infection being pushed deeper into the respiratory system due to gases from the machines using greater pressure than atmospheric pressure. So under these conditions use of analgesia is contraindicated.^{8,9,13,20,21}

4. Tuberculosis

The use of any inhalation agent for the performance of dentistry is contraindicated in tuberculosis and pulmonary diseases as the respiratory system is already under stress.^{8,9,20,21}

5. Acute Fear of Losing Consciousness

The use of analgesia should be explained and suggested but never forced in case patients are deathly afraid of losing any degree of consciousness.^{12,20,21}

6. Epilepsy and Seizure Disorders

The use of analgesia in a dental office is relatively contraindicated in such conditions due to the possibility of epileptic seizure with all its side reactions. The person with a history of chronic seizure activity is more sensitive to hypoxia than a normal healthy patient. Seizure activity may be precipitated more easily due to hypoxia. Nitrous oxide is not an epileptogenic agent and therefore may be used in these patients as long as hypoxia is avoided. It can easily be achieved with the sedation machines and technique of administration available today. Use of nitrous oxide sedation reduces the stress and anxiety, which in turn reduces the possibility of epileptic seizure because the patient is more relaxed.^{20,21,22} Normally, every epileptic child is encouraged to take his/her prescribed drugs regularly and particularly before a dental appointment.

7. Patients under Psychiatric Treatment

Sensations under analgesia may disturb the emotional poise of subjects under these conditions. Psychiatrists must be consulted before administering analgesia to patients undergoing psychiatric treatment.^{21,22}

8. Extreme Fear

Patients having an extreme uncontrollable fear of dentists, dentistry and analgesia, and who do not allow the dentist to introduce it, should never be forced to take analgesia.^{20,21}

Clinical Application of Relative Analgesia

Technical skill alone is of little value to the dentist working on a child unless the child co-operates during the treatment. Patients of all ages, however,

show withdrawal, anticipatory tension and avoidance even in the absence of pain. When the pain is superimposed, it is impossible for the patient to allow the dentist to perform his best work. Local anaesthesia is the common technical aid to produce reasonable working conditions but it is difficult to administer local anaesthesia in a nervous, fearful patient especially the one with needle phobia. Relative analgesia produces a rapid and profound relaxation. Moreover it is a highly suggestive state and suggestions by the dentist are easily accepted by the patient. Combined with a degree of analgesia, working conditions are improved remarkably. There is no aspect of clinical dentistry which can not be enhanced by the use of relative analgesia.^{21,24,25}

Nitrous Oxide Dosage in Relative Analgesia

The technique of relative analgesia consists of two components: nitrous oxide and oxygen, and semi-hypnotic suggestions. It is thus, essentially, an interpersonal method. A feedback channel is established between the operator and the patient to ensure that the patient is taken only to that depth of sedation which is psychologically acceptable at that time.^{22,26} Nishibori *et al* (1979)²⁷ presented an analysis of 985 patients seen over a period of four years. The dosage of nitrous oxide required ranged from 10-60 percent. The majority of patients received no more than 30 percent nitrous oxide; all age groups had a number requiring higher proportions, especially children under 10 years of age. Allen (1984),² in his study of 400 patients of all age groups requiring relative analgesia, has presented an excellent analysis of dosages of nitrous oxide analgesia. Requirements varied from 15–70 percent with 75 percent of the patients needing no more than 30 percent. He also found that 41.7 percent of the emotionally handicapped patients (those who found it difficult or impossible to accept dental treatment) required nitrous oxide dosages higher than 30 percent, the highest proportion of any group. The second highest were the children under the age of 10. Some 36.5 percent of this group required more than 30 percent nitrous oxide compared with 22.6 percent of the older age group.

The relationship between the systemically administered dose of a drug and the desired effect

has always been a complex one. When the drug is introduced by the inhalation route using a nosepiece and the operation is taking place in the mouth several additional factors are introduced. Allen (1984)² has divided these factors into three categories i.e. mechanical, physiological and neurological factors.

Mechanical Factors

In relative analgesia, gases are delivered by a somewhat loosely fitting nosepiece with zero tension on the expiratory valve, while the mouth is held wide open when dental procedures proceed. Considerable quantities of nitrous oxide can escape from the periphery of the nosepiece or expiratory valve without reaching the patient's airway. In children, variable amounts of dilution may occur due to their inadequate nasal airways. Flow of gases is matched with the tidal volume of the patient and the expiratory valve is set at zero tension. There is no possibility of blowing the lation anaesthesia machines. Thus, from a purely mechanical aspect, there is considerable interpatient variability in the quantity of nitrous oxide inhaled.

Physiological Factors

The adequacy of the nasal airway is reduced when the mouth is wide open, especially in children. The presence of adenoidal tissue in young patients adds to the difficulty as it further reduces the already small airway present in this age group. Many children continue with the habit of mouth-breathing even after the removal of tonsils and adenoids. In these cases nitrous oxide in higher proportions must be used occasionally to compensate for the inevitable air dilution. Basic metabolic rate is higher in children. It varies a lot at different ages up to early teenage. It probably explains the wide variation in dosage for the younger age groups. Poor physical health reduces the dosages of nitrous oxide. There are a number of other physiological factors which influence the gaseous exchange in the lungs. These factors include adequacy of lung function, pattern of breathing (rapid, shallow breathing is inefficient), the varying diffusion/pervasion rates existing in different areas of the lungs at different times and

varying degrees of adequacy of the central respiratory drive. Because of all these factors even identical, partial pressures of nitrous oxide entering the lungs will not necessarily produce the same nitrous oxide level in the blood stream.

Neurological Factors

Individual response to all drugs covers a wide range of variations. The administration of sedatives by the intravenous route points towards this fact quite clearly. It is an everyday observation that response to the same quantity of alcohol differs very widely from individual to individual. Nitrous oxide is not different from other drugs in this respect. The maturing state of the central nervous systems of children is one reason why younger patients require higher dosages of nitrous oxide. Accumulated stress within the individual may increase the dosage in some cases. The habitual use of alcohol not only produces the tolerance to alcohol itself but also to other CNS depressants. Therefore, the dosage of nitrous oxide required to produce sedative analgesia will be high in people consuming alcohol regularly. In mentally-handicapped patients the influence of site and degree of neurological damage on the dosage of nitrous oxide is not yet clear. In general, it seems that the more severe the handicap the greater the dosage of nitrous oxide is required.

Summary

Inappropriate management of the fears of children may lead to long term avoidance of dental care from childhood even up to adult life. Therefore successful management of child's fears is essential for cooperative behavior and the completion of dental treatment as well as for the laying of the foundation for acceptance of dental treatment by the child for life. This article reviews the role of nitrous oxide analgesia in the minority of children who are fearful that they need to be managed by sedation instead of the more common methods of tell show and do, reinforcement and modelling.

The indications, contraindications and benefits of nitrous oxide analgesia are discussed. The clinical application of relative analgesia including the factors that may influence the dosage both in

children and adults as well as signs, and symptoms are fully catalogued. The ease and rapidity of induction as well as quick recovery, with no after-effects have proved and will continue to recommend nitrous oxide/oxygen analgesia as a suitable and successful behavioral guidance for fearful children in dentistry.

References

1. Guedel AE, Inhalation anaesthesia, New York: MacMillan Co, 1937:15.
2. Allen WA. Nitrous oxide dosage in relative analgesia. *Br Dent J* 1984;156:9-15.
3. Levitas TC. Home: hand over mouth exercise. *J Dent Child* 1974;39:178-82.
4. Weinstein P. Difficult children: the practical experience of 145 private practitioners. *Pediatr Dent* 1981;3:303-5.
5. Berggren U, Meynert G. Dental fear and avoidance: causes, symptoms and consequences. *J Am Dent Assoc* 1984;109:247-51.
6. Lutch H. Dental phobia. *Br J Psych* 1971;119:151-58.
7. Molin C, Seeman K. Disproportionate dental anxiety: clinical and nosological considerations. *Acta Odontol Scand* 1979;28:197-212.
8. Langa H. Relative analgesia in dental practice: inhalation analgesia with nitrous oxide. Philadelphia: FA Davis Co, 1976:135-231.
9. Cohen EN, Byron WB, Marion LW. Occupational disease in dentistry and chronic exposure to trace anaesthetic gases. *J Am Dent Assoc* 1980;101:21-3.
10. Rowland AS, Baird DD. Reduced fertility among women employed as dental assistants exposed to high levels of nitrous oxide. *N Engl J Med* 1992;327:993-7.
11. Federation Dentaire Internationale. Dental anesthetic gases-hazards and hygiene. Technical Report No. 21. *Int Dent J* 1985;35:173-4.
12. Allen WA. Nitrous oxide in the surgery: pollution and scavenging. *Br Dent J* 1985;157:222-30.
13. Bennett CR. Conscious sedation in dental practice. 2nd ed. St. Louis; CV Mosby Co, 1978:67-81.
14. Barber J. The relationship between nitrous oxide conscious sedation and the hypnotic state. *J Am Dent Assoc* 1979;99:624-6.
15. Rosenberg HM. Behaviour modification for child dental patient. *J Dent Child* 1974;41 111-4.
16. Berger DE, Allen CD, Everett GB. An assessment of the analgesic effects of nitrous oxide on the primary dentition. *J Dent Child* 1972;39:265-8.
17. Hallonsten AL. Nitrous oxide scavenging in dental surgery. I. A comparison of the efficiency of different scavenging devices. *Swed Dent J* 1982;6:203-13.
18. Major E, Winder M, Brook AH, Berman DS. An evaluation of nitrous oxide in the dental treatment of anxious children. *Br Dent J* 1981 ;151:186-8.
19. Roberts GJ. Relative analgesia in clinical practice. In: Coplans MP, Green RA, eds. Anaesthesia and sedation in dentistry. Amsterdam:Elsevier, 1983:Chapter 10.

20. Malamed SF. Inhalation sedation in sedation: a guide to patient management. 2nd ed, Toronto: CV Mosby, 1989:21-37.
21. Allen KR. Personal communication. Department of Pediatric Dentistry, Faculty of Dentistry, University of Adelaide, Feb 1990.
22. Allen WA. Relative analgesia. *Dent Pract* 1976,14:7,8,10,12-14.
23. Roberts GJ, Gibson A, Porter J, Dezoysa S. Relative analgesia: an evaluation of the efficacy and safety, *Br Dent J* 1979;146:177-82.
24. Allen GD. *Dental anaesthesia and analgesia*. 3rd ed. Baltimore: William & Wilkins Co, 1979:254-66.
25. Andlaw RJ, Rock WP. *A manual of paedodontics*. 2nd ed. UK: Churchill Livingstone, 1987:20-4.
26. Baum JJ, Tekavee MM. Maintained hypalgesic state (operative phase). *Anesth Prog* 1970;17:133-38.
27. Nishibori M, Suzuki N, Amemiya Y, Nakachi S. Clinical experience in inhalation sedation with nitrous oxide and oxygen in a dental office. *Proceedings of the second International Congress on Modern Pain Control*. London:SAAD, 1979:147-54.