Nitrous oxide and hypnotherapy in paediatric dentistry

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Abstract

Aim Patient compliance is of paramount importance for proper dental treatment, which can be difficult to achieve in children due to anxiety and fear, hindering the therapeutic procedure. In addition to well-known sedation methods (pharmacological and nitrous oxide), further methods of approach are being tested, such as hypnotherapy.

Materials and methods The sample consisted of 150 children (90 males, 60 females). Paper questionnaires, frequency meter, nitrous oxide dispenser in association with the use of the television were exploited. At the end of treatment, subjective pain was assessed using the VAS scale, while objective pain was assessed using the FLACC scale and heart rate. This made it possible to compare two experimental groups, one treated with nitrous oxide, and the other with hypnotherapy. The control group was treated with classic behavioural approach techniques. The results obtained were analysed by SPSS Software (Statistical Package for Social Science, version 27) and the inferences between the results were calculated for confirmation.

Results Significant differences were found between the two experimental groups and the control group (p=0.05). The results show that patients in the nitrous oxide group perceived less pain unlike the others, most likely because the nitrous oxide is a pain reliever. Furthermore, during treatment, the heart rate of the patient treated with hypnotherapy is low, similarly to that of patients treated with nitrous oxide.

Conclusions Hypnotherapy can be a valid substitute for nitrous oxide in paediatric dentistry.

KEYWORDS sedation, dental treatment, nitrous oxide, hypnotherapy

Introduction

Despite the new and revolutionary dental techniques, "anxiety" and "fear" remain a constant in dental field. The prevalence of anxiety about dental care in children and adolescents varies from 5% to 40% [Ramírez- Carrasco et al., 2017; Paglia et al., 2017; Cianetti et al., 2017], instead the incidence of fear of the dentist ranges from 5-6% to 16% in the population.

During school-age (7-11 years), this is due to children more developed survival instinct than that of adults [Akbay et al., 2009; Bahrololoomi et al., 2022].

Anxiety is an emotional state that precedes an encounter with a feared object or situation, while fear refers to the actual or "active" response to the object or situation. Both can have a physiological, cognitive, emotional and behavioural involvement. They are closely linked to pain, that is usually caused by a physiological process, but it also has a strong cognitive component: that is why anxious people at the dentist can have expectations of pain that exaggerate perceptions of pain. For these reasons, in Competence Profile of European Dentists it was reiterated that the dentist must be competent in the management of anxiety using both pharmacological and behavioural techniques, to be able to treat each patient appropriately, according to age, guaranteeing the best therapeutic quality [Cianetti et al., 2017].

Currently, the studies of dentists are aimed at hypnosis as option to reduce anxiety, fear and therefore pain, becoming a further valid tool to manage the behavior of paediatric patient during dental treatment. [Armfield et al., 2013; Rienhoff et al., 2022; Libonati et al., 2018].

Hypnotherapy, according to the definition of CIICS (Italian Center for Clinical and Experimental Hypnosis) of Turin, is "the plastic manifestation of the adequately oriented creative imagination". Moreover, "hypnosis is a physiological and dynamic change, in which a subject obtains psychic, somatic and visceral modifications, by means of plastic monoideisms and operator-subject relationship " [Granone, 1989; Casiglia et al., 2018]. The doctor-patient relationship that is created, and the power of the imagination that is guided by the suggestion proposed by the operator, make possible psychic, somatic and visceral changes in the patient.

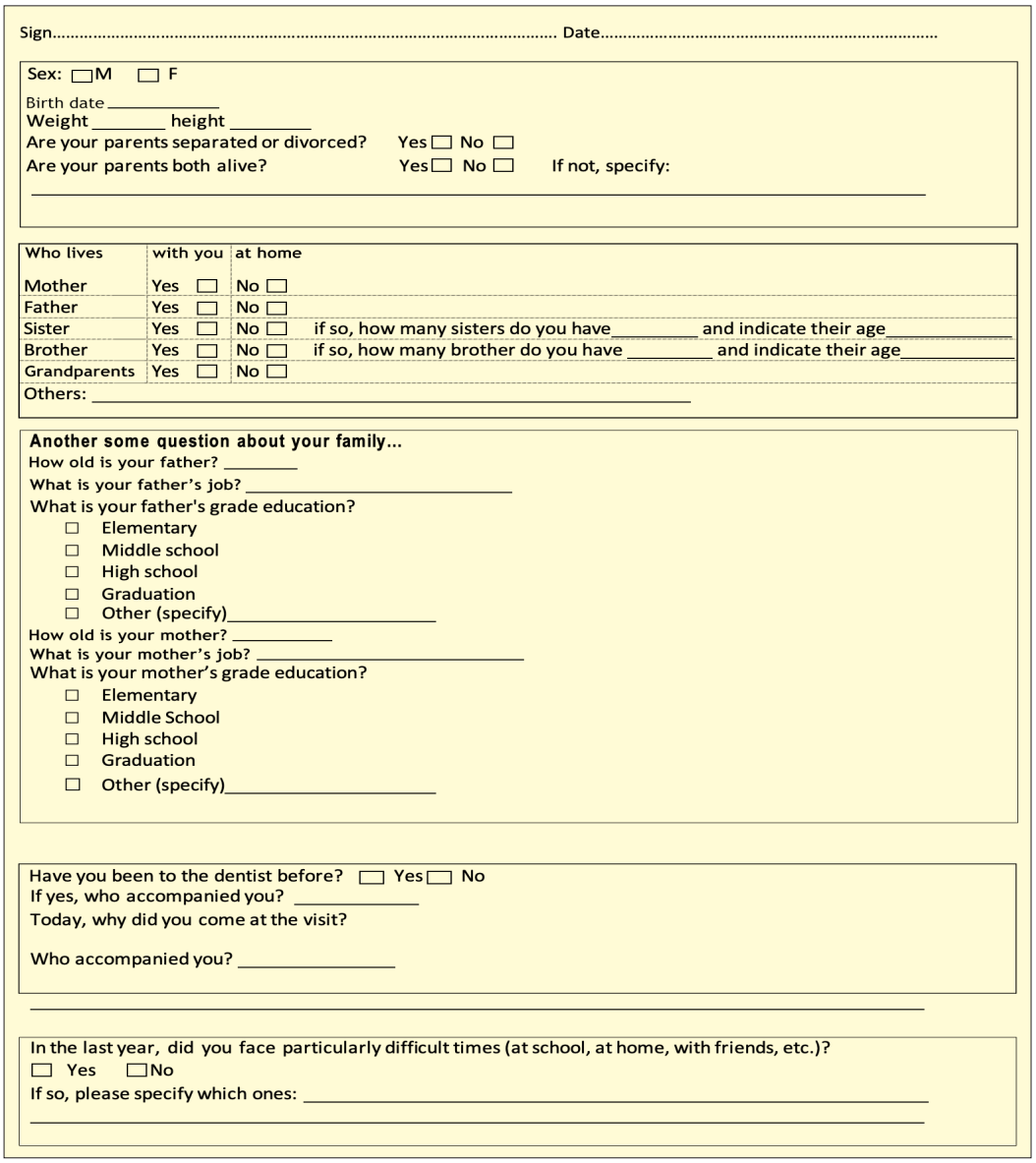
Nitrous oxide, on the other hand, is a sedation modality in which the patient is asked to inhale, through a special nasal mask, a gas mixture consisting of low percentages of protoxide and high percentages of oxygen (in a 100% mixture, 30% of the total is represented by nitrous oxide, the remaining 60-70% by oxygen) [Erickson et al., 1979; Fiorillo et al., 2019]. These proportions can vary; in fact, it is possible to have mixtures consisting of equal percentages of nitrous oxide and oxygen; however, by decreasing the amount of oxygen at service of that of nitrous oxide, there is an increase in side effects [Kharouba et al., 2020].

The children's inability to collaborate with the dentist is mainly caused by their fear. This work aims to consider the use of hypnotherapy as a possible keystone in solving the root problem, comparing it with conscious sedation using nitrous oxide and with conventional behaviour management techniques.

Materials and Methods

Distribution of the sample

This study was conducted at the Department of Paediatric Dentistry of the Department of Medical, Oral and Biotechnological Sciences of the "G. d'Annunzio" Chieti-Pescara, Italy, where the data of the control group and hypnotherapy were



Sign..... Date.....

Sex: ☐M ☐ F

Birth date _____
Weight _____ height _____
Are your parents separated or divorced? Yes ☐ No ☐
Are your parents both alive? Yes ☐ No ☐ If not, specify:
_____

Who lives	with you	at home	
Mother	Yes ☐	No ☐	
Father	Yes ☐	No ☐	
Sister	Yes ☐	No ☐	if so, how many sisters do you have_____ and indicate their age_____
Brother	Yes ☐	No ☐	if so, how many brother do you have _____ and indicate their age_____
Grandparents	Yes ☐	No ☐	

Others: _____

Another some question about your family...
How old is your father? _____
What is your father's job? _____
What is your father's grade education?
☐ Elementary
☐ Middle school
☐ High school
☐ Graduation
☐ Other (specify)_____
How old is your mother? _____
What is your mother's job? _____
What is your mother's grade education?
☐ Elementary
☐ Middle School
☐ High school
☐ Graduation
☐ Other (specify)_____

Have you been to the dentist before? ☐ Yes ☐ No
If yes, who accompanied you? _____
Today, why did you come at the visit?

Who accompanied you? _____
_____

In the last year, did you face particularly difficult times (at school, at home, with friends, etc.)?
☐ Yes ☐ No
If so, please specify which ones: _____
_____

FIG 1 Anagrafic paper

collected, and at the Stomatological Institute of Milan (ISI), Department of Paediatric Dentistry, Italy, which provided the cases treated with nitrous oxide. The sample size was 150 patients, 50 per group, the first treated by conscious sedation, the second subjected to hypnotherapy, and the third treated by conventional behaviour management techniques. Subjects between 5 and 10 years old were included in the study, to take advantage of the same hypnotherapy method.

Design of study

All parents have consented to the collection of personal data by signing the informed consent (Figure 1a).

The children were fitted with a chest strap (Decathlon Dual HR®: Zentan Technology & CO., LTD NO. 92, Taiwan) which detects the heart rate, and the data was continuously transmitted via bluetooth on the "Decathlon Coach"smartphone app.

At the end of the treatment, a total anxiety indicator scale, called FLACC (Face, Legs, Activity, Cry and Consolability) [Pala et al., 2016], was completed. This scale allows us to evaluate the child's stress not only from a psychological point of view, but in an objective way. The children were also subjected to the VAS (Visual Analogue Scale) [Porter et al., 2020], an indicator of the pain perceived by the young patients (Figure 2a).

For inclusion in this study, dental therapies did not have to exceed a duration of 15-20 minutes, children had to be free of mental illness, systemic disease, mental retardation, blindness or deafness, psychological problems of any kind, and should have a good knowledge of the Italian language. Therefore, foreign children were excluded from the study.

Instruments

VAS

The Visual Analogue Scale (VAS) was introduced by Aitken in 1960 to measure psychological states, and modified in 1975 by Ohnhouse and Adler to misure also pain [Facco et al., 2021]. Today it is frequently used to measure the intensity of pain, but also to evaluate other subjective experiences; since it is fast and simple, it is often used in clinical trials.

The VAS is a non-verbal test and as such is not subject to any difficulty in interpreting words and sentences, it is unique for subjects of different languages and easier to submit than

First name ..... Surname .....
Date of birth ...../...../.... N° Folder:
Type of treatment:

FLACC SCALE

Time of frequency calculation	bmp
T0= before to enter in office	
T1= after the induction period	
T2= during treatment (one measurement every 5 min) higher frequency recording	
T3= end of treatment	

FIG. 2 Heart Rate Assessment, VAS, FLACC

FIG. 2A Visual Analogue Scale (VAS)

FLACC scale (Face, Legs, Cry, Activity Consolablity scale9	Score
Fece 0-No particular espression or smile 1-Occasional grimace or frown, withdrawn, disinterested 2-Frequent to constant frown, quivering chin,clenche jaw	
Legs 0-Normal position or relaxed 1-Uneasy, restless, tese 2-Kicking or legs drawn up	
Activity 0-Lying quietly, normal position, moves easily 1-Sqirming, shifting back and forth, tense 2-Arched, rigid, or jerking	
Cry 0-No cry (awake or asleep) 1-Moans or whimpers; occasinal complaint 2-Crying steadily, screams or sobs, frequente complaints	
Consolability 0-Content, relaxed 1-Reassured by occasional touching, hugging, or being talked to; distractile 2-Difficult to console or comfort	
Total score (0-10)	

FIG. 3

a verbal test. This test was submitted to the children at the end of the treatment to evaluate their experience. We wanted to use a graphic-type test: smileys with different expressions associated with a number on the VAS scale from 0 to 10 have been used (Figure 2a).

FLACC

The FLACC (Face, Legs, Activity, Cry, and Consolability Scale) assesses postoperative pain in young children, and it is one of the most used tools for assessing objective pain [Campbell-Yeo et al., 2022]. It calculates the intensity of pain based on the score obtained by observing 5 behaviours, on a scale from 0 to 2: face, legs, activity, comfort, and cry with a maximum score of 10 (Figure 3).

In this study it was used to objectively assess pain in children, correlating it with another objective patient stress rating index: heart rate [Ramírez-Carrasco et al., 2017].

Heart rate monitoring

Heart rate variability (HRV), a measure of the functioning of the cardiac autonomic nervous system, has emerged as a physiological marker for emotional regulation and psychological well-being [Paniccia et al., 2017].

To calculate heart rate variation, we recorded the heart rates at different timepoints:

- before entering the treatment room (T0);
- after sedation with nitrous oxide or hypnotic induction (T1);
- during treatment (T2);
- at the end of the treatment (T3).

During the treatment, the frequencies were recorded approximately every 5 minutes, paying attention to the critical moments of the patient, such as anaesthesia [Ramírez-Carrasco et al., 2017], the moment of the "drill".

The instrument used for measuring all frequencies was the Decathlon Dual HR® strap (Zentan Technology & CO., LTD NO. 92, Taiwan).

Hypnotic induction

To induce "light" hypnosis in children, we exploited the child's visual imagination through a story that allowed them to identify with: the story of the flying carpet or the flying cloud.

Throughout the session, the hypnotic state must be constantly maintained by the hypnotist, member of the dental team, and the contact between the hypnotist and the subject should never be interrupted [Kohen et al., 2014; Kaiser et al., 2018].

Children in hypnosis do not necessarily remain still with their eyes closed, but the important thing is that they keep their attention in the hypnotic task. It can happen that children come out or seem to come out of the

hypnotic state: in this case is important to be very careful to invite them to return to their favourite place or to the game or to any context they have chosen for the "journey" by reinforcing the suggestions given previously. At the end of the procedure, just as the child has been accompanied on his "journey" on the unit, he must also be accompanied on the way back to prepare him to leave the unit, closing the dental operating session and the storytelling (Figure 4).

Sedation with nitrous oxide

Children sedated with nitrous oxide were all treated at the

FIG. 4

FIG. 5

Italian Dental Institute in Milan, using the DIGITAL MDM® model (Parker Hannifin Ltd Instrumentation Products Division, Riverside Road, Pottington Business Park Barnstaple, EX 31 1NP, England) (Figure 5).

Each child was seated on the unit in an room isolated from the rest of the office. A large television screen was mounted in front of the child's chair, showing a cartoon chosen by the little patient. Then, the child was placed a mask on the nose and asked to breathe the air that came out of the sedation machine for about a minute. The percentage of nitrous oxide did not exceed 50–60% of the amount of oxygen delivered. Once the child had reached a good level of sedation, the operator proceeded with the therapy.

Statistics analysis

All the obtained results were reported on an Excel sheet and transferred for statistical analysis in the SPSS (Statistical Package for Social Science, version 27) software.

The following statistical analyses were performed:

- arithmetic means of age, of VAS and FLACC values;
- standard deviation, the most used measure of variability;
- skewness (the symmetry value of the sample distribution respect to the standard distribution curve). It's very useful in large samples;
- kurtosis, that tells us if the distribution curve of the results is more or less sharp compared to the normal distribution. This is also a useful test for very large samples;
- cumulative percentage, useful to graphically observe the results we have obtained respect to the total.
- statistical deviance;
- significance;
- the ANOVA test, that allow us to evaluate the correlation between more than two sample groups;
- Tukey HSM and Bonferroni, both correlation tests between multiple groups.

Results

Each group was denoted by a number: 1=nitrous oxide, 2=hypnotherapy, 3=control cases. Tables 1 to 5 describe the information that was collected and statistically analysed.

In Table 1 the average age of the children is 7.5 years old, so most of the children were older than 7 years. Total FLACC and VAS are also considered. Both pain assessment scales show a positive kurtosis, and this indicates that the results obtained are very close to the average.

The statistical mean of the FLACC is very low (1.93±1.21) while the mean of the VAS is slightly higher (2.53±1.21). This indicates that subjective pain was greater than objective pain.

The standard deviation is very low for age (1.7), higher for FLACC (3.39) and total VAS (3.66).

Table 3 shows the number of boys (90) and girls (60) in the sample, which shows that both groups are balanced.

Table 5, shows the number of children whose parents are separated.

In Table 6, the ANOVA test was used to evaluate significant variations between intra-group and between- group results. For both the total FLACC value and the total VAS value, the differences are statistically significant.

In Table 7 the data are compared based on two post hoc systems, the Tukey HSM system and the Bonferroni system. In particular, the total FLACC and total VAS of each group are compared with the other two groups. The results for total FLACC are slightly significant between Group 1 and Group 3 (0.63). On the other hand, the total VAS also differs significantly between Group 2 and Group 3 (0.64).

We wanted to investigate the results obtained previously on the FLACC, to be sure that there was no significant difference between the results of Group 1 and 2 with respect to Group 3. To do this we looked for whether there was a statistically significant difference between all groups with the Tukey HSD system: the difference is not statistically significant (Table 8).

The same goes for Table 9, where we considered more specifically the total VAS of the three groups to better confirm the presence of a significant difference between Group 1 and Group 2 and between Group 2 and Group 3.

As regards the first point, the equivalence between the group of patients sedated with nitrous oxide and the hypnotised group was confirmed. In the second case, there is a slight significant difference between the hypnosis group and the control group (0.064).

Table 10 shows the heart rates at T0, T1, T2 and T3, analysed with the Anova test. There is no statistically significant difference between T0, T1 and T3. At T2, the difference between the groups is statistically significant (0.69).

Table 11 shows the correlations between the age of children, sex and the three parameters evaluated for each group.

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Age (months, years)	150	5	10	7.07	1.792	.229	.580	-1.555	1.121
FLACC tot	150	0	10	1.93	3.390	1.779	.580	2.006	1.121
VAS-Tot	150	0	10	2.53	3.662	1.318	.580	.408	1.121
Valid N (listwise)	150								

TABLE 1 Descriptive Statistics

		Sex (M=1/F=0)	Nitrous oxide=1; Hypnosis=2; nothing=3	Separated or divorced parents (yes=1 / no=2)
N	Valid	150	150	150
	Missing	0	0	0

TABLE 2 Statistics

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0	60	40.0	40.0	40.0
1	90	60.0	60.0	100.0
Total	15	100.0	100.0	

TABLE 3 Gender (M=1/F=0)

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	50	33.3	33.3	33.3
2	50	33.3	33.3	66.7
3	50	33.3	33.3	100.0
Total	150	100.0	100.0	

TABLE 4 Nitrous oxide=1; hypnosis=2; nothing=3

	Sum of Squares	df	Mean Square	F	Sig.
FLACC-TOT					
Betwee groups	62.533	2	31.267	3.813	.052
Within Groups	98.400	12	8.200		
Total	160.933	14			
VAS-tot					
Between Groups	96.533	2	78.267	6.351	.013
Within Groups	91.200	12	7.600		
Total	187.733	14			

TABLE 6 ANOVA

FLACC-TOT		
Nitrous oxide=1; hypnosis=2; nothing=3	N	Subset for alpha = 0.05 1
Tukey HSDa 1	50	.20
2	50	.80
3	50	4.80
Sig.		.063
Means for groups in homogeneous subsets are displayed. *a. Uses Harmonic Mean Sample Size = 5.000.*		

TABLE 8 Total FLACC: comparison

Nitrous oxide=1; hypnosis=2; nothing=3	N	Subset for alpha = 0.05	
		1	2
Tukey HSDa 1	50	.00	
2	50	1.60	1.60
3	50		6.00
Sig.		.640	.064
Means for groups in homogeneous subsets are displayed. *a. Uses Harmonic Mean Sample Size = 5.000.*			

TABLE 9 VAS-tot

		Sum of Squares	df	Mean Square	F	Sig.
Heart rate-T0	Between Groups	281.200	2	140.600	.688	.521
	Within Groups	2452.400	12	204.367		
	Total	2733.600	14			
HR T1	Between Groups	17.733	2	8.867	.059	.943
	Within Groups	1794.000	12	149.500		
	Total	1811.733	14			
HRT2	Between Groups	1750.533	2	875.267	3.368	.069
	Within Groups	3118.400	12	259.867		
	Total	4868.933	14			
HR T3	Between Groups	53.733	2	26.867	.189	.830
	Within Groups	1706.000	12	142.167		
	Total	1759.733	14			

TABLE 10 ANOVA

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 1	30	20.0	20.0	20.0
2	120	80.0	80.0	100.0
Total	150	100.0	100.0	

TABLE 5 Separated or divorced parents (yes=1/no=2)

							Lower bond	Upper Bound
LACCTOT	Tukey HSD	1	2	-.600	1.811	.942	-5.43	4.23
			3	-4.600	1.811	.063	-9.43	.23
		2	1	.600	1.811	.942	-4.23	5.43
			3	-4.000	1.811	.110	-8.83	.83
		3	1	4.600	1.811	.063	-2.3	9.43
			2	4.000	1.811	.110	-.83	8.83
	Bonferroni	1	2	-.600	1.811	1.000	-5.63	4.43
			3	-4.600	1.811	.078	-9.63	.43
		2	1	.600	1.811	1.000	-4.43	5.63
			3	-4.000	1.811	.142	-9.03	1.03
		3	1	4.600	1.811	.078	-.43	9.63
			2	4.000	1.811	.142	-1.03	9.03
VS-OT	Tukey HSD	1	2	-1.600	1.744	.640	-6.25	3.05
			3	-6.000*	1.744	.013	-10.65	-1.35
		2	1	1.600	1.744	.640	-3.05	6.25
			3	-4.400	1.744	.064	-9.05	.25
		3	2	6.000	1.744	.013	1.35	10.65
			1	-4.400	1.744	0.64	-2.5	9.05
	Bonferroni	1	2	-1.600	1.744	0.13	-6.45	3.25
			3	-6.000	1.744	0.64	-10.85	-1.15
		2	1	-1.600	1.744	1.000	-3.25	6.45
			3	-4.400	1.744	0.80	-9.25	.45
		3	1	6.000*	1.744	0.15	1.15	10.85
			2	4.400	1.744	.080	-.45	9.25
** The mean differences is significant at the 0.05 level*								

TABLE 7 Multiple comparisons

In group 1, many results were not calculated because at least one of the variables was constant (the VAS for all patients subjected to nitrous oxide was zero). The only certain and statistical correlation can be observed between the age of the patients and heart rate at T2. For group 2, two correlations were observed: first of all, between the age of the patients and heart rate at T2, and also between FLACC and VAS. In group 3 many more statistically significant correlations can be observed, that is between the age of patients and the FLACC index, between age and VAS, between FLACC and VAS, between FLACC and T2 and finally between VAS and T2.

Table 12 shows the correlations between the sex of the child and the tools that were evaluated during this study. For both girls and boys there is a strong correlation between all three analysed parameters, VAS, FLACC, and heart rate at T2.

Discussion

Various approaches facilitate behaviour management of paediatric patients, such as behavioural techniques with a psychological approach and pharmacological techniques [Cosi et al., 2022; Kohli et al., 2022].

Techniques of psychological approach have been outlined

Nitrous oxide=1; hypnosis=2; nothing=3			Age (in month)	Sex (M=1/F=0)	FLACC- TOT	VAS-tot	Heart rate T2
1	Age (in mouth)	Pearson Correlation Sig. (2-tailed) N	1 50	-.408 .495 50	-.612 .272 50	.a . 50	-.949* .014 50
	Sex (M=1/F=0)	Pearson Correlation Sig. (2-tailed) N	-.408 .495 50	1 50	.250 .685 50	.a . 50	.154 .804 50
	FLACC-TOT	Pearson Correlation Sig. (2-tailed) N	-.612 .272 50	.250 .685 50	1 50	. a . 50	.728 .163 50
	VAS-tot	Pearson Correlation Sig. (2-tailed) N	.a . 50	.a . 50	.a . 50	.a 50	.a . 50
	HR T2	Pearson Correlation Sig. (2-tailed) N	-.949* .014 50	.154 .804 50	.728 .163 50	.a . 50	1 50
2	Age (in mouth)	Pearson Correlation Sig. (2-tailed) N	1 50	.491 .401 50	-.642 .243 50	-.642 .243 50	-.971** .006 50
	Sex (M=1/F=0)	Pearson Correlation Sig. (2-tailed) N	.491 .401 50	1 50	.210 .735 50	.210 .735 50	-.321 .598 50
	FLACC-TOT	Pearson Correlation Sig. (2-tailed) N	-.642 .243 50	.210 .735 50	1 50	1.000** .000 50	.799 .105 50
	VAS-tot	Pearson Correlation Sig. (2-tailed) N	-.642 .243 50	.210 .735 50	1.000** .000 50	1 50	.799 .105 50
	HR T2	Pearson Correlation Sig. (2-tailed) N	-.971** .006 50	-.321 .598 50	.799 .105 50	.799 .105 50	1 50
3	Age (in month)	Pearson Correlation Sig. (2-tailed) N	1 50	.456 .440 50	-.892* .042 50	-.875 .052 50	-.752 .143 50
	Sex (M=1/F=0)	Pearson Correlation Sig. (2-tailed) N	.456 .440 50	1 50	-.441 .45850	-.456 .440 50	-.423 .478 50
	FLACC-TOT	Pearson Correlation Sig. (2-tailed) N	-.892* .042 50	-.441 .458 50	1 50	.997** .000 50	.888* .044 50
	VAS-tot	Pearson Correlation Sig. (2-tailed) N	-.875 .052 50	-.456 .440 50	.997** .000 50	1 50	.919* .027 50
	HR T2	Pearson Correlation Sig. (2-tailed) N	-.752 .143 50	-.423 .478 50	.888* .044 50	.919* .027 50	1 50

*a. Cannot be computed because at least one of the variables is constant. *Correlation is significant at the 0.05 level (2-tailed).**Correlation is significant at the 0.01 level (2-tailed).*

TABLE 11 Correlations

over several years:

- Pre-appointment to change behaviours or appointment to approach.
- Communication, to obtain a response from the child to operator's commands [Alsaleh et al., 2020].
- Use of a second language, such as in euphemism technique and the "tell-show-do" [Martinez Mier et al., 2019]. Euphemism consists in addressing the child with a language at his level of understanding, this obviously should not be confused with the use of "baby talk" or an excessive maternal attitude. In the Tell-Show-Do techniques, "Tell" consists in describing the tools that will be used, how they will be used and the procedures that will be done. "Show" consists in showing the functioning of the tools previously described, stimulating the child's senses such as sight, hearing, smell, and touch. "Do" consists in putting the instruments into operation and, if possible, making the patient use them.
- Desensitisation: first introduced by South African psychiatrist Joseph Wolpe, it is a technique often used on highly anxious children.
- Modeling: it is based on the psychological principle of learning and acquiring behaviours that occurs through the observation of a suitable model [Kevadia et al., 2020]
- Distraction [Robertson et al., 2019]
- Absence or presence of parents [Riba et al., 2019].
- Voice control: it is usually indicated in uncooperative and inattentive patients, but it should not be used in children who are unable to understand due to age, disability, mental or emotional immaturity.
- Hypnosis.

Pharmacological approaches consist of three methods: premedication with drugs such as flumazenil, naloxone and ketamine, conscious sedation with nitrous oxide, and general

Sex (M=1/F=0)			Freq. Heart T2	VAS-tot	FLACC-TOT
0	HR T2	Pearson Correlation	1	.943**	.933**
		Sig. (2-tailed)		.005	.007
		N	60	60	60
	VAS-tot	Pearson Correlation	.943**	1	.985**
		Sig. (2-tailed)	.005		.000
		N	60	60	60
	FLACC-TOT	Pearson Correlation	.933**	.985**	1
		Sig. (2-tailed)	.007	.000	
		N	60	60	60
1	HR T2	Pearson Correlation	1	.684*	.687*
		Sig. (2-tailed)		.042	.041
		N	90	90	90
	VAS-tot	Pearson Correlation	.684*	1	.906**
		Sig. (2-tailed)	.042		.001
		N	90	90	90
	FLACC-TOT	Pearson Correlation	.687*	.906**	1
		Sig. (2-tailed)	.041	.001	
		N	90	90	90

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

TABLE 12 Correlations

anaesthesia.

However, we must be aware that the use of pharmacological methods for the management of uncooperative children should only be used after all the other ways behaviour management techniques just listed have proved unsuccessful.

In this article we deepened the comparison between hypnotic induction, a very young technique, and nitrous oxide, which is increasingly used in dental practices.

Before analysing the statistical results obtained, it is necessary to point out that all the subjects selected for the sample were free from pathologies correlated to nitrous oxide (50%). These pathologies are associated with an increased risk of occurrence of adverse events [Oussalah et al., 2019]

The main contraindications to the use of nitrous oxide are:

- low solubility in the blood: when inhaled, it will spread quickly in air-filled spaces. In closed body cavities, this can cause the rapid expansion of nitrogen with consequent pressure increase injuries. That is why it cannot be used in the presence of distended cavities (head trauma, middle ear occlusion, pneumothorax). For this reason, patients suffering from chronic lung disease (emphysematous subject) or patients with a marfanoid appearance (very tall subjects who undergo a hypertensive pneumothorax) cannot be treated with protoxide as this promotes the expansion of the cavity, giving rise to respiratory problems and very strong otodynia, dangerous for the subject;
- potential teratogenic effect, in fact it is contraindicated during the first trimester of gestation
- occlusion of an auditory tube with consequent otodynia or perforation in patients with a blocked nose;
- subjects suffering from an ongoing lung disease or patients with severe mental illness [Ashley et al., 2021].

Today, COVID-19 is a concern presenting mild to persistent airway symptoms after recovery [Carf et al., 2020]. Respiratory distress or congestion may limit the use of conscious sedation which is a recommended drug modality for the management of anxiety or uncooperative paediatric patients [Myles et al., 2004; Vanhee et al., 2020]. Additionally, there may be an increased risk of cross-contamination across the loop leading to increased investment in sterilisation [Vanhee et al., 2020].

Anyway, from the results obtained it clearly emerged that the pain perceived by the patients, both objectively (total FLACC) and subjectively (total VAS), is very different between the groups. These results allow us to confirm that pain and anxiety perceived by children are lower when children were subjected to nitrous oxide nitrogen or hypnosis respect to subjects with whom only the classic behaviour management techniques have been used.

In the analysis of objective pain assessed with the FLACC scale, small statistically significant differences emerged between the group of children subjected to conscious sedation and the group of control cases, and no significant difference between the children subjected to hypnosis. Even less relevant was the difference between the FLACC values obtained from the group of hypnotised children compared to those approached with conventional techniques. This has been demonstrated for the use of nitrous oxide in a recent study by Sharma et al. [2020] that used the scores of the SEM scale (Sound Eyes Motor Scale) to assess pain using a level of N2O of 40-50% the electrical stimulation of the dental pulp, demonstrating a clear reduction of the latter signal.

The SEM scale in response to the electric pulp tester was used because it is an objective criterion in which the sensation of pain is detectable in the patient's eyes, body movements and verbal expressions of discomfort. The results showed that pain experience was higher when patients were no longer under the effects of nitrous oxide. In addition, it was seen that N2O also works for anxiolysis, allowing the patient to tolerate difficult procedures reducing discomfort, thus accelerating the end of treatment [Sharma et al., 2020].

Some scholars, however, such as Grønbæk et al. [2014] found that inhalation of N2O/O2 increases the patient's reaction time, but it has no effect on pulp sensitivity. It essentially reduces induced pressure and muscle pain, but this effect can be explained due to a delayed reaction caused by the sedative effect of the drug [Sharma et al., 2020; Grønbæk AB., 2014].

Returning to our study, as far as the pain subjectively perceived by the child, assessed with the VAS scale, a statistically significant difference was reported between the sedated patients and the control group. There is a low significant difference between the hypnotherapy group and the control group, although it seemed to exist clinically. This indicates that hypnosis does not induces analgesia unlike sedation, which if intensecan anesthetise the patient. However, hypnosis can represent a valid support for reducing the child's anxiety, fear and pain threshold [Shankar et al., 2022].

In the future, it would be appropriate to carry out an assessment of the patient's preoperative anxiety using psychological scales such as mYPAS [Griffin et al., 2022], to obtain a more complete picture the psychological state of the patient. This could guide us in using a well-targeted approach.

In the review "Role of Hypnosis in Dental Treatment" Venkiteswaran and Tandon [2021] selected studies conducted between January 2000 to January 2020. Studies have shown a variety of cases in which the use of hypnosis has proven effective, and it has been used for the following purposes:

- additional anxiolytic agent for minor surgeries;
- to reduce the intensity of orofacial pain and temporomandibular pain;

- to reduce anxiety;
- to increase compliance in the use of orthodontics;
- to manage the pain resulting from hypersensitivity of the teeth;
- to increase the pain threshold;
- to reduce salivary flow during dental treatment.

There were four studies that specifically looked at the use of hypnosis in the paediatric age group below 16 years of age. Three of these studies evaluated the effects of hypnosis on anxiety during local anaesthetic administration [Venkiteswaran et al., 2021].

Anxious patients made up the majority of the subjects in the sample and their level of anxiety was assessed using official rating scales, in the form of visual analogue scales (VAS) and McGill pain questionnaires, useful self-assessment tools, while pain was quantitatively and objectively measured using an electrical pulp tester, vitality scanner, and by the amount of analgesics required during and after treatment and finally by the FLACC verbal pain rating scale, using numbers to indicate intensity of pain between 0 (no pain) to 10 (worst pain), based on observations by an operator [Venkiteswaran et al., 2021].

Clinical research on the use of hypnosis in dentistry focuses primarily on pain and anxiety. However, Trakyali et al. [2008] shows us how hypnosis can be used to increase motivation in wearing the orthodontic appliance and [Satzl et al., 2014] showed that it could be used to control salivary flow during dental treatment. All studies that evaluated the pain and anxiety have shown favourable effects of hypnosis. Hypnosis has the potential to be a useful tool in managing children and adults [Venkiteswaran et al., 2021].

Regarding the pain perceived by the child during treatment, it was noted that the peak heart rates (T2) of the three groups present a slightly significant difference between them. Less significant were the differences between hypnosis and the other two methods.

The study by Kalra et al. [2020] saw a significant drop in heart rate and blood pressure in the groups treated with hypnosis and progressive muscle relaxation (PMR). The results agree with ours and those of Oberoi et al. [2016] who noted a drop in heart rate in children after hypnosis. The authors attributed this change to the relaxed, attention-focused state created by hypnosis that masked the physical stimulation of the injection. Similar results were found by Ramirez-Carrassco et al. [2017] who found better heart rate control under hypnosis.

Park et al. [2019] found a decrease in heart rate and blood pressure in patients treated with PMR, prior to periodontal surgery as in the present study. Unfortunately, this is one of the very few studies that have dealt with the search for parameters that assess the control of anxiety through the technique of progressive muscle relaxation, especially in children [Kalra et al., 2020]. In the analysis of the correlation between the parameters evaluated (VAS, FLACC and peak frequency), children's gender and age, it was observed that:

- the first group showed a significant correlation between the age of the child and the peak frequency, which was also reported by the other two groups. In this way it has been shown that anxiety and pain threshold are directly proportional to the child's age;
- there is no correlation with gender in any case [Peretz et al., 2013];
- statistically significant correlation between pain and increased frequency are important [Ramírez-Carrasco et al., 2017]. In fact, all the peak frequencies were significantly correlated to the two pain assessment parameters in the control group;
- in the case of the hypnosis group, we obtained less significant results. An explanation for this outcome could be that the child experienced real pain during the treatment but he remained calm and relaxed. It should be kept in mind that this represents one of the main goals of the dentist as it represents the necessary condition for effective treatment [Ramírez-Carrasco et al., 2017].

Conclusions

Conscious sedation with nitrous oxide is very effective in suitable cases, such as in all patients who do not have pathologies such as: otitis, COPD, emphysema, and allergies. It also requires close surveillance by the operator to make sure the child inhales the gas.

The use of hypnotherapy has proved very useful in managing the child's pain and behaviour and makes up for those cases where nitrous oxide is deficient.

Unfortunately, there are few cases in the literature on the clinical use of hypnotic induction and relaxation techniques, especially in children, because they require a certain amount of experience to make it effective. In addition, for the management of more complex cases, it is advisable the help of a psychologist.

Given the lack of literature on the subject, it is recommended to carry out further studies on the clinical use of hypnosis in paediatric dentistry.

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