

Comparison of the Effectiveness of 30% And 40% Nitrous Oxide Oxygen Inhalation Sedation in Children Aged 6-12 Years on Pain and Anxiety during Inferior Alveolar Nerve Block

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Abstract: *Background:* Pain and anxiety during dental procedures, especially inferior alveolar nerve block, are major challenges in pediatric dentistry, and nitrous oxide-oxygen inhalation sedation is commonly used to manage patient cooperation. This study aimed to compare the effectiveness of 30% and 40% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block. *Materials and Methods:* Thirty children were divided into three groups: control, 30% N₂O, and 40% N₂O. Pain and anxiety were assessed using Face, Legs, Activity, Cry and Consolability (FLACC) scale and Facial Image Scales (FIS). *Results:* Both 30% and 40% nitrous oxide-oxygen sedation significantly reduced pain and anxiety during inferior alveolar nerve block in children aged 6-12 years. FLACC and FIS scores improved markedly compared to control ($p < 0.001$). No significant difference was observed between the 30% and 40% groups in behavioural scores, though the 30% group showed a slightly higher pulse rate ($p = 0.046$). SpO₂ remained stable in all groups. *Conclusion:* Both 30% and 40% nitrous oxide concentrations are effective and safe for reducing pain and anxiety during dental procedures in children. Given similar outcomes, 30% may be preferred as a lower yet effective concentration for clinical use.

Keywords: Inhalation Sedation, Nitrous Oxide, Nitrous Oxide Inhalation Sedation, Oxygen, Rapid Analgesia.

INTRODUCTION

Nitrous oxide (N₂O) is a widely used sedative in pediatric dentistry due to its analgesic and anxiolytic effects. It provides rapid onset, quick recovery, and maintains protective reflexes, making it ideal for conscious sedation. Recognized by the American Academy of Pediatric Dentistry, nitrous oxide-oxygen inhalation helps manage anxiety and pain, especially during procedures like the inferior alveolar nerve block (IANB). This study evaluates the effectiveness of 30% and 40% nitrous oxide in reducing anxiety and pain during IANB in children aged 6-12 years.¹ Dental anxiety is common in children, affecting 5% to 24%. It can lead to fear, avoidance of care, and poor cooperation. Factors such as unfamiliar environments, strange sounds, and especially the fear of injections like IANB contribute to this anxiety. Around 12% of children report inadequate local anaesthesia, highlighting the need for sedation techniques that improve patient comfort.² Pain is a major factor in dental fear and one of the main reasons children seek treatment. It can result from trauma, caries, or pulpal involvement. Inadequately managed pain and anxiety can negatively affect treatment outcomes and

future dental behavior.³ Nitrous oxide sedation helps manage these challenges by reducing pain perception and easing anxiety, thus supporting more effective and comfortable dental care.⁴

MATERIALS AND METHODS

The Study was conducted to compare the effectiveness of 30% and 40% nitrous oxide oxygen inhalation sedation. The present randomized clinical trial was conducted on 30 patients according to the inclusion criteria : Children requiring inferior alveolar nerve block (IANB) local anaesthesia during Nitrous Oxide Oxygen Inhalation Sedation, Parents who are willing to give written consent, Frankl behaviour rating 3 And 4 and exclusion criteria: Children with a history of allergy to lignocaine in local anaesthesia, Medically compromised children, Frankl behaviour rating 1 And 2 and Parents not willing to give consent. Samples were divided into 3 groups: Group I (Control group) – No nitrous oxide oxygen inhalation sedation was delivered, Group II - 30% nitrous oxide oxygen inhalation sedation was delivered, Group III - 40% nitrous oxide oxygen inhalation sedation was delivered.

Procedure

The baseline data for all groups for facial image scale, pulse rate and oxygen saturation will be recorded for the selected patients. In Group 1, Inferior alveolar nerve block (IANB) will be administered FLACC scale, FIS scale; pulse rate and oxygen saturation will be measured. For Group 2 and 3, slow induction technique for the administration of nitrous oxide oxygen inhalation sedation will be used after determining the flow rate, the nitrous oxide oxygen inhalation sedation concentration will be increased in increments of 10% every 3 minutes until 30% and 40% concentration respectively is achieved at which sedation is expected to be obtained. Inferior alveolar nerve block (IANB) will be administered at this point by the operator using the standard protocol. During the administration of IANB, FLACC scale, FIS scale, pulse rate and oxygen saturation will be measured.

After the procedure, the nitrous oxide inhalation sedation flow will be tapered by reducing 5–10% nitrous oxide inhalation sedation every 3 minutes, and 100% oxygen was given for 3-5 minutes. The physiological parameters of the subject were monitored at all times

Statistical Analysis

The data for the present study was entered in the Microsoft Excel 2010 and analysed using the SPSS statistical software 27.0 Version. The descriptive statistics included frequency and percentage. The level of the significance for the present study was fixed at 5%. The intergroup comparison of the quantitative data was done by One Way ANOVA test and qualitative data was done by Chi-Square test. Data level of significance will be ≤ 0.05

RESULTS

Both 30% and 40% nitrous oxide–oxygen inhalation sedation were effective in reducing pain and anxiety during inferior alveolar nerve block in children aged 6–12 years. **Table 1** show that in the 30% nitrous oxide group, most children were female (80%) with minimal pain (FLACC 0–1) and low anxiety (FIS 1–2); mean pulse rate was 91.10 bpm and SpO₂ 98.10%. **Table 2** show similar findings in the 40% group, with 60% females, FLACC 0–1 in all, FIS 1–2 in all, mean pulse rate 86.70 bpm, and SpO₂ 98.10%. **Graphs 1–2** demonstrate that both 30% and 40% groups had significantly lower FLACC and FIS scores than control ($p < 0.05$). **Graph 3** show a significantly higher pulse rate in the 30% group compared to control and 40% ($p = 0.025$), while SpO₂ remained stable. **Table 3** confirms significant pulse rate differences between control and 30% ($p = 0.046$) and between 30% and 40% ($p = 0.046$), with no difference in SpO₂. **Table 4** shows no significant difference in FLACC and FIS scores between 30% and 40% groups ($p > 0.05$). **Table 5** reveal a significant difference in pulse rate between the two sedation groups ($p = 0.029$), while SpO₂ values were unchanged.

Table 1: Effectiveness of 30% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block. (n-frequency, %-percentage)

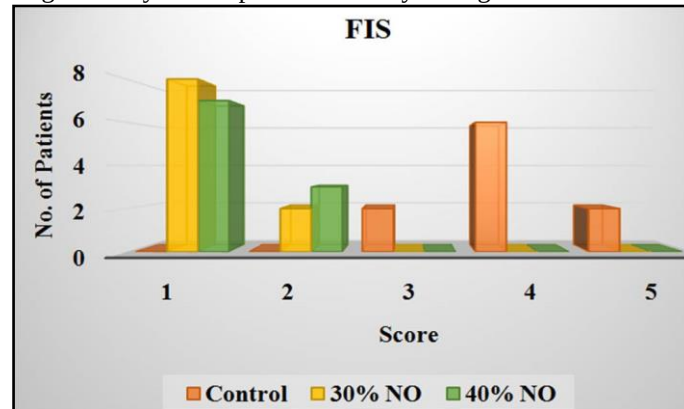
Gender	Frequency(n)	Percent (%)
Female	8	80.0
Male	2	20.0
FLACC SCORE		
0	6	60.0
1	4	40.0
FIS Score		
1	8	80.0
2	2	20.0
Variable	Mean	SD
Pulse Rate	91.10	4.841
SPO₂	98.10	0.568

Table 2: Effectiveness of 40% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block. (n-frequency, % percentage)

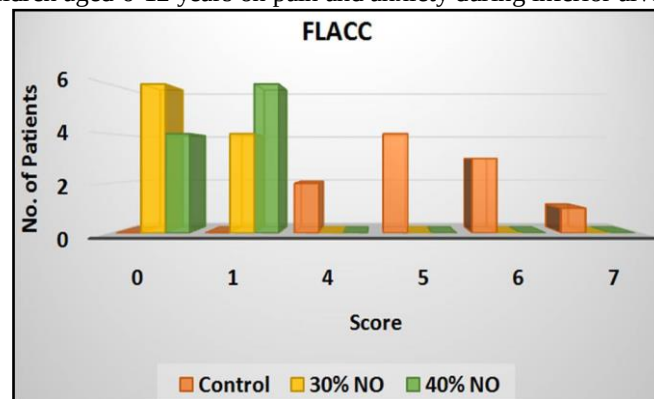
Gender	Frequency(n)	Percent(%)
Female	6	60.0
Male	4	40.0
FLACC Score		
0	4	40.0
1	6	60.0
FIS Score		
1	7	70.0
2	3	30.0

Variable	Mean	SD
Pulse Rate	86.7	3.335
SPO2	98.10	0.568

Graph 1: Comparative evaluation of FIS Score effectiveness of 30% and 40% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block



Graph 2: Comparative evaluation of FLACC Score effectiveness of 30% and 40% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block



Graph 3: Comparative evaluation of pulse rate and SPO2 among children aged 6-12 years having pain and anxiety during inferior alveolar nerve block using control group, 30% and 40% nitrous oxide oxygen inhalation sedation in children



Table 3: Intergroup Comparison and evaluation of pulse rate and SPO2 among children aged 6-12 years having pain and anxiety during inferior alveolar nerve block using control group, 30% and 40% nitrous oxide oxygen inhalation sedation in children. ($p < 0.05$ – Significant, CI = 95 %)

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	p-value
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Pulse Rate	Control	30% NO	-4.4	0.046,S
		40% NO	0.00	1.000,NS
	30% NO	40% NO	4.4	0.046,S
SPO ₂	Control	30% NO	-0.5	0.183,NS
		40% NO	-0.5	0.183,NS
	30% NO	40% NO	0.00	0.183,NS

Table 4: FLACC and FIS Scale evaluation of effectiveness of 30% and 40% nitrous oxide oxygen inhalation sedation in children aged 6-12 years on pain and anxiety during inferior alveolar nerve block. ($p \leq 0.05$ – Significant, CI = 95 %)

Variable	Score	30% NO	40% NO	Chi-square value	p-value, S/NS
FIS Scale	1	8 (40%)	7 (35%)	0.267	0.606,NS
	2	2 (10%)	3 (15%)		
FLACC	0	6 (30%)	4 (20%)	0.800	0.371,NS
	1	4 (20%)	6 (30%)		

Table 5: Comparison and evaluation of pulse rate and SPO₂ among children aged 6-12 years having pain and anxiety during inferior alveolar nerve block using 30% and 40% nitrous oxide oxygen inhalation sedation in children. ($p \leq 0.05$ – Significant, CI = 95 %)

Variable	Group	Mean	Std. Deviation	F- value	p-value, S/NS
Pulse Rate	30% NO	91.1	4.848	5.603	0.029,S
	40% NO	86.7	3.335		
SPO ₂	30% NO	98.1	0.567	0.000	1.000,NS
	40% NO	98.1	0.567		

DISCUSSION

Effective pain and anxiety management is fundamental to pediatric dental care, particularly during invasive procedures like the inferior alveolar nerve block (IANB). The anticipation of pain often triggers significant anxiety in children, which can lead to disruptive behaviour, hinder treatment, and contribute to the development of long-term dental fear. Inhalation sedation using nitrous oxide-oxygen (N₂O-O₂) mixtures has emerged as a reliable and minimally invasive method to mitigate these concerns, offering both analgesic and anxiolytic benefits. Nitrous oxide, commonly known as laughing gas, has a long-standing history of use in dentistry due to its ease of administration, rapid onset, and favourable safety profile. The gas works by modulating neurotransmitter systems, including enhancing gamma-aminobutyric acid (GABA) activity and antagonizing N-methyl-D-aspartate (NMDA) receptors, which results in reduced neural transmission of pain and anxiety signals. Its minimal impact on cardiovascular and respiratory functions, along with its quick elimination through exhalation, makes it especially suitable for use in children. The present study evaluated and compared the effectiveness of 30% and 40% concentrations of nitrous oxide-oxygen inhalation sedation in managing pain and anxiety during IANB in children aged 6 to 12 years. Behavioural pain and anxiety were measured using FLACC and Facial Image Scale (FIS), while physiological parameters like pulse rate and oxygen saturation (SpO₂) were monitored to assess sedation safety. Both 30% and 40% N₂O-O₂ groups demonstrated significantly lower FLACC and FIS scores compared to

the control group ($p < 0.001$), indicating effective reduction in procedural pain and anxiety. Notably, 60% of children in the 30% group and 40% in the 40% group scored 0 on FLACC, suggesting no signs of observable pain. Similarly, 80% of children in the 30% group and 70% in the 40% group selected the happiest face on FIS, indicating minimal anxiety. These findings are consistent with previous literature Nitrous oxide-oxygen inhalation sedation is an effective method for managing pediatric dental patients. Studies have shown that 30-40% nitrous oxide concentrations can significantly improve patient behaviour and cooperation during dental procedures (Samir et al., 2017; Primosch et al., 1999)^{5,6}. A 40% nitrous oxide concentration was found to reduce adverse behaviour, respiratory rate, and pulse rate without affecting oxygen saturation (Primosch et al., 1999). Combining nitrous oxide with intravenous midazolam resulted in reduced midazolam dosage, improved patient recovery, and better cooperation (Venchard et al., 2006)⁷. While higher concentrations (60-70%) of nitrous oxide showed increased sedation and cooperation, they also presented potential adverse effects (Devi & Jeevanandan, 2023)⁸. The 60% concentration was found to be more effective than 50% in achieving satisfactory cooperation without adverse effects. However, caution is advised when using 70% concentration for extended periods due to observed adverse effects (Devi & Jeevanandan, 2023) NOIS is safe and effective for dental treatment in Thai children, with minimal adverse events, particularly pronounced in children with prior NOIS experience and those who are non-anxious.(Poonyarit P,2025)⁹. Nitrous oxide/oxygen inhalation sedation at

concentrations between 20-50% is a safe and effective technique for managing child behaviour in paediatric dentistry. (Ana Catarina Barbosa, 2014)¹⁰. The study concluded that rapid induction using a pre-adjusted mix of 30% nitrous oxide and 70% oxygen was effective and safe, with no hypoxia observed, and significantly reduced the time to achieve ideal sedation compared to slow induction. (P. Samir, 2017) The study concluded that nitrous oxide-oxygen inhalation sedation significantly reduces pain reaction during inferior alveolar block administration in children aged 7-10 years. (Dr. Asiya Basheer 2022)¹¹. When directly comparing 30% and 40% concentrations, no statistically significant difference was observed in FIS and FLACC scores ($p > 0.05$). This supports existing guidelines by the American Academy of Pediatric Dentistry (AAPD), which emphasize starting with the lowest effective dose and titrating upward only when necessary.¹² Pulse rate differed significantly between the groups. The 30% group recorded a higher mean pulse rate (91.10 bpm) compared to the 40% group (86.7 bpm), and the difference was statistically significant ($p = 0.029$). This may suggest a marginally deeper sedation level achieved in the 40% group. However, both values remained within normal clinical limits. SpO₂ remained consistent (98.10%) in both groups, indicating that nitrous oxide did not compromise respiratory function. These results are in agreement with the study by Kanagasundaram et al. (2001), who reported stable cardiorespiratory parameters during nitrous oxide sedation in children.¹³ Despite the positive outcomes, this study has limitations. The sample size was relatively small, which may affect the generalizability of the result. In summary, both 30% and 40% nitrous oxide-oxygen inhalation sedation are effective and safe for managing pain and anxiety in pediatric patients undergoing IANB. Given its equal efficacy and potentially lower side effect profile, 30% N₂O should be considered the preferred choice for routine procedures. These findings support the integration of minimal sedation into pediatric dental protocols to enhance patient comfort, improve cooperation, and promote positive dental experiences.

CONCLUSION

This study demonstrates that both 30% and 40% nitrous oxide-oxygen inhalation sedation are effective and safe in managing pain and anxiety during inferior alveolar nerve block procedures in children, with 30% proving equally effective and potentially safer, supporting its use as the preferred concentration in routine pediatric dental practice.

REFERENCES

1. Esmaeili H, Malekzadeh M, Esmaeili D, Nikeghbal F. Dental anxiety and the effectiveness of local anaesthesia. *Braz J Oral Sci* 2020; 19:e208127-.
2. Alzahrani F, Duggal MS, Munyombwe T, Tahmassebi JF. Anaesthetic efficacy of 4% articaine and 2% lidocaine for extraction and pulpotomy of mandibular primary molars: an equivalence parallel

- prospectively randomized controlled trial. *International Journal of Paediatric Dentistry*. 2018 May;28(3):335-44.
3. Klingberg G, Ridell K, Brogårdh-Roth S, Vall M, Berlin H. Local analgesia in paediatric dentistry: a systematic review of techniques and pharmacologic agents. *Eur Arch Paediatr Dent*. 2017 :323-9.
4. Takkar D, Rao A, Shenoy R, Rao A, Suprabha BS. Evaluation of nitrous oxide inhalation sedation during inferior alveolar block administration in children aged 7-10 years: A randomized control trial. *J Indian Soc Pedod Prev Dent*. 2015 ;33(3):239-44.
5. Samir PV, Namineni S, Sarada P. Assessment of hypoxia, sedation level, and adverse events occurring during inhalation sedation using preadjusted mix of 30% nitrous oxide + 70% oxygen. *J Indian Soc Pedod Prev Dent*. 2017 Oct-Dec;35(4):338-345.
6. Primosch RE, Buzzi IM, Jerrell G. Effect of nitrous oxide-oxygen inhalation with scavenging on behavioural and physiological parameters during routine pediatric dental treatment. *Pediatr Dent*. 1999 Nov-Dec;21(7):417-20.
7. Venchard GR, Thomson PJ, Boys R. Improved sedation for oral surgery by combining nitrous oxide and intravenous Midazolam: a randomized, controlled trial. *Int J Oral Maxillofac Surg*. 2006 Jun;35(6):522-7.
8. Devi MN, Jeevanandan G. Efficacy and Safety of Nitrous Oxide Inhalation Sedation in Paediatric Dental Patients: A Comparison of Different Concentrations *J Clin of Diagn Res*. 2023; 17(12):ZC13-ZC17.
9. Poonyarit P, Chaipattanawan N, Manmontri C, Chompu-Inwai P, Nirunsittirat A, Phinyo P. Effectiveness and predictive factors of nitrous oxide and oxygen inhalation sedation for paediatric dental procedures: a retrospective cohort study of Thai children. *Eur Arch Paediatr Dent*. 2025 Aug;26(4):695-708.
10. Barbosa AC, Mourão J, Milagre V, Andrade DC, Areias C. Inhalation conscious sedation with nitrous oxide/oxygen in pediatric dentistry. *Medical Express*. 2014 Jun;1(3):102-4.
11. Basheer A, Maroofa, Mansha. Evaluation of nitrous oxide inhalation sedation during inferior alveolar block administration in children aged 7-10 years. *International Journal of Applied Dental Sciences*. 2022;8(4):117-119.
12. American Academy of Pediatric Dentistry. Behaviour guidance for the pediatric dental patient. *The Reference Manual of Pediatric Dentistry*. Chicago, Ill.: American Academy of Pediatric Dentistry; 2021:283–298.
13. Kanagasundaram SA, Lane LJ, Cavalletto BP, Keneally JP, Cooper MG. Efficacy and safety of nitrous oxide in alleviating pain and anxiety during painful procedures. *Arch Dis Child*. 2001 Jun;84(6):492-5.