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Abstract

Objectives to analyse the characteristics of comprehensive dental care provided under general anaesthesia (CDGA) and to review the additional treatment required by children over the six years subsequent to CDGA. **Method** Information collected from hospital records for the six-year period following the first CDGA included; the types of dental treatment performed at CDGA, the return rates for follow-up appointments, further treatment required subsequent to CDGA and the types of dental treatment performed at repeat DGA. **Results** The study population consisted of 263 children, of whom 129 had a significant medical history, with mean age of 6.7 years. The results revealed the waiting time for CDGA was significantly shorter in children who had a significant medical history, with 49% being admitted for CDGA within 3 months of pre-GA assessment as compared with 29% of healthy children. 67% of children had follow-up care recorded, with a slightly higher proportion of children with significant medical history returning for follow-up [70% (90/129)] compared with 65% (87/134) of healthy children. Re-treatment rates were 34% (88/263), the majority of cases being treated under local analgesia (44/88). Thirty four of 263 children had repeat DGA (12.9%). Of these 71% (24/34) were children with significant medical history. The mean age at repeat DGA was 9 years. In 25 of 34 children (74%), repeat DGA was due to trauma, oral pathology, supernumerary removal, hypomineralized teeth or new caries of previously sound or un-erupted teeth at CDGA. The ratio of extraction over restoration (excluding fissure sealants) performed at repeat DGA was 2.8, compared with the ratio of 1.3 in the initial CDGA.

Conclusions There was a higher ratio of extraction over restorations at the repeat DGA. This suggests that the prescribed treatments at repeat DGA were more aggressive as compared with the initial CDGA in 1997. The majority of the treatment required at repeat DGA was to treat new disease.

Introduction

Epidemiological surveys of the dental health of 5-year-old children in the UK by Pitts et al (2001) have indicated that the care index (i.e. the amount of caries treated by restorative care) is relatively low and has remained so over the past 2 decades. While many children with caries in the primary dentition can be successfully treated under local anaesthesia (LA) alone, some will require other modalities for anxiety and pain management for treatment to be successfully delivered. These include very young children with extensive dental decay and highly anxious, but otherwise healthy, children who are unable to comply with the demand of treatment due to behavioural management problems (Tyler, 1999), where dental treatment under general anaesthesia (GA) often remains the only viable option. Apart from the very young children and highly anxious patients, a significant proportion of children requiring DGA are those who have medically comorbidity (Wong et al., 1997; Harrison and Roberts, 1998; Camilleriu et al., 2004).

The provision of dental treatment under GA for children is well documented in the literature (Murray, 1993). O'Sullivan and Curzon (1991) reported on the outcome of comprehensive care under general anaesthesia and two recent studies reported on the differences between the patterns of dental treatment provided for healthy children and children with special needs (Harrison and Roberts, 1998; Camilleriu et al., 2004). The characteristics of comprehensive dental treatment under general anaesthesia have been reported in several studies (Rule et al., 1967; Mitchell et al., 1985; Nunn et al., 1995; Berkowitz et al., 1997). The reasons for repeat dental treatment under general anaesthetic in healthy but uncooperative children (Sheller et al., 2003) and the restorative outcome of CDGA have also been reported in the literature (Eidelman et al., 2000; Ng Man Wai et al., 2001; Tate et al., 2002; Drummond et al., 2004). However, no studies have previously investigated the further dental treatment received under LA and GA in the years following the administration of CDGA. Therefore, it seemed

appropriate to carry out a study to investigate the further dental treatment needs of children who previously received comprehensive dental care under GA at Leeds Dental Institute (LDI) and to analyse the characteristics of dental care provided under general anaesthesia.

MATERIALS AND METHODS

In order to obtain the comprehensive information required, a retrospective longitudinal record analysis was employed. The study was considered and approved by the Leeds (West) Research Ethics Committee.

Study population

The study sample consisted of children between the ages of 1 to 16 years, who attended for CDGA at the Leeds General Infirmary from January the 1st in 1997 to 31st December 1997.

The criteria for providing treatment under GA were; highly anxious but otherwise healthy children with inability or unwilling to undergo treatment under LA or LA with sedation, very young children with extensive caries (children up to 5 years of age), chronically sick children with physical and/or learning difficulties and children who had significant co-morbidity.

Healthy children and those whose learning, physical and medical conditions did not necessitate full admission were treated as a day-cases. Some children with more significant complicating medical condition were admitted the night before the procedure for pre-anaesthetic preparation and monitoring.

The dental records of each child in the study group were collected and the required data pertaining to the first course of dental treatment under general anaesthesia and any subsequent dental treatment, either as an out-patient or under general anaesthesia, carried out over the 6 years following the initial GA procedure (as presented in table 1) was recorded and transferred to a database for further analysis (Statistical Package for Social Sciences (SPSS), Inc., Chicago, IL, USA).

Intra-examiner reproducibility

Intra-examiner reproducibility testing was estimated using kappa statistics for categorical variables. Random selections of 26 records from 263 dental records were reassessed. This was equivalent to 10% of the total population group.

Statistical analysis

Descriptive statistics and the SPSS package were used. All data were subjected to Kolmogorov-Smirnov test for normality. As the data was not normally distributed, the non-parametric statistical test using Mann Whitney U test for independent groups was used for statistical comparison. The level of significance was set at 5%.

RESULTS

Study Population

In total, 263 children aged between 1-16 years were identified. There were 148 males and 115 females with mean age of 6.7 years. One hundred and eighty one children were seen as day cases and 82 children with a significant medical history were admitted as in-patients (ie either admitted to the hospital the night before the procedure or anticipated to possibly need an overnight stay post-operatively). The results showed that 52% of the children were below the age of 6 years at the time of operation.

Children with medical conditions, physical disability, mental and learning disability made up 49% of the population. The most common medical conditions present in the study population were respiratory disorders (40/129) followed by cardiac (19/129) and neurological disorders (18/129).

Eighty five percent of the children in the study group had no previous DGA experience. At the other end of the spectrum, one child had 6 previous DGAs (Table 2). The number of children who previously had at least one DGA was almost the same for both healthy and those with a significant medical history.

Dental diagnosis leading to CDGA in 1997

The dental diagnoses leading to admission for CDGA are shown in figure 1. Caries was identified as the main dental diagnosis in 210 of children (80%) at the pre-GA assessment. Out of these children, 81 had indicated that they had suffered from toothache with or without dental abscess at least on one occasion prior to pre-GA assessment.

Waiting time for CDGA in 1997

The results showed that 195 of 263 children (75%) had their CDGA within six months of pre-GA assessment. The mean waiting time between pre-GA assessment and treatment under CDGA was 4.8 months (range 1-12 months). Sixty three out of 129 children (49%) with a significant medical history were admitted for CDGA within 3 months of pre-GA assessment. On the other hand, only 39 out of 134 healthy patients (29%) were admitted for CDGA over the same period. Using Mann Whitney U test the difference was found to be significant at the 5% level. This reflects the fact that children with a significant medical history were treated at an earlier date compared with the healthy children.

Types of dental treatment carried out at CDGA in 1997

The results revealed that 146 out of 263 (55.5%) children had both extractions and restorative treatment. Fifty seven patients had extractions only and another 38 had restorative treatment only. Thirteen children had supernumerary teeth removed with or without involvement of

other dental procedures. The mean number of primary and permanent teeth extracted per child were 3.8 (range 0-20) and 0.55 (range 0-10) respectively. There was no statistically significant difference in the mean number of extractions between the healthy children and those with a significant medical history.

Restorative treatments were also provided for both primary and permanent teeth in both medically compromised and healthy children. The mean number of restored primary and permanent teeth were 2.8 (range 0-15) and 0.5 (range 0-13) respectively. The results showed that healthy children received significantly more primary teeth restorations (mean 3.2, range 0-15) compared with children with a significant medical history (mean 1.4, range 0-12), however no difference was found with regard to number of permanent teeth restorations.

The results showed that although there was no significant difference in the mean number of composite strip crowns, posterior composites, amalgam restorations, glass ionomer cements and stainless steel crowns on primary teeth per child, there was a significantly (at 5% level) more vital pulpotomy procedures carried out in healthy children (mean 0.8, range 0-6) as compared with those children with a significant medical history (mean 0.3, range 0-3).

Pattern of follow up attendance after CDGA 1997

As shown in figure 2, out of the 263 children in the study group 177 returned for at least one follow up visit. Of these, 86 children received preventive measures during subsequent follow up visits.

Further dental treatment needs following CDGA in 1997

34% (88/263) of subjects had records indicating further operative dental treatment (ie either extraction or restorations) during the 6 years following their dental treatment under general anaesthesia; the majority of cases were treated under local analgesia (44/88). However, in

order to complete dental treatment, five children required oral sedation and another five children required inhalation sedation with nitrous oxide and oxygen as an adjunct to LA. Out of the 88 children requiring further operative treatment, 27 children received only restorative treatment while 26 children had dental extractions. Twenty three children received both restorative treatment and extraction. One of these children also received one course of antibiotic therapy for an infected tooth.

Thirty four of 263 children had repeat DGA (12.9%). Of these 71% (24/34) were the children who had a significant medical co-morbidity. The average age at repeat DGA was 9 years, ranging from 3 to 16 years. In 25 of 34 children (74%), repeat DGA was due to trauma, oral pathology, supernumerary removal, hypomineralized teeth and new caries of previously sound or un-erupted teeth at CDGA. The average time of new caries first recorded on previously sound posterior teeth after CDGA in 1997 was found to be 18.11 (± 13.01) and 27.18 (± 18.16) months for primary and permanent teeth respectively.

The number of restorations placed at CDGA 1997 which were recorded as being replaced at a later date due to restorative failure or recurrent caries is presented in table 3.

The dental diagnosis leading to repeat DGA following their first CDGA in 1997 is presented in figure 3. For 22 of 34 children (65%), the repeat DGA was for the management of dental caries.

Eighteen children had a repeat DGA within three years after CDGA in 1997. The peak period of attendance for a repeat DGA was between 13 and 24 months after CDGA in 1997. The number of children who had received repeat DGA and the pattern of dental treatment carried out in the second DGA are presented in table 4.

It is interesting to note that if we excluded children with significant medical history it would leave 10 repeats only (7.4%) of which 7 of the 10 were primarily for new or recurrent caries. The difference in the median number of teeth restored between the two groups was analysed using the Mann Whitney U test and was found to be not statistically significant at the 5% level. The results also show that on average, both groups received less than 1 restoration per child at repeat DGA.

The results indicate that 9 children who received further treatment under a repeat DGA due to failure of treatment (restorative treatment excluding fissure sealants) could have avoided repeats DGA.

For a significant proportion of children requiring further dental treatment under DGA, this was to treat new problems not present at the initial DGA. This included, restorative treatment and or extraction due to new caries in previously sound or unerupted teeth (13/34) , developmental anomalies becoming clinically apparent after CDGA in 1997 (especially molar-incisor hypomineralisation 6/34 (MIH), management of dental trauma or other oral pathology not of dental origin which were 6/34.

There was no evidence that any of the repeats were due to treatment being required for teeth recorded as carious at the time of the first GA.

Intra-examiner reproducibility

Intra-examiner reproducibility was analysed using kappa scores for categorical variables. Twenty six dental records (10%) were randomly selected for re-analysis of 12 categorical variables. The kappa scores showed good intra-examiner agreement ranging from 0.68 to 1.

DISCUSSION

The term comprehensive dental general anaesthesia (CDGA) was used in the present study to include any treatment involving dental extraction, restorative procedures, and surgical removal of supernumerary teeth and management of oral pathology or dental trauma.

In 1998, the General Dental Council issued new guidelines on referral process for DGA. The year 1997 was selected for this study so that a baseline result can be establish prior to the implementation of the new guidelines and its subsequent impact on the service of DGA provided at Leeds Dental Institute and allowing for a period of up to six years of follow up.

The population studied at Leeds Dental Institute in the current review (1997) differed in some respects from the patients reviewed over the period of 1984-1987 by O'Sullivan and Curzon (1991) at the same centre. The study population was larger in the current study (263 children compared with 80 children) and on average, children in the present study were older (6 years of age compared to 4.5 years of age). The type of patients has also changed over the period of the reviews. It would appear that there was an increase in the number of children with a significant medical condition in the current review (49%) compared with O'Sullivan and Curzon's study (1991) (30%). The majority of other UK studies (Wong et al., 1997; Harrison and Roberts, 1998; Camilleriu et al., 2004) reported a different case mix, with medically compromised children and/or handicapped children forming the vast majority of their study groups.

In the previous study by Nunn et al (1995) on CDGA in the UK the study population were almost the same as in the present study. However a study by Mitchell et al (1985) was based on a smaller population group than the present study. On the other hand, several studies from London hospitals have reported findings base on a larger group of (Wong et al., 1997; Harrison and Roberts, 1998; Camilleriu et al., 2004).

The types of dental treatment performed under GA have changed slightly between the current study and previous review by O'Sullivan and Curzon (1991). The finding of the present study shows that in general, the total number of extractions was higher than restorations. On the other hand, the previous review reported higher numbers of restorations than extractions. There are also differences in terms of restorative procedures and the use of restorative materials between the two studies. In O'Sullivan and Curzon's study (1991), stainless steel crowns were placed twice as often as amalgams or composite restorations. Their study reported that on average, children in their group received a higher number of pulpotomy procedures per child compared to the current study. Their findings also showed that the number of amalgam restorations was almost equal to composite and GIC restorations combined. The differences in the preference of restorative materials and the choice of other restorative procedures such as pulpotomy procedure between the two studies may be partly explained by the fact that the composition of the study group was different and may also reflect changes in prescription practices due to the development of newer dental materials. As previously discussed, children in the present study were much older and a high proportion had a significant medical condition. It is interesting to note that their findings of more conservative treatment over extraction are similar to the findings of the present study for healthy children. This suggests that conservative treatment is the preferred option in the young but otherwise healthy children.

Several investigators proposed a more radical approach of extractions over restorations when treating young children with Early Childhood Caries (ECC) under GA (Berkowitz et al., 1997; Almeida et al., 2000; Jamjoom et al., 2001; Drummond et al., 2004). Similar recommendation was endorsed by other investigators, particularly if there is an underlying medical condition presents (Wong et al., 1997; Harrison and Roberts, 1998).

The return rates of 67% in the current review are comparable to 75% reported in the study by O'Sullivan and Curzon (1991). The review period of 6 years in the current study was longer compared to a period of 2 years reported in the previous study. Higher return rates were documented in two other studies (Mitchell et al., 1985; Drummond et al., 2004).

Of the total study population 34% of the children (88 of 263) required further dental treatment. This figure is slightly lower than the previously reported by O'Sullivan and Curzon (1991) (44%). The difference between the two studies may be related to differences in prescribed treatment at CDGA and differences in case mix. In the study by study, Drummond et al (2004) reported that two thirds of their total 292 patients required further treatment after 2 years of CDGA. The mean age of children at CDGA in their study was 4.3 years, significantly lower compared with the present study. Their findings did reveal that half of the children in their study had developed at least one new carious lesion. Eidelman et al (2000) reported that at an average follow-up period of 13 months, 59% of children in their study required further treatment, mostly due to new caries.

In the present study 44 of 88 children who required further dental treatment have had subsequent treatment provided without resorting to a second GA; this included patients who were treated under LA with or without the aid of relative analgesia and oral sedation. The majority of children in this group had no relevant medical history. Only 18 of 44 children who received further dental treatment under LA had a significant medical comorbidity. Thirty four out of a total of 263 (12.9%) children received further dental treatment under GA. The proportion of children with a significant medical history (24 of 129) who received further treatment under a repeat DGA was higher compared to healthy children (10 of 134). On average the median age between the two groups at repeat DGA were almost the same.

It was interesting to see that the ratio of extractions over restorations in the repeat DGA was higher compared with the initial CDGA. There are several potential explanations for the

differences between the two treatments (CGDA in 1997 and repeat DGA). Children in the repeat DGA group were much older (average age of 9 years); therefore, instead of performing more conservative treatment on primary teeth, extractions may have been preferred. The findings could also suggest that there was a change in the treatment philosophy when performing comprehensive treatment at the repeat DGA, with treatment plans being more aggressive at the repeat DGA in that significantly more extractions were performed compared with conservative treatment.

The findings also show that 25 cases of repeat DGA were probably unavoidable as the subsequent GA was required to treat disease or problems not present at the time of the first DGA. It is interesting to note that the majority of probably unavoidable repeat DGAs involved children who had a significant medical condition (21 cases), mostly due to new caries on previously sound or unerupted teeth (13 cases). Overall 9.5% of the patients had repeat GA that was probably unavoidable. In light of a high proportion of repeat DGAs due to new caries in children with a significant medical condition, it suggests that children with co-morbidity are a high priority group requiring more intensive preventive care and careful subsequent follow up and oral health support.

Two New Zealand studies (Thompson, 1994; Drummond et al., 2004) reported lower repeat DGA rates of 4.2% and 5.1% respectively. In both studies, the follow-up period was 5 and 4 years respectively. A more recent study by Kakaounaki et al (2006) who investigated the further dental treatment needs of children receiving outpatient exodontia under GA at the same Dental Hospital as the current study found that 10.7% of children had needed repeat DGA, which is comparable to the current study.

Previous UK studies investigating repeat DGA following outpatient exodontia presented with contrasting results. A lower DGA repeat rate of 5% was reported by Smallridge et al (1990) whilst a repeat DGA rate of 17% was reported by Keniry (1974).

Overall, the ratio of extraction over restoration (excluding fissure sealants) performed at CDGA in 1997 was 1.3. On average, children with a significant medical history received more extractions than restorations whereas healthy children received more restoration than extraction. There was a higher ratio of extraction over restorations at the repeat DGA. This suggests that the prescribed treatments at repeat DGA were more aggressive as compared with the initial CDGA in 1997. It is interesting to note that there was no evidence indicating that any of the repeats were due to treatment being required for teeth recorded as carious at the time of the first GA. This had been a significant cause of DGA repeats in a previous UK study (Harrison and Nutting, 2000) and the finding so f this current study probably reflect the more comprehensive nature of diagnosis and planning now employed in many Paediatric Dentistry clinics in the UK.

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Table 1. Data collected from the dental records: (GA) general anaesthesia; (CDGA) comprehensive dental treatment provided under general anaesthesia; (CS) conscious sedation and (LDI) Leeds Dental Institute, Leeds, UK.

A) Demographic Backgrounds

- Age in years, according to the child's last birthday at the date of the DGA in 1997), gender & medical history

B) Pre-GA Information

- Date of pre-GA assessment
- Original diagnosis of dental problems
- Main indications for CDGA
- Medical status at pre-GA assessment
- Previous history of DGA including the number of DGA received before the CDGA in 1997
- Waiting time for CDGA since pre-GA assessment visit

C) Information on Treatment Provided Under CDGA

- Date that the actual CDGA procedure took place in 1997
- Characteristics of dental treatment provided (i.e. extractions, restorative treatment, minor oral surgery, trauma management etc.)
- Types of restorative procedures and materials used

D) Post-GA Information

- Pattern of attendance at recall/review visits following CDGA
- Interval between CDGA and first review visit
- Characteristics of further dental treatment provided at LDI subsequent to CDGA until 31st December 2003
- Record of further dental treatment carried out under LA, CS or GA
- Record of children with repeat DGA subsequent to CDGA in 1997 (age at repeat DGA, medical status, frequency and reasons of repeat DGA).

Table 2. Number of past DGAs previous to CDGA in 1997

No DGA	No healthy children	No medical/disability patient	Percent
0	116	108	85.2
1	16	18	12.9
2	2	2	1.5
6	0	1	0.4
Total	134	129	100

Table 3. Number of restorations placed at CDGA 1997 which were recorded as being replaced at a later date due to restorative failure or recurrent caries

	Primary* Composite	Strip Crowns	Anterior Permanent Composite	Primary Amalgam	Primary SSC	Permanent SSC
No of replacement**						
1	4	11	2	2	4	2
2	6		4	2	1	1
3		2				
4	1		1			
Total no of teeth	11	13	7	4	5	3

*=Posterior composites only

** =Number of times individual restoration was replaced

Table 4. Pattern of dental treatment under a repeat DGA

Treatment pattern at repeat DGA	Healthy children	Children with a significant medical history
Extraction only	8	12
Restoration only	0	2
Extraction and restoration	1	8
Minor oral surgery	1	2
Total	10	24

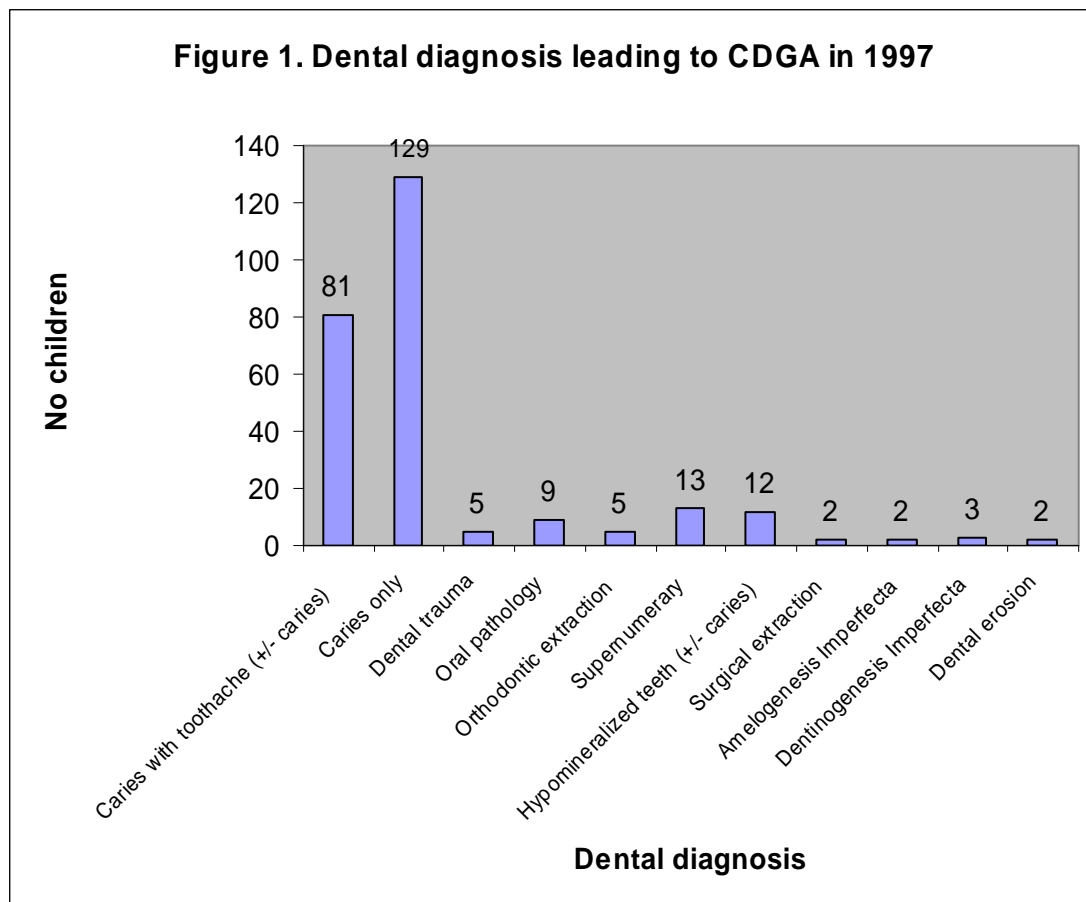


Figure 2. Summary of follow up attendance following CDGA in 1997

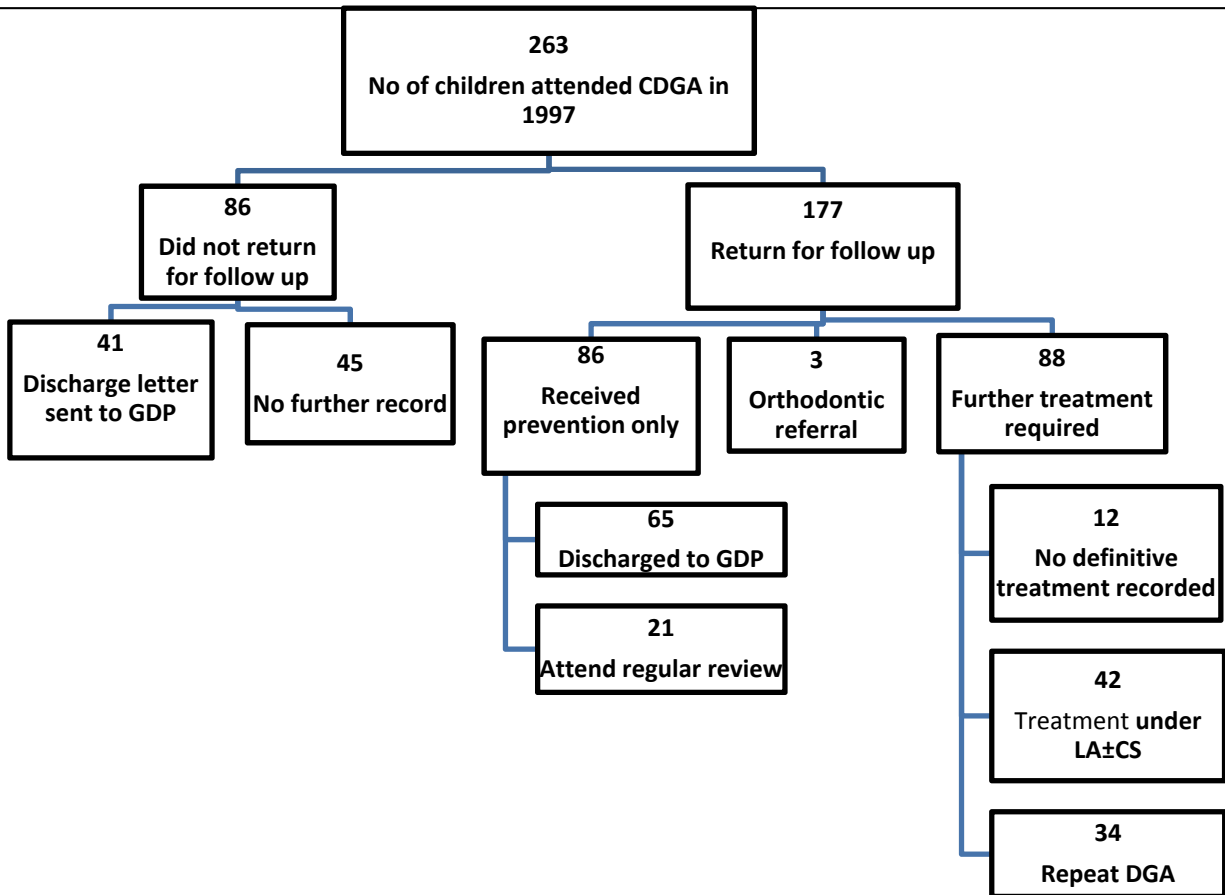


Figure 3. Primary diagnosis leading to repeat dental treatment under general anaesthesia

