

Success of Dental Treatments under Behavior Management, Sedation and General Anesthesia

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Objective: To present comparative data with the aim of assisting the practitioner to choose between behavior modification (BM) techniques, pharmacologic sedation (N₂O-O₂ alone or combined with midazolam 0.5 mg/kg) or routine general anesthesia (GA) for the most successful approach in enabling pediatric dental care. **Study design:** Dental records of 56 children treated in a university dental clinic between 2006-2016 were reviewed, and data on age, gender, required treatment (amalgam restorations, composite restorations, pulpotomy, and stainless steel crowns [SSC]), treatment approaches and therapeutic success at final follow-up were retrieved. **Results:** Treatment under GA had the best success rates compared to both BM and pharmacologic sedation. N₂O-O₂ alone had a 6.1-fold greater risk of failure compared to N₂O-O₂+midazolam ($p < 0.008$). Amalgam restorations had a 2.61-fold greater risk of failure than SSC ($p < 0.008$). **Conclusions:** The GA mode yielded significantly greater success than the N₂O-O₂ mode alone. There were no significant differences in success rates between GA and combined midazolam 0.5 mg/kg+N₂O-O₂. When choosing restoration material, it is important to remember the high success rate of SSC compared to amalgam restoration.

Keywords: Success, dental restorations, children, sedation, general anesthesia

INTRODUCTION

The level of the child's cooperation in the dental situation and his/her general behavior are pivotal in the dentist's choice between behavioral management (BM) "soft" approaches, such as "tell show do", desensitization and BM through pharmacological sedation (N₂O-O₂ alone, a sedative agent [midazolam or hydroxyzine hydrochloride] alone or in combination with N₂O-O₂), or general anesthesia (GA) ¹⁻⁵. BM is preferred by parents but may not suffice, while GA adds between \$1,000-\$6,000 to the cost of dental care ¹ and bears greater risk for morbidity and mortality compared to conscious sedation or behavior techniques ⁶. The reported mode most favored after BM was N₂O-O₂ sedation ^{7,8}. One survey among program directors and students of advanced pediatric dentistry training programs on sedation issues in the United States concluded that strategies should be developed to strengthen the consistency of competencies in sedation practices across academic training programs ³.

Comparing dental treatments under GA and under sedation presents some difficulties due to many differences among children of various populations, among them the extent and severity of dental caries, the level of the child's cooperation, and the policy of the dental practitioner or institution ⁵. As such, there are no clear criteria to enable the practitioner to choose between BM techniques, sedation or GA ⁹. Some parameters have been suggested to assist in decision making: a) the patient's age (the younger the patient,

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the higher the likelihood for the need for GA), b) the extent of the dental caries (the more extensive, the higher the likelihood for the need for GA), c) the physical/emotional health of the patient (when GA is the only option), d) the risks of each mode vis-à-vis the necessity to treat, e) cost, and f) the parents' expectations and their compliance with the demands of the treatment^{4,9-11}.

The aim of the present study was to assess the success of restorations on primary and permanent molars performed under BM techniques, sedation or GA on children in the setting of a university clinic in a developed western country.

MATERIALS AND METHOD

This study was approved by the ethics committee of Tel Aviv University, Tel Aviv, Israel. Most of the children who are treated in the university clinic are referred by other dentists who could not carry out the dental treatment due to lack of the child's cooperation. The dental records of all children between 2-9 years of age who were treated in the Department of Pediatric Dentistry clinic between 2006-2016 were reviewed. The oldest child who had dental treatment under GA was 9 years old. Children were selected for the study if they had no major systemic diseases or were not taking any medications for chronic conditions. They also had to have undergone routine dental examination after the dental treatment every 6–12 months for at least 3 years. Dental records which did not contain full clinical or radiographic documentation were excluded. Fifty-six records of pediatric dental patients were found suitable for the study.

All treatments were performed by post-graduate students under the supervision of a senior, board-certified pediatric dentist. Pharmacologic sedation consisted of midazolam (0.5 mg/kg) and nitrous oxide (N₂O-O₂) (30-50%). GA was delivered according to routine protocol. Complete data on age, gender, the mode of providing the dental treatment (BM, pharmacologic sedation or GA), the specific

type of dental treatment (amalgam restorations, composite restorations, pulpotomy, and stainless steel crowns [SSC]) and the level of cooperation (using the Frankl scale¹² were recorded.

Only restorations on posterior teeth were examined since they could be observed on bitewing X-rays. The scores that were given to describe the degree of success were "good" or "failure" for overhang, secondary caries, or fracture for restorations (amalgam or composite), "good" or "failure" for pulpotomies (internal resorption, external resorption, periapical radiolucency, furcation radiolucency), and "good" or "failure" for SSC (lack of marginal adaptation: over crown margin, under crown margins [the latter when the crown margins did not cover the tooth crown properly or the crown was missing]).

Statistical analysis

The data were analyzed utilizing SPSS 15.0 software (SPSS Inc., Chicago, IL, USA). A binary logistic model was used, and generalized linear mixed models were applied.

RESULTS

Out of 2000 dental files available in the pediatric dentistry database, 56 were found to contain full records and were suitable for the current study. The study children included 29 boys [51.7%] and 27 girls [48.21%] whose age range was 2.8-9.4 years (mean age ± standard deviation 4.53 ± 0.86 years). A total of 311 treatments were performed on primary and permanent molars. The distribution of the mode of treatment was as follows: 7.3% by BM only, 16.7% by N₂O-O₂ only, 13.8% by N₂O-O₂ + midazolam (0.5 mg/kg), and 63.34% by routine GA.

Table 1 shows the distribution of the success rates of the four modes of dental treatments. The first postoperative examination was carried out between 13-18 months, the second between 13-18

Table 1: Distribution of treatment modes of successful treatments in the follow-up examinations

	1 st exam post-op: 6-12 mo	2 nd exam post-op: 13-18 mo	3 rd exam post-op: 19-24 mo	4 th exam post-op: 25-36 mo
Behavior management	14 (8%)	1 (0.8%)	1 (0.85)	1 (3.22)
N ₂ O-O ₂	37 (21.14%)	27 (22.68%)	4 (7.4)	4 (12.9%)
Midazolam and N ₂ O-O ₂	26 (14.85%)	16 (13.44%)	0	5 (16.12%)
GA ^a	98 (56%)	75 (63.2%)	49 (90.74%)	15 (16.12%)
Total (240)	175 (56.26%)	119 (73.45%)	54 (72%)	25 (80.64)

^aRoutine protocol

Table 2: Distribution of the success of dental procedures on follow-up examinations

	1 st exam post-op: 6-12 mo	2 nd exam post-op: 13-18 mo	3 rd exam post-op: 19-24 mo	4 th exam post-op: 25-36 mo
Amalgam restorations	74 (42.28%)	57 (47.98%)	19 (35.18%)	8 (25.80%)
Composite restorations	24 (13.71%)	15 (12.60%)	5 (9.25%)	4 (12.9%)
Pulpotomy	28 (16%)	12 (10.08%)	10 (18.51%)	2 (6.45%)
SSC	49 (28%)	35 (29.41%)	20 (37.03%)	11 (35.48%)
Total successful treatments	175 (56.26%)	119 (73.45%)	54 (72%)	25 (80.64)

months, third between 19-24 months, and the fourth between 25-36 months. Complete information was available for 240 of the 311 treatments, among which 175 (56.26%) were diagnosed as being fully successful at the first examination. The highest number of successful treatments was under the GA mode.

Table 2 shows the distribution of the types of successful dental procedures (amalgam restoration, composite restoration, pulpotomy, SSC) according to the findings at the follow-up examinations. The most successful procedures in the first and second examinations were amalgam restorations (74 [42.28%] and 57 [47.89%], respectively), while only eight amalgam restorations were successful (25.80%) by the fourth examination. There were no differences between genders, maxillary and mandibular teeth, primary and permanent molars, or the first and the second primary molars.

Since treatment under GA had the best success rates, the other three treatment modes were compared to it (Table 3). The only significant difference was between treatment under N₂O-O₂ alone and GA ($p = 0.008$): treatment under N₂O-O₂ alone had a 6.1-fold greater risk of failure compared to treatment under GA. Table 4 demonstrates the risk of failure under SSC: there was a significant difference between SSC and amalgam restorations ($p = 0.008$), with amalgam restorations having a 2.61-fold greater risk of failure than SSC.

Table 3: Risk of failure related to treatment modes

	Odds ratio for failures	p
BM	0.730	0.629
N ₂ O-O ₂	6.190	0.008
Midazolam and N ₂ O-O ₂	1.496	0.448

Table 4: Risk of failure related to SSC

	Odds ratio for failures	p
Amalgam restorations	2.612	0.008
Composite restorations	1.761	0.291
Pulpotomy	1.265	0.539

DISCUSSION

Children with a past history of extensive dental caries may be expected to have recurrent carious lesions, and some of them will undergo the treatment again under GA or sedation¹³⁻¹⁵. This trend towards a higher risk for recurrent caries is prominent among children who had undergone full mouth rehabilitation due to severe early childhood caries. This risk has led many practitioners to plan delivering the treatment by GA or sedation, and altering the dental treatment itself by using crowns instead of restorations, pulpotomy in deep caries, or extraction over possible root canal treatment¹⁶.

It has been suggested that parents who have not experienced caries during their own childhood fear the treatment under GA, are less prone to accept advanced treatment modes of sedation, and opt for the more simple BM approach^{4,5}. In addition, the costs of GA may be prohibitive, making the GA mode the last solution¹. Interestingly, younger dentists are more likely to prefer less aggressive modes of treatment than older dentists.¹⁷

It is reasonable to assume that treatment under GA would provide the most optimal conditions in terms of patient cooperation, and therefore produce high success rates. Eidelman *et al* demonstrated a higher success rate of treatments, which were carried out under GA, compared to treatments under sedation in very young children, and reported a higher survival rate for the restorations¹¹. The use of N₂O-O₂ is very common in pediatric dentistry, and considered by many parents as a very minor sedation modality since it does not involve any medication. In our current study, the only significant difference in the success of treatments was between GA and sedation with N₂O-O₂ alone, where the former achieved much greater success. By trying to avoid the use of pharmacologic sedation and GA to please the parents, dental treatments under N₂O-O₂ are carried out even when cooperation is not optimal and conditions for proper restorations are not favorable. This may partly explain the inferior quality of restorations under N₂O-O₂ compared to restorations performed under GA found by us.

As expected, the less successful procedures were found more frequently in the sedation group. This finding is not surprising, since it allows a wide range of uncooperative behaviors from anxious and frightened children who have neither been calmed down by BM or treated under GA^{18,19}. However, it should be remembered that not every procedure which was considered “not successful” according to our criteria needed to be replaced.

We also compared between amalgam restorations, composite restorations and SSC because these types of procedures could be evaluated radiographically. The finding that SSC scored better than amalgam restorations is in accordance with the report by Papathanasiou *et al*²⁰, who demonstrated that the longevity of restorations was the highest with SSC, followed by amalgam, composite and glass ionomer restorations. Furthermore, Soncini *et al* showed that those differences increased as the post-treatment period lengthened²¹. An *in vivo* comparison between the longevity of restorations materials is difficult, however, since the materials are often chosen according to the extent of dental caries. Class I cavities in a cooperative child will most probably be treated with composite materials. This may skew the success of the overall number of restorations, and may result in an overall high success rate of composite restorations compared to amalgam. The decision for the treatment material does not always depend on the survival of the restoration. In extensive caries among young children who are not treated under GA, consideration must be also given to the urgency of treatment when eliminating the caries must be done as quickly as possible. In addition, the survival of the restoration is often less relevant due to the limited time the teeth will last in the mouth before exfoliating²². SSC were found to last longer than amalgam restorations, but amalgam which may require less preparation and is less technique-sensitive may be the right choice for treating an uncooperative child not under GA.

It should be noted that the treatment modality is chosen according to a number of variables other than parental preference, among them the severity of the carious lesions, the patient’s age, the level of cooperation, etc. Moreover, not all children who need GA can receive it due to limited availability of facilities, anesthetists, licensed dentists, etc. These considerations add to the importance of finding restoration alternatives that will survive until the primary tooth exfoliates. Finally, the worldwide use of amalgam is gradually being eased out by the year 2020^{23, 24}, thus forcing

the dental profession to find alternative reliable and long-lasting restoration materials.

Our study findings support the importance of thorough follow-up after dental treatments and regular dental examinations as a part of prevention of dental diseases. Recurrence of dental caries among children who had undergone dental treatment under GA was reported as being as high as 37-57%, irrespective of the “aggressiveness” of the treatments^{11,25}.

Another important issue that needs to be considered is treatment of the cause for the disease. Improving the oral health after oral rehabilitation among children with severe caries depends on a number of factors, among them the bacterial component²². Reducing the amount of mutans streptococci must be an integral part of the treatment plan. This can be better achieved by regular follow-up visits. Children who suffer from caries at a young age are at risk to develop caries later in their life¹⁵. Thus, providing children with comprehensive dental treatment, which involves long-lasting restorations, in combination with meticulous follow-up appointments and preventive modalities, is essential.

We recognize that the relatively small number of complete dental records, which were available for the study, precluded a more thorough analysis.

CONCLUSIONS

Dental procedures under GA had a significantly higher success rate than procedures carried out under N₂O-O₂ alone. There were no significant differences in success rates between dental procedures under GA and those under sedation by midazolam 0.5 mg/kg and N₂O-O₂. SSC demonstrated the highest success rate among all dental procedures. Our results indicate that BM alone or under N₂O-O₂ may not be enough to complete proper dental treatment. Therefore, parents should be made aware of the safety and greater likelihood of therapeutic success with sedation or GA, especially the parents of the youngest children who will retain their deciduous teeth for a longer period of time.

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