Oral rehabilitation under dental general anesthesia, conscious sedation, and conventional techniques in patients affected by cerebral palsy

Juan Pablo Loyola-Rodriguez / Ana Alicia Aguilera-Morelos / Miguel Angel Santos-Diaz / Veronica Zavala-Alonso / Claudia Davila-Perez / Honorio Olvera-Delgado / Nuria Patiño-Marin / Iris De Leon-Cobian

The purpose of this report is to find the use of different alternatives for dental treatment, from general anesthesia to conventional techniques, in patients affected by cerebral palsy (CP) in a dental school setting. The sample was divided into two groups: (1) children, and (2) adolescents and young adults; 38 patients (20 female and 18 male) with diagnostic of CP were included. Risks and benefits of conscious sedation and general anesthesia were written into a consent form and these were discussed with parents or guardians of each affected patient. The mean age was 7.14 ± 2.2 years for children´s group and 18.5 ± 3.06 years for adolescent and young adult group. Most children (77.3%) were classified as ASA II with a level of behavior I-II according to Frankl´s scale and these patients were treated under general anesthesia (GA). For patients that were classified as of positive behavior with little necessity of dental procedures, independent of the medically compromised level, dental treatment was done with conventional techniques or with conscious sedation. Dental frequency procedures were as follows: composites, dental prophylaxis, and dental extractions in children; in adolescents and adults, important to point out is that in anterior teeth and molars endodontic treatment, and surgical procedures increased in frequency. The mixture sevoflurane-propofol worked well during pre-, peri-, and post-operative procedures. During the discharge process, most patients needed a recovery of 20-40 minutes, after which they were awake and oriented, breathing comfortably with stable vital signs. It was concluded that GA with sevoflurane-propofol and conscious sedation are an excellent tool to provide dental treatment in CP patients in a dental school setting without most of the major postoperative complications, such as nausea and vomiting.
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INTRODUCTION

Although overall prevalence of dental caries has declined in the world, a significant population with disabilities, especially those with cerebral palsy, still remains at high risk of dental caries and periodontal disease.[1] The proportion of handicapped children with cerebral palsy, who survive for many years is rising; so, there is an increasing need for special dental care for disabled children, adolescents and adults that require special procedures and techniques to deliver dental treatment. Also, there is a great responsibility for dental care providers to maintain oral health of the medically, behaviorally, cognitively, and physically impaired population. Often cerebral palsy patients require pharmacological management, such as oral sedation and general anesthesia (GA) to be provided with intensive dental care.[2,3]

There have been reports that in some countries, the use of GA is strictly confined to the hospital environment and its indication restricted to tooth extractions[4,5]; in other countries, there are reports of GA use in restorative dental procedures as well.[2,3] However, at present the necessities for dental care have changed: people with disabilities require restorative, endodontic, and periodontal treatment which need more specific techniques and trained personnel in a GA room setting. Recently, there has been interest

* Juan Pablo Loyola-Rodriguez, DDS, PhD
** Ana Alicia Aguilera-Morelos, MD
*** Miguel Angel Santos-Diaz, MD, MSc
**** Veronica Zavala-Alonso, DDS, MSc
***** Claudia Davila-Perez, DDS, MSc
****** Honorio Olvera-Delgado, DDS
******* Nuria Patiño-Marin, DDS, MSc.
******** Iris De Leon-Cobian, DDS.

Dental Research Center and Master´s Degree in Dental Science at San Luis Potosi University, Mexico.

Send all correspondence to Juan Pablo Loyola-Rodriguez, DDS, Ph.D., Centro de Investigacion y Maestria en Ciencias Odontologicas, Universidad Autonoma de San Luis Potosí, Mariano Avila # 295-2, Col. Tequisquiapam, CP 78250, San Luis Potosi, SLP, Mexico.

Tel: 52 444 8 26 23 61 ext. 102
Fax: 52 444 8 26 23 61 ext. 104
E-mail: jloyola@uaslp.mx

focusing on analyzing the criteria for selecting patients to be treated under GA, such as necessities of treatment, physical status, discharge criteria, and level of collaboration with the dentist.[6] In developing countries such as Mexico, there are few institutions that have facilities for handicapped people, most of them concentrated in the capital (Mexico City area, in this case) and focused on children. Due to the aforementioned circumstances, it is necessary to provide access to GA to people with disabilities and to train young dentists in a general practice residency program. Cerebral palsy and Down's syndrome populations are so far the main proportion of handicapped children seeking dental treatment under GA in Mexico.[2] The need for GA in dentistry, coupled with a general lack of insurance coverage in developing countries and few facilities to provide dental care for special needs patients, supports the possibility of increasing or fortifying the facilities for ambulatory anesthesia in dental school settings.

The availability of rapid and short-acting anesthetic drugs for the maintenance of general anesthesia (e.g., propofol and sevoflurane) has facilitated the early recovery of outpatients after ambulatory surgical procedures.[7] The use of propofol as an intravenous induction agent in ambulatory anesthesia is very helpful, with a very fast clearance, reducing postoperative nausea and vomiting.[8-11] Several anesthesiologists select sevoflurane as the anesthetic agent of choice for induction and maintenance of pediatric anesthesia because of its rapid induction and recovery characteristics, lack of pungency and agreeable odor, and acceptable cardiovascular profile.[12-15]

Dentistry has amassed an enviable safety record for outpatient anesthesia in dental care, an incidence of mortality of about 1 in 300,000 cases having been reported.[16] It is important to point out that oral rehabilitation requires a team concept, where people who need to be trained in providing dental care under GA, are trained in the most important specialties in dentistry and anesthesiology. The team needs to integrate the following specialties: pediatric dentistry, anesthesiology, endodontics, and maxillofacial surgery. The aim of the present investigation is to report the use of different alternatives of dental treatment in patients affected by cerebral palsy in a dental school setting.

PATIENTS AND METHODS

The Ethics Committee of the Faculty of Dentistry at San Luis Potosi University, Mexico, approved this study. This clinical study involved 38 subjects with diagnostic of cerebral palsy, who desired dental treatment. Risks and benefits of conscious sedation and general anesthesia were written into a consent form and these were discussed with the parents or guardians of each affected patient. The treatment plan was explained to the legal caregiver, and when general anesthesia had to be performed, informed written consent was obtained.

This clinical report is a series of case reports with the following inclusion criteria: medical diagnostic of cerebral palsy, uncooperative patients, and only ASAII-III patients in accordance with the American Society of Anesthesiology classification of physical status, either gender, and age between 4-25 years were included.[17] Exclusion criteria were: patients with a history of difficulties in tracheal intubation, and patients that did not consent to be treated. All patients were classified according to their collaboration with the dentist by using Frankl´s classification.[18] All patients were referred from different institutions of the central states of Mexico: San Luis Potosi, Guanajuato, Aguascalientes and Zacatecas.

This clinical trial was done from May of 1997 to May of 2002, using a nonprobabilistic consecutive sampling, dental treatment delivery being by ambulatory general anesthesia, also known as outpatient. All procedures, preanesthetic evaluation, medical and dental clinical history, oral rehabilitation under general anesthesia, and management of the postoperative anesthetic period, were done in the Oral Medicine Clinic of the Master's Degree in Advanced General Dentistry Program at San Luis Potosi University, Mexico. The multidisciplinary team that participated in the whole process included the following personnel: anesthesiologists, clinical assistant, pediatrician, nurse, pediatric dentist, oral and maxillofacial surgeon, endodontist, periodontist, and residents. All procedures were done according to the American Academy of Pediatric Dentistry Guidelines.[19,20]

The oral route was used for conscious sedation (CS), diazepam (valium, doses of 0.3-0.5 mg/kg) was used for adolescents or midazolam (doses of 0.5 mg/kg) was used for children.[21-24] The general anesthetic management was as follows: most patients were accompanied into the operating room by a parent or caregiver, who remained there until anesthetic induction was completed. All patients received facial mask induction forinhalatory anesthesia by sevoflurane, since: 1. propofol administration is painful by injection, and 2. cerebral palsy patients are usually uncooperative. Ambulatory inhalatory anesthesia using sevofluare (Abbott Lab., Bogota, Colombia) was done in children´s cases.[13,25] Balanced anesthesia was used for adolescent and adult cases, this procedure was done by the intravenous route, using: propofol (Recofol, 200 mg/20 ml, 2-3 mg/kg; Lab. Pisa, Lieras Oy, Turku, Finland) as intravenous anesthetic agent[11]; Tracrium (atracurium, 10 mg/ml, 0.3-0.6 mg/kg, Glaxo Wellcome Foundation Lab, London, UK) as neuromuscular blocker[27,28]; Sevoflurane (Abbott Lab., Bogota, Colombia) as inhalatory anesthetic[25]; Ketorolac (30 mg/ml, 1 mg/kg, Lab. Pisa, Guadalajara, Mexico) as analgesic.[29,30] Local anesthetic was used for pain

management and hemorrhage control in cases of oral surgery, endodontic treatment, and periodontal surgery.

Equipment used to monitor anesthesia care in a faculty outpatient setting was as follows: Welch Allyn Atlas Monitor equipped with Electrocardiogram (model 622SO, Skaneateles Falls, NY, USA) and anesthetic machine (Narkomed 2A11, North American Drager, PA, USA). Heart rate, temperature, arterial hemoglobin oxygen saturation, and arterial pressure were noted before anesthetic induction, during oral rehabilitation and after the oral rehabilitation until patient recovery, Aldrete´s criteria being applied to each patient.[31] After patients were fully awake, they were discharged from the office with appropriate written instructions; follow-up appointments next day and a week later were programmed for all patients. All oral rehabilitations were done in a dental chair (Adec Performer, Portland, OR, USA).

Restorative materials used in this study were: composites (Tetric-Ceram and Teric-Flow, Vivadent Co., Liechtenstein); para-post-system (Whaladent, Mahwah, NJ, USA); amalgam regular set (Denstplay Caulk, Milford, CN, USA); gutta percha points (Colténe/Whaladent, Mahwah, NJ, USA); stainless steel crowns for primary and permanent molars (3M ESPE, Dental Products, St Paul, MN, USA); local anesthetics with 2% of epinephrine (Unipharm, Veracruz, Mexico); all materials were used as per instructions of the manufacturer. The support equipment for oral rehabilitation included: a visible light cure unit (Optilux 500, Demetron, Danbury, USA), amalgamator mixer (Roto Mix, Espe, Germany), and a scaler (Suprasson P-5, Satelec, Merignac, France).

RESULTS

Twenty females and 18 males participated in the whole study, the mean age being 12.80 ± 2.6 years old (range from 4 to 25). In the pediatric group, the mean age was 7.14 (2.2 and the age range was from 4 to 12 years old. In the adolescent and young adult group, the mean age was 18.5(3.06 and the age range was from 13 to 25 years old.

Table 1 shows that most pediatric patients (42.85%) were classified as ASA II with a level of behavior I according to Frankl's scale. These patients were treated under GA. One patient ASA II with behavior classified as definitively negative with necessity of few dental procedures was treated under CS. For most patients classified as ASA II, who had a cooperative behavior with the dentist (level III of Frankl's scale), it was possible to deliver dental treatment with conventional techniques or conscious sedation when they needed few dental procedures. All patients classified as ASA III, who required several dental procedures were treated under GA.

In Table 2 are the patients, who were classified according to behavior scale. Most patients, who received dental treatment under GA, were classified as definitive negative (47.61%) or negative (4.46%) level of behavior (level I and II, according to Frankl´s scale). Only one patient in this classification had need of little treatment, which was done under CS. When patients were classified as positive behavior (19.04%), treatment was delivered with conventional techniques (CT); in 5 patients (23.8%) dental treatment was delivered with CS.

Table 1. Classifications of physical status and behavior in CP children and the association with the dental delivery system used

	ASA	FS	Dental delivery system used		
n (%)			CT	CS	GA
1 (4.76)	II	I		*	
9 (42.85)	II	I			*
4 (19.04)	II	III	*		
4 (19.04)	II	III		*	
1 (4.76)	II	III			*
1 (4.76)	III	I			*
1 (4.76)	III	II			*

CP: cerebral palsy; n: sample; ASA: classification of physical status according to the American Society of Anesthesiology; FS: Frankl´s scale; CT: conventional techniques; CS: conscious sedation; GA: general anesthesia.

Table 2. Classification of behavior according to Frankl´s scale and dental delivery system in CP children

	Dental delivery system		
FS	CT n (%)	CS n (%)	GA n (%)
I	———	1 (4.76)	10 (47.61)
II	———	———	1 (4.46)
III	4 (19.04)	4 (19.04)	1 (4.76)
Total	**4 (19.04)**	**5 (23.80)**	**12 (57.14)**

n:sample; CT: conventional techniques; CS: conscious sedation; GA: general anesthesia; FS: Frankl´s scale.

Table 3 shows the frequency of different dental procedures done in patients with diagnostic of cerebral palsy. The procedures most performed were: restoring with composites (43.09%), dental extractions (15.46%), stainless steel crowns in primary and permanent molars (14.36%), dental prophylaxis (10.49%), and sealants (6.62%). Basically, the procedures were concentrated in restorative dentistry and some endodontic treatments in permanent teeth (2 pulpectomies in molars) with rebuilding with post and composites in anterior teeth, and molars were restored with posts, composites and stainless steel crowns placement. Some patients (2.76%) required oral surgery as well.

Table 4 shows that some adolescents and young adults (23.52%) were classified as ASA II with a level of behavior I according to Frankl's scale. These patients were treated under GA. Patients classified as

Table 3. Dental procedures done in cerebral palsy children

n	Dental procedures	Frequency	(%)
17	CO	78	43.09
10	DE	28	15.46
5	SSC	26	14.36
16	DP	19	10.49
6	FS	12	6.62
3	OS	5	2.76
3	AM	4	2.20
3	ED	3	1.65
3	PS	3	1.65
2	PE	2	1.10
1	OR	1	0.55

n: sample; CO: composites; DE: dental extractions; SSC: stainless steel crowns; DP: dental prophylaxis; FS: fissure sealants; OS: oral surgery; AM: amalgam; ED: endodontics in permanent teeth; PS: posts; PE: pulpectomy in primary teeth; OR: orthodontics.

Table 4. Classifications of physical status and behavior in CP adolescents and young adults and the relationship with the dental delivery system used

	ASA	FS	Dental delivery system used		
n (%)			CT	CS	GA
4 (23.52)	II	I			*
1 (5.88)	II	II		*	
2 (11.76)	II	II			*
6 (35.29)	II	III	*		
1 (5.88)	II	III		*	
1 (5.88)	II	III			*
1 (5.88)	III	I			*
1 (5.88)	III	II	*		

CP: cerebral palsy; n: sample; ASA: classification of physical status according to the American Society of Anesthesiology; FS: Frankl´s scale; CT: conventional techniques; CS: conscious sedation; GA: general anesthesia.

Table 5. Classification of behavior according to Frankl´s scale and dental delivery system in adolescents and young adults with CP

	Dental delivery system		
FS	CT n (%)	CS n (%)	GA n (%)
I	———	1 (5.88)	5 (29.41)
II	1 (5.88)	———	2 (11.76)
III	6 (35.29)	1 (5.88)	1 (5.88)
Total	**7 (41.17)**	**2 (11.76)**	**8 (47.05)**

n:sample; CT: conventional techniques; CS: conscious sedation; GA: general anesthesia; FS: Frankl´s scale.

ASA II and level of behavior II (11.76 %), and one patient classified as ASA II and level of behavior III (5.88 %) were treated under GA, since these patients needed several dental procedures. Only one patient ASA III with behavior classified as definitive negative was treated under general anesthesia since he was medically compromised. For several patients classified as ASA II, who had a cooperative behavior (level III of Frankl´s scale) with the dental team (35.29%), it was possible to deliver dental treatment with conventional techniques.

In Table 5, we show that 41% of the adolescents and young adults were classified as uncooperative (level I and II of Frankl´s scale) according to this behavior scale, and they were treated under GA. Two patients (11.76%), with few dental procedures to be done, were treated under CS, and 7 patients (41.17%) were treated under conventional techniques. Approximately 47% of patients of this group needed general anesthesia to be provided with dental treatment.

Table 6 shows the frequency of different dental procedures done in adolescents and young adults with diagnostic of cerebral palsy. The trend being much the same as in children where most of the procedures were restoring with composites (56%), dental prophylaxis (12%), and dental extractions (11%). Two procedures important to point out are: endodontic treatment in anterior and molar increased in frequency (6%), and both anterior teeth and molars were reconstructed with posts and composites; in the case of permanent molars, stainless steel crowns were placed. Some patients required oral surgery as well.

Table 7 depicts the means of the most important points carried out in the GA, the procedure itself taking more time in adolescents and adults in both total time of GA and working time to deliver dental treatment. The recovery time was similar in both populations and none of our patients showed postoperative nausea or vomiting, each patient staying in the recovery room until they reached a score of 9 according to Aldrete´s discharge criteria. Almost twice as many procedures were done in adolescents and young adults, 8 minutes was the mean time per procedure, whereas in children the mean time was 9.5 minutes.

DISCUSSION

General anesthesia in a hospital setting has traditionally been used to deliver dental treatment for medically compromised patients that cannot cooperate, comprehend or tolerate treatment with usual techniques. On the other hand, financial considerations in a hospital setting are an important point to take into account, since most medical and dental insurance does not cover oral rehabilitation under GA. In Mexico, almost none of the total population of disabled people has access to the national medical system provided by the Mexican government. Often these institutions do not have the facilities and the trained personal to provide dental care for special needs patients.

The use of propofol as an intravenous induction agent in ambulatory anesthesia was very helpful in our

Table 6. Dental procedures done in adolescents and young adults with CP.

n	Dental procedures	Frequency	(%)
11	CO	119	56.13
16	DP	27	12.73
8	DE	24	11.32
8	ED	13	6.13
4	FS	11	5.18
8	PS	10	4.71
2	OS	5	2.35
3	SSC	3	1.41

n: sample; CO: composites; DP: dental prophylaxis;DE: dental extractions; ED: endodontics in permanent teeth; FS: fissure sealants; PS: posts; OS: oral surgery; SSC: stainless steel crowns

Table 7. GA and timing of dental procedures done in children, adolescents and young adults with CP.

Procedure	Children	Adolescents & adults
TTGA	81.6 ± 28.9	128 ± 48.8
Working time	72.1 ± 28.5	118.9 ± 48.1
Recovery time	21.2 ± 1.3	23.0 ± 7.0
Procedures/patient	8.57 ± 3.6	15.9 ± 8.2
Mean time/procedure	9.36 ± 3.7	8.0 ± 2.1

TTGA: total time in general anesthesia; results are expressed as minutes and standard desviation; GA: general anesthesia.

study, none of our patients showed postoperative nausea or vomiting. After an oral rehabilitation under GA of approximately 70 minutes for children and 120 for adolescents, cerebral palsy patients were discharged from our clinic after a recovery of 20-40 minutes. They were completely awake and oriented, breathing comfortably with stable vital signs. There are several clinical studies that have shown that the recovery after propofol anesthesia compares favorably with other anesthetics in the outpatient setting, mainly because of extremely low occurrence of postoperative nausea and vomiting, which are the major factors that limit discharge of these patients.[8,30,32,33] Several anesthesiologists select sevoflurane as the anesthetic agent of choice for induction and maintenance of pediatric anesthesia because of the rapid induction and recovery characteristics, lack of pungency and agreeable odor, and acceptable cardiovascular profile.[13-15,34]

In our study, the combination sevoflurane-propofol proved an excellent choice for ambulatory anesthesia in patients with cerebral palsy during the whole process, which involved oral rehabilitation until the patients were officially discharged from the office with written instructions. We consider that the use of sevoflurane-propofol is an excellent choice in pediatric and mentally or physically handicapped patients, who benefit from expeditious recovery without several postoperative complications.

Collaboration of cerebral palsy patients with the dental team is a main point, patients classified in level III (positive), independently of whether they were classified as ASA II or III. In these patients, we were able to deliver dental treatment with conventional management behavior as tell-show-do or with help of conscious sedation. On the other hand, patients that were not collaborative and were classified as level I of Frankl's scale (definitively negative) do not cooperate with a dental team, so, oral rehabilitation was delivered under GA or by using CS.

There are some related studies to ascertain the cost/benefit of treating patients using CS and GA. The results showed the cost of several appointments for CS exceeded the cost of GA in a hospital setting.[35] Besides, there was evidence that quality of restoration performed under GA is better than restoration done under CS.[36] Since there are many similar indications for CS and GA, several clinicians prefer GA in treating disabled people with extensive decay, rather than multiple CS appointments.[35,36] In our study all GA was done in a dental school setting, using ambulatory anesthesia, in this way saving the patient approximately 40-50% of cost in comparison with hospital setting for the same type of oral rehabilitation. The greatest cost saving in a school setting is attributable to no hospitalization.

It has been reported that some procedures, such as endodontic treatments, require multiple visits. It is a time-consuming procedure that cannot be provided ideally under GA.[4] In our experience, we were able to do an endodontic treatment in molars or two endodontic treatments in anterior teeth in approximately 30-40 minutes, probable due to our team concept, which includes an endodontist. All anterior teeth that require endodontic treatment were restored with a post and composite restoration; in case of molars the reconstruction was with post, composites and stainless steel crowns.

We suggest that an avenue is open to study risk associated with greater duration of anesthesia and complexity of dental procedures, to establish safety protocols for oral rehabilitation under GA in special needs patients. On the other hand, an important matter to mention is that most dental schools in Mexico do not have material to provide information and knowledge about providing dental care for special needs patients. However, young students are interested in obtaining experience to deliver dental care for people with disabilities and the elderly population.

On the whole, medically compromised patients constitute a heterogeneous group that includes persons of all ages with cognitive, behavioral, and physical disorders. Some of these patients will require oral

rehabilitations under GA. Also, older adults are a rapidly growing segment of the population, who will need pharmacological behavior management, especially safe and inexpensive dental procedures that probably should include GA.[6] We concluded that outpatient anesthesia will increase in frequency for special needs patients in developing countries as Mexico. Local dental school settings could play an important role in the near future.

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