Retrospective Audit of Caries Management Techniques for Children under General Anesthesia over an 18-year Period

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The aim of this study was to review the outcomes of dental treatment under general anesthesia and to analyze the different types of caries management techniques for children in different age groups and time periods. Seven hundred in-patient general anesthetics were administered for 656 children between 1982 and 1999 were included in the analysis. This study concluded that the treatment modality of the caries management techniques varied according to the different age groups. Furthermore, the nature of the treatment changed, the relative proportion of restorative procedures increased during the period under investigation.
J Clin Pediatr Dent 31(1):58-62, 2006

INTRODUCTION

The successful provision of dental treatment to a young child depends on the co-operation of the child and the clinical skills of the pediatric dentist. The principle goal of patient management is to accomplish the necessary treatment whilst maintaining the child's level of comfort and cooperation. Therefore, a proper mode of pain control is one of the most important factors in successful treatment. The majority of children, with the careful use of behavior management and local anesthetic techniques, can cope with most types of dental treatment. However, some young children are particularly difficult to manage; they can be anxious due to a lack of dental experiences, or fearful due to the influence of their parents' and peers' impressions of dentistry. Furthermore, fear can decrease the pain threshold and hence increase the tension in a child. The cooperation of these children is inevitably limited by the immaturity of their mental development.

The main reason for providing general anaesthetics for children in the dental environment is the management of dental caries or its sequel.[1,2,3] Severe dental caries affects the quality of life of young children;[4] therefore, restoration of carious primary teeth under dental general anaesthesia is justified because it can be expected to help the child have an increase in body weight and growth velocity.

The aim of this study was to produce a comprehensive audit of general anesthesia for pediatric patients over an 18-year period. The objectives were i) to review the outcomes of the in-patient dental treatment under general anesthesia and ii) to analyze the frequency of different types of caries management techniques used in the primary dentition in different age groups and any changes that occurred with time in the treatment protocols.

MATERIAL AND METHODS

Children in this study were routine patients of a teaching hospital serving various socio-economical classes in the community in which the fluoridation of water was launched in 1961. The records of the children who received general anesthesia on an in-patient basis between May 1982 and October 1999 for dental treatment by the staff and postgraduate students in pediatric dentistry were collected. The children initially attended the out-patient clinic and received a clinical examination and had the appropriate radiographs taken. Evaluation of the level of cooperation and the extent of the carious lesions were used to identify those children who required treatment to be performed under general anesthesia.

The child was usually admitted to the hospital one day prior to the scheduled date of the operation under general anesthesia. The anesthesiologists would then carry out a pre-operative anesthetic assessment including a full medical assessment and laboratory examination of urine and blood samples. On the morning of the operation, following a simple oral examination, details of the tentative treatment plan were reiterated to the parents, emphasizing the need for this to be modified during the operation if circumstances dictated the necessity.

A thorough oral examination was performed under general anesthesia and correlated to the radiographic findings, if available. No additional radiographs were taken in the operating theatre. Usually, the operative procedures were routinely performed under rubber dam isolation while tooth extractions were performed after all the restorative treatment had been completed. The extraction sites were routinely sutured, after 0.25% bupivacaine had been injected adjacent to the extraction site. The child was discharged on the day following the operation and reviewed two weeks post-operatively.

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The personal identification data of each patient and the details of the treatment received under general anesthesia were recorded on individual general anesthetic record cards which were also used to locate the patients' folders. The data were checked and if necessary supplemented in order to include any additional information. For the purposes of analysis, the different types of caries management techniques were classified into four groups: i) restorative: composite resins, glass ionomer cements, amalgams, sealants, stainless steel crowns; ii) pulp therapy: pulpotomy, pulpectomy; iii) simple extraction and iv) tooth disking.

Five percent of the patient records were randomly re-selected to verify any data entry errors. The data on the types of caries management techniques on each tooth were collected according to the tooth type. The data were analyzed using descriptive statistics and compared using the chi-square test with a 95% confident level of significance.

MATERIAL AND METHODS

A total of 656 children (404 boys and 252 girls) received 700 general anesthetics to facilitate 468 restorative, 176 surgical, 56 combined restorative and surgical treatment procedures. The mean age of the children at the time they received general anesthesia was 76.3±43.2 months. Most of these children (45.3%) were between 3 and 6 years of age. Over 57%(401) of them were under 6 years old; however, 8.1%(57) were older than 12 years of age. Behavioral management problems were the main reason why 47.9% of the children were recommended for general anesthesia. Nasal intubation was used for 86.9% of the children. Eighty eight percent (616) of the general anesthesia were free of post-operative complications. The only complications were nausea (7.8%), fever (3.7%) and bleeding (1.7%).

Frequencies of different types of caries management techniques

There were 524 children who received treatment for carious primary teeth. The mean number of carious teeth was 10.6±5.1 per child. The majority of the procedures performed on these children were restorative in nature, which comprised 52.9%(2814) of the total treatment procedures, the mean number of restorative treatment procedures per child was 5.4. The majority, 44.9%(1265), were composite resin restorations followed by amalgam restorations at 19.3%(537), and stainless steel crowns at 18.3%(515). Simple extractions were another major treatment modality and represented 41.1%(2187) of all the treatment procedures, with a mean of 4.2 treatment procedures per child. Only 3.6%(194) of the carious primary teeth were treated by pulp therapy and less than 3%(128) of the teeth were disked.

Comparison of the provision of dental general anesthesia among different age groups

The 524 children who received restorative treatment were divided into four age cohorts to make them representative of the early primary (less than 3 years old, n=42), late primary (3-6 years old, n=299), early mixed (6-9 years old, n=115) and, late mixed dentitions (older than 9 years, n=68). The modalities of caries management for those children who were under 6 years of age were mainly restorative in nature, comprising of 56.9%(2361) of the treatment procedures. For children under 3 years of age, 32.0%(122) of the treatment procedures were tooth extractions. In contrast, when the children were in the mixed or late mixed dentition stage, extraction of the primary teeth was more frequently employed. In the 6-9 years old group, 41.4%(406) were restorative procedures and 54.4%(534) were extractions. Pulp therapy accounted for less than 4%(194) of all the treatment procedures and was mainly for children in the late primary and early mixed dentitions. Statistically significant differences in the treatment modalities were found among the age groups. More restorative treatments were performed in the children between 3 to 6 years of age (p=0.02) (Table 1).

TABLE 1: The different caries management techniques among the 524 children according to age group.

Treatment modality	Age in years							
	less than 3		3-6		6-9		older than 9	
	n	%	n	%	n	%	n	%
Restorative treatment	244	63.9	2117	56.2	406	41.4	33	19.5
Pulp therapy	10	2.6	155	4.1	29	3.0	0	0
Simple extraction	122	32.0	1389	36.8	534	54.4	128	75.8
Disking	6	1.5	107	2.9	12	1.2	8	4.7

Comparison of the provision of dental general anesthesia between 1982-1990 and 1991-1999

The mean age of the children who received dental general anesthesia between 1991 and 1999 (66.9±36.8 months old) was lower than in the period between 1982 and 1990 (77.2±35.1 months old). Before 1991, carious primary teeth were more often extracted (50.7%) than restored (42.6%). In contrast, between 1991 and 1999, the number of restorations placed in primary teeth had risen to 58.9% while the frequency of primary teeth extraction had fallen from 50.7% to 35.5%. Statistically, there was a significant difference in the treatment modalities for the two study periods (p<0.01). Between 1982 and 1990, pulp therapies comprised 4.4% of all the treatment procedures which was slightly higher than the 3.1% in the subsequent period. Tooth disking was fairly constant throughout both the study periods (Table 2). The patterns of use of restorative materials were also different in the two study periods. Before 1991, 53.3% of the restorations were amalgam while only 21.4% were composite resins. However, between 1991 and 1999, composite resin became the preferred material for the restoration of carious primary teeth (54.9%) and only 4.6% were restored with amalgam. The use of stainless steel crowns dropped marginally from 19.6% to

TABLE 2: Comparison of caries management techniques among the 524 children between 1982-1990 and 1991-1999.

Treatment modality	Time period				p value
	1982-1990		1991-1999		
	n	%	n	%	
Restorative treatment	835	42.6	1979	58.9	p<0.01
Pulp therapy	87	4.4	104	3.1	p=0.01
Simple extraction	996	50.7	1191	35.5	p<0.01
Disking	45	2.3	83	2.5	p=0.75*

* no significant difference

17.8%. However, there was a dramatic increase in the usage of fissure sealants from 1.7% to 11.2% (Table 3).

TABLE 3: The distribution of materials used to restore carious primary teeth of 524 children in 1982-1990 and 1991-1999.

Restorative material	Time period in years				p value
	1982-1990		1991-1999		
	n	%	n	%	
Composite	179	21.4	1086	54.9	p<0.01
GIC•	33	4.0	228	11.5	p<0.01
Amalgam	445	53.3	92	4.6	p<0.01
Sealant	14	1.7	222	11.2	p<0.01
SSC †	164	19.6	351	17.8	P=0.25*

• glass ionomer cement; † stainless steel crown * no significant difference

Repeat general anesthetics

Over the 18 years under study, only 3.5% (23) of children received a repeat general anesthetic for the treatment of failed restorations, or the management of new carious lesions.

DISCUSSION

The main reasons for these children to receive dental treatment under general anesthesia were behavioral management problems and the needed for extensive dental treatment. Currently, there is an increasing number of surgical procedures such as for impacted and supernumerary teeth; which supports the work of Holt and her co-workers[1] who reported that over 40% of the in-patients received surgical treatment under general anesthesia, which further confirms our findings that surgical treatment is another reason for general anaesthesia to be available in a major pediatric dentistry centre.

Post-operative complications were limited to 12% of the children, most of which were mild and transient in nature. The morbidity following the procedure was minimal; post-operative pain was seldom reported. This could probably be attributed to the fact that the extraction sites were anesthetized by the long acting local anesthetic agent, bupivacaine, prior to extubation and the first dose of an analgesic agent, usually paracetamol, was given in the recovery room by the rectal route. In addition, the administration of post-operative analgesic medication, whenever possible, by the oral route was routinely prescribed to help minimize pain. A retrospective study in England reported that 51% of children complained of post-operative oral pain.[1] A finding which seems to justify our routine of administrating analgesic agents and a long acting local anesthetic solution for post-operative pain control. However, younger children sometimes complained about the sensation of anesthesia caused by the local anesthetic agent.

Although two studies reported that over 95% of patients had hyperpyrexia after dental general anesthesia,[5,6] post-operative fevers were rare in the current study; only 3.7% of the patients manifested this complication. Several factors, such as tissue destruction, dehydration and bacteraemia, can be related to temperature elevations after general anesthesia. The routine administration of antibiotics during and after general anesthesia for procedures that can provoke bacteraemia, such as nasal intubation, could in part be responsible for the lower incidence of post-operative hyperpyrexia. This finding seems to agree with that of a prospective double-blind study of antibiotic therapy after tonsillectomy in children, which concluded that antibiotics could effectively reduce post-operative symptoms such as fever and pain.[7] However, currently this practice has been discontinued. Another possible explanation for the low incidence of post-operative pyrexia in our study was that the body temperature of the children was kept at a constant level by using a forced-air warming blanket during the whole anesthetic period.[8]

Nausea or vomiting after treatment occurred in 7.8% of the children which was similar to the results reported in other studies.[9] In the current study, all of the children were admitted to hospital one day prior to the operation; therefore, the children had an adequate period of fasting before general anesthesia and were under the close supervision of the nursing staff. Another possible reason to explain this finding was that rubber dam was routinely placed for restorative treatments which can avoid the involuntary swallowing of water. One possible cause of vomiting was the post-operative ingestion of a gastric irritant, such as blood, following surgery or tooth extraction. This was in spite of routinely suturing sockets to minimize post-operative haemorrhage.

There was a trend for the treatment strategies to be customized according to the age of the children. The concept of trying to conserve carious primary teeth predominated in the under 6 years old age cohort with 56.2% of the procedures being restorative in nature. Furthermore, 4.1% of all procedures in the 3 to 6 years old age cohort and 2.6% in the under 3 years old age group, involved pulp therapy which further confirmed the conservative management of caries in young primary teeth. In healthy children, the five-minute formocresol pulpotomy was frequently employed on vital primary teeth but pulpectomies were seldom performed. This is probably because of the anecdotal belief that pulpectomies are less successful than pulpotomies. For children in the mixed dentition, the treatment strategy was slightly different because similar proportions of restorative procedures and extractions were used; possibly because the life span of the primary teeth was less, and so the cost effectiveness of restorative procedures was difficult to justify. Also, there was the over-riding factor of justifying a prolonged general anesthetic.

The lower age at the time of receiving general anesthesia meant that early intervention is possible, and the change in the belief of conservative dental treatment for primary teeth may account for the modifications to our treatment strategies. The patients' characteristics and the nature of treatment modalities changed during the periods between 1982 to 1990 and 1991 to 1999. In the former period, more aggressive techniques were applied; 50.7% of carious primary teeth were extracted, in contrast to the 42.6% that were managed by various restorative techniques. However, in the latter period, 58.9% of the carious lesions on the primary teeth were restored and only 35.5% of the teeth were extracted.

The actual restorative techniques for primary teeth also altered with time. Between 1982 and 1990, 53.3% of the restorations were silver amalgam; while 21.4% were composite resin and 4% were glass ionomer cements. This pattern of usage of amalgam is supported by the literature prior to 1990 which showed high survival rates in primary teeth.[10,11]

During the early audit period, the durability of the composite resin restorations was frequently compromised probably because of the inferior wear resistance of composites compared to amalgam,[12] and that 46% of the auto-polymerized composite resin restorations could

be expected to fail after 6 years.[13] Furthermore, only 9% of class II glass ionomer cement restorations were found to be of an acceptable quality after 12 months.[14] Therefore, not surprisingly amalgam was the restorative material of choice between 1982 and 1990.

Between 1991 and 1999, 54.9% of the restorative procedures were composite resins. Improvements in the properties and clinical performance of the composite resins are, according to the literature, the likely reasons for the increase in the utilization of composite resin in primary teeth. One study showed that the clinical performance of composite resins was comparable to amalgam after 4 years;[15] while another 4-year clinical trial produced a similar result.[16] Furthermore, a Swedish study using light-cured composite resin restorations demonstrated that the success rate of class II composite restorations in primary molars was significantly higher than that of amalgam after 2 years.[17] Although the literature extols the clinical efficacy of composite resins for restoring primary teeth, most of the results indicate that the proximal restorations have a higher failure rate than one-surface restorations.[13,16] Indirect evidence from the literature reveals the posterior composite placed in permanent molars, over a 8-year period, had failure rates two to three times higher than amalgam18 and the 10-years failure rates were estimated to reach between 40 and 50%.[19] However, the limited life span of the primary teeth would seem to justify the use of composite resin.

Glass ionmer cements were infrequently used to restore the carious primary teeth, only 4% and 11.5%, in both study periods. This probably arose from the unsatisfactory outcomes indicated in the literature on the clinical performance of this restorative material. A study which targeted the experienced paediatric dentists, with controlled operative procedures indicated that only 9% of the class II conventional glass ionomer restorations were of an acceptable quality after 12 months;[14] because this material is more susceptible to wear and eventually losses its anatomic form.

The use of stainless steel crowns for restoring carious primary teeth was fairly constant throughout the whole study period. Between 1982 and 1990, 20% of the teeth were restored using stainless steel crowns, while the figure was 18% between 1991 and 1999. Although the preformed metallic crown was introduced to paediatric dentistry 50 years ago, it is still a popular treatment modality amongst paediatric dentists. Stainless steel crowns show a low failure rate of 1.2% to 12.8%.[11,20] However, relatively high frequencies of failures of stainless steel crowns, caused by pulpal complications have been reported;[11,21] this is, in reality, a false-failure because the crown itself does not fail, so care needs to exercise when interpreting published data.

The need for re-treatment of carious teeth in children who have behavioral problems is a serious problem. It may be possible to perform the treatment with or without local anesthesia; nevertheless, it will be difficult for the child to cope. For the child who cannot cope it means another general anesthetic has to be administered and this is highly undesirable due to the inherent risks. Hence great care must be exercised when formulating and executing the treatment plan and choosing the materials to ensure a long term successful outcome. In only 9 of the cases was a second general anesthetic administered because of a failed restoration; however 14 of the children had a second general anesthetic for the restoration of new carious lesions or tooth extractions. This figure of 3.5% for repeat anesthetics is approaching the lower limit of the other studies in the literature which ranges from 2.5% to 17.7%.[2,3,22,23] In order to minimize the requirement for a second general anesthetic, the pre-operative treatment plan and post-operative preventive measures must be careful developed. The creation of a strict treatment protocol for carious teeth with a doubtful long-term prognosis is prudent,[3,24] which may involve the careful examination and adoption of a radical approach in order to reduce the incidence of repeat general anesthetics.[22,23,25]

The low incidence of repeat general anesthetics in the present study can be explained by the adoption of a less conservative approach. For example, 41% of all the treatment procedures were simple extractions which on average meant that four carious primary teeth were extracted from each child. Severely damaged teeth with a questionable prognosis and non-vital teeth were routinely extracted, which was also advocated by other studies.[26,27] In addition, the liberal use of stainless steel crowns probably reduced the likelihood of the need for re-treatment. Therefore, this probably helped to reduce the incidence of re-treatment in the short term. This treatment approach probably also contributed to the long time elapse between the first and repeat general anaesthetics, which was 39 months on average. These factors should be considered in the context of the findings from an Israeli study, which reported that 92% of these children had behavioral improvements two years after dental general anesthetics.[28] Therefore, an extensive period of time post-operatively can allow the behavior of a child to improve and so eventually help to minimize the need for repeat general anesthesia on grounds of behavioral problems. Also, the implementation of a post-operative review program provides the opportunity to modify a child's behavior, initiate a preventive regimen such as fluoride therapy and diet modification, offer oral health education to the parents and children, and allow early intervention and evaluation of the treatment outcomes.

CONCLUSIONS

Under the present treatment protocol, the post-operative complications were relatively uncommon and the frequency of repeat general anaesthesia for restorative treatment was low. In our centre, most of the treatment procedures involved the restoration of carious teeth. The majority of the restorative procedures were composite resin restorations; followed by amalgams and stainless steel crowns. In addition, the treatment modality was customized according to the age of the children. For children under 6 years of age, the treatment procedures were mainly restorative in nature; however, more extractions than restorations were provided for the children who were between 6 and 9 years of age.

The treatment protocol was evolved and modified over the 18 years. Before 1991, most of the treatment procedures were simple extractions By contrast, between 1991 and 1999, restorative procedures predominated over extractions. The pattern of usage of restorative materials changed between the two study periods. Before 1991, amalgam was widely used to restore primary teeth; however, composite resin predominated over amalgam after 1991. The majority of the fissure sealants were placed between 1991 and 1999. The frequency of usage of stainless steel crowns was similar in both time periods.

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