Children with rampant caries in the primary dentition: oral health situation one year after total dental rehabilitation under general anaesthesia

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**SUMMARY.** Aim. The aim of the present study was to evaluate the dental status of children with rampant caries in their primary dentition, one year after full-mouth rehabilitation, and to assess the impact of a follow-up program on the clinical outcome. Method. A longitudinal follow-up study was undertaken at the paediatric dental clinic of the Catholic University of Leuven. Children younger than six years of age, with rampant caries in the primary dentition (more than 6 active lesions) and treated under general anaesthesia, were randomly allocated to two different programs. A first group received standard preventive instructions on one single occasion while the test group returned for 4 additional preventive sessions (at 2, 4, 6 and 9 months post-treatment). All children were re-examined after 12 months. Caries experience, level of plaque accumulation, degree of gingival inflammation, and mutans streptococci and Lactobacilli counts were determined at baseline and one year later. Results. A considerable drop-out rate was noted in both groups of children (± 40%, no difference between groups). Although oral cleanliness and gingival condition improved and microbial load decreased, caries experience showed an important increase with a dmfs-increment of 5.6 and 3.9 in standard and test-group, respectively. Failure rates of restorations were considerable (33.0 and 26.1% of restorations in standard and test-group, respectively). Differences between both groups were statistically not significant. Conclusion. It was concluded that caries activity remained a problem in most of the children studied. Restorations failed in a considerable number of cases and the proposed follow-up program could not significantly influence the outcome. More adapted restorative techniques should be used and/or developed, a specific follow-up strategy needs to be worked out and the primary prevention of rampant caries should receive more attention. Key words. Rampant caries, Primary dentition, General anaesthesia, Treatment outcome

**Introduction**

At the paediatric dental clinic of the University Hospital of the Catholic University of Leuven (Belgium), about 800 patients per year receive dental treatment under general anaesthesia. It was shown that 15% of the patients treated under general anaesthesia at this centre were re-treatment cases [unpublished data]. A considerable number of them were young children with multiple active carious lesions in the primary dentition, a condition described as ‘rampant caries’. Reasons for re-treatment were in most cases the development of new carious lesions and/or failure of existing restorations. Recurrent disease has been reported as a frequent event after total dental rehabilitation of small children with high caries experience [Yiu and Wei, 1992]. This is also the case for high failure rates of restorations on primary teeth prepared under general anaesthesia [O’Sullivan and Curzon, 1991]. These findings underline the need for a strict follow-up of children with rampant caries [Yiu and Wei, 1992; Johnston and Messer, 1994; Muller, 1996]. However, reports on the longterm outcome of the oral health of these children after total dental rehabilitation are rare [O’Sullivan and Curzon, 1991].
In a study by Berkowitz et al [1996], almost two-thirds of the children with high caries experience treated under general anaesthesia did not attend for a check-up while more than half of the children who did attend at the 6-months recall visit presented new lesions into the dentine. When Benitez and co-researchers [1994] tried to apply a preventive program to young children with nursing caries, the intervention had to be discontinued after three months because of considerable progression of disease in most children and poor compliance of the parents with the program. When specific follow-up programs are designed for children with rampant caries, compliance problems are to be expected.

The aims of the present study were therefore:
1) to evaluate the oral health condition and microbial profile of young children with rampant caries, one year after full-mouth rehabilitation under general anaesthesia;
2) to assess the impact of an intensive preventive follow-up program on the oral health situation of the child;
3) to determine factors relevant for treatment outcome.

Methods

Study sample. The study sample consisted of 98 children with high caries experience (dmft-score ≥6) and a mean age of 4.8 (SD = 1.1) years. They had received total dental rehabilitation under general anaesthesia at the paediatric dental clinic of the University Hospital of the Catholic University of Leuven between September 1995 and June 1996 [Vinckier et al, 2001]. Young age, limited level of co-operation and need for extensive dental rehabilitation were the main reasons for selecting general anaesthesia as the preferred treatment modality. Most of the children had been referred to the dental clinic by their private dental practitioner.

The children were randomly allocated to a test or standard group based on a coin toss. Children from the standard group (n=47) received standard preventive instructions in one single visit. Those from the test group (n=51) received an additional preventive program with follow-up visits at 2, 4, 6 and 9 months after general anaesthesia. All children were invited for a recall visit 12 months after treatment under general anaesthesia.

Oral health profile. The evaluation of the oral health profile of the children was carried out using a multiple choice questionnaire covering topics on parental oral health knowledge, attitude and reported behaviour. Parents completed the questionnaire at the first visit to the university dental hospital (prior to treatment under general anaesthesia). The same questions were repeated at the one-year recall visit. In both instances, parents were asked to complete a detailed dietary diary of their child (covering a period of 7 consecutive days).

Clinical parameters. The registration of clinical parameters (oral hygiene, gingival inflammation and caries experience) was performed at the university dental hospital. At baseline, all children were examined by one single examiner (SG). At the 1-year recall visit the children were examined by a second examiner (DD) who did not know to which group the child belonged. The examination technique was calibrated and agreement between both examiners was assessed (clinical examination of same group of children). Because of the duration of the study period, calibration exercises were repeated at regular intervals (4 months). Inter- and intra-examiner reliability tests were performed prior and during the study period and showed kappa-scores higher than 0.8 (very good agreement).

Caries at the cavitation stage and initial lesions were recorded separately after removal of food debris and supragingival plaque (with the use of cotton rolls). All teeth were scored. A mouth mirror and a blunt probe (in order to avoid perforation of initial lesions) were used for caries assessment. An initial lesion was defined as the condition where a smooth surface showed a chalky appearance and slight roughness on probing. Pits and fissures were registered as presenting initial lesions when the fissure showed a white or dark discoloration. Radiographs were taken for the detection of approximal and occlusal lesions. For radiological diagnosis panoramic radiographs were chosen because of the limited level of cooperation of the children. In case of disagreement between clinical and radiographic scores, the examiner scored the worst condition. The individual dm/dmf/dmfs-scores were calculated, including only lesions at the level of cavitation for the d-component. The caries experience score at baseline reflects the situation after the completion of total dental rehabilitation under general anaesthesia.

The extent of plaque accumulation adjacent to the marginal gingiva was measured using the
Silness and Löe plaque index [1964]. Gingival inflammation was assessed using the Sulcus Bleeding index of Mühlemann and Son [1971]. Plaque accumulation and gingival inflammation were scored on the following teeth: 55, 61, 64, 75, 81 and 84 and this at four sites per tooth: mesio-, mid- and disto-buccal, and mid-lingual.

Total dental rehabilitation. A II children received total dental rehabilitation using general anaesthesia, as described by Vinckier et al [2001]. For restorations in anterior teeth the acid etch technique and composite materials were used. Primary molars were restored with amalgam.

Microbial load. Counts of S. mutans (S.m.) and lactobacilli (Lb) were determined in plaque and tongue-loop samples. Both samples were collected from each child at baseline (before treatment under general anaesthesia) and at the 1-year recall visit. Plaque samples were obtained by inserting sterile wooden wedges from the buccal site into the approximal areas between primary molars and molar/canines, based on the method described by Tenovuo et al. [1990]. Tongue-loop samples were collected by scraping the dorsum of the tongue using a 10 µL bacteriological loop [Beighton, 1986]. Both samples were dispersed into 1 mL RTF and transferred to the laboratory of microbiology within 5 hours for culturing and identification of cariogenic species. TY CSB (Led Techno, Ekses, Belgium) and Rogosa medium (Bacto Rogosa SL agar®, Led Techno, Ekses, Belgium) were used as selective media for the detection of S.mutans [van Palenstein-Helderman et al, 1983] and lactobacilli [Rogosa et al, 1951]. All plates were incubated anaerobically (80% N₂, 10% CO₂ and 10% H₂) for 3 and 5 days respectively and for both media a representative plate (harbouring ± 100 colony forming units) was chosen. Each colony type, on the representative TY CSB plate, was characterized by colour, surface appearance, architecture, form, presence of halo, size and adherence capacity to the medium. Every third colony was subcultured by streaking onto blood agar plate. After 24 to 48h of anaerobic incubation, the pure cultures were classified as S. mutans or other species. This was based on gram-staining, phase contrast microscopy and a series of biochemical tests including fermentation of mannitol and melibiose, β-glucosidase activity and the hydrolysis of arginine and bile-esculin (Diagnostic tablets for microbial identification®, International Medical, Brussels, Belgium). The identification of lactobacilli on the selective Rogosa plates was based on colony morphology, gram-staining and phase contrast microscopy [Rogosa et al, 1951]. The results were recorded as colony forming units per mL (cfu/mL).

Follow-up program. Children from the control group received standard preventive instructions at baseline including advice on frequency and technique of toothbrushing, use of toothpaste and fluoride supplements, frequency of sugar consumption and dental attendance. The children were instructed to return to the university hospital for a recall visit, 1 year after dental treatment under general anaesthesia. Children from the test group received the same instructions but returned to the clinic for four additional follow-up sessions (at 2, 4, 6 and 9 months after general anaesthesia). During these sessions an additional preventive program was provided. During the follow-up period, all children received restorative treatment, if necessary. This was performed at the university hospital or by the referring dentist.

Follow-up sessions. At each recall visit (2, 4, 6 and 9 months), with a duration of ± 45 minutes per visit, each child received a clinical examination, always by the same dentist (SG), with evaluation of oral hygiene and gingival condition. The different preventive instructions were discussed, oral health education was given and problems were analysed. Positive changes were encouraged. At each recall visit the brushing technique was re-instructed and teeth were professionally cleaned using a rubber cup, polishing brush and fluoride containing polishing paste (Zircate®, Dentsply International, Belgium) [Gizani, 1998]. If a patient did not return for a recall visit, the parents were contacted by phone or by mail and were invited to make a new appointment.

Oral health outcome. Oral health outcome was measured at the level of hard tissues (increment of dmfs and subindices, outcome of sound surfaces and surfaces with initial lesions at baseline, outcome of restorations), oral hygiene, gingival condition and microbial load. In order to identify factors with a significant impact on dmfs-increment, the children were regrouped according to the number of tooth surfaces that developed signs of caries experience (new dm, new m or new f-surface) during the follow-up period. This yielded a group of 31 children with a dmfs increment of ≤4 and 29 children with dmfs increment of ≥5. This level of dmfs-increment was chosen according to the clinical guidelines for caries risk assessment issued by the Royal College of Surgeons in the U K
The following variables were considered: socio-demographic situation of the child (age, gender, educational level of mother/father, family situation and size, rank order of child, work situation of mother), reported oral health habits at baseline and at 1-year recall (brushing frequency, help with brushing, type and quantity of toothpaste used, fluoride supplements, total number and between-meals sugar occasions), oral condition at baseline and at 1-year recall (extent of plaque accumulation, gingival inflammation, bacterial load -tongue and plaque samples, dmfs-score at baseline, initial lesions), follow-up group (standard or test) and level of dental anxiety (at baseline and at 1-year recall).

Statistical analysis. Differences between test and control group, at baseline and at the 1-year recall visit, were tested by Wilcoxon (continuous variables) and Fischer's exact tests (discrete variables). Intra-group changes (baseline versus 1 year) were tested by marginal homogeneity tests. The inter-group differences in the mean change of the sub-indices of the dmfs-scores during the 1-year period, were tested with an unpaired t-test. Chi-square tests (2x2) were used to analyse inter-group differences in the 1-year outcome of initially sound surfaces and surfaces with initial lesions. For the analysis of factors relevant for treatment outcome, variables were analysed using univariate analysis with dmfs-increment as response variable. For the multiple analysis, the logistic model was constructed by a backward selection criterium starting with the variables which were significant at the 20% level in the univariate analysis. Then the remaining variables were entered. The significance level of all tests was set at 5%.

Results

Drop-out rate. From the whole group of patients, who initially entered the program, 60 children (61.2%) completed the study: 28 children from the control group (59.6%) and 32 from the test group (62.7%). The main reasons for drop-out, reported by the parents, were: difficulties to comply with the frequency of recall visits during the year (e.g. unsuitable working schedule of the parents, frequent sickness of the child), family problems (e.g. divorce) and a negative parental attitude towards the program. The mean age of the children that dropped out was 4.9 (SD = 1.1) years and the group comprised 21 boys and 17 girls. No differences were found with children that completed the study regarding family profile, oral health condition before treatment and habits reported by the parents at baseline. More information is presented in Table 1.

Caries experience. Children from the control and the test group entered the study with a comparable caries experience (mean dmfs: 21.9 ± 10.8 and 25.0 ± 11.3, p=0.27). The changes in dmfs subindices and number of initial lesions during the 1-year follow-up period are summarized in Figure 1. A n average increase of the total dmfs-score with 5.6 units was seen in the standard group (Table 1). In the test group the increase was lower (3.9 units) but not significantly different (p>0.05). The dmfs-score remained unchanged for 10.7% of the children from the standard group and 31.2% of the test-group children (p>0.05).

As illustrated in Figure 2, most of the surfaces that were sound at baseline remained sound during the follow-up period, in both groups (92.5% in the control group; 92.3% in the test group). Surfaces with initial lesions at baseline (Fig. 3) were scored as sound at the 1-year recall examination in 19.3% of cases in the control group and in 27.8% of the cases in the test group. Most of the initial lesions in the control group and in the test group progressed to the stage of cavitation or were filled during the follow-up period. Differences between both groups did not reach statistical significance.

The number of restorations that were placed during treatment under general anaesthesia (at baseline) in both groups and their position in the mouth (anterior/molar teeth) is shown in Table 2. At the 1-year recall examination, 67% of the restorations in the control group and 73.9% in the test group were found to be clinically acceptable. Reasons for failure of restorations were classified as loss/fracture of the restoration (with or without recurrent caries) or secondary caries development at the margins of the restoration. Deficient restorations (loss/fracture) without evidence of caries were seen in 12.9% and 10.1% of the restorations in control and test groups. Caries was present (with/without intact restoration) in 20.1% and 16.0%, respectively. Differences between standard and test group did not reach significance. Overall, the success rate of restorations in anterior teeth (adhesive, composite material in combination with acid etch technique) was considerably lower than for amalgam restorations.
in molar teeth. Reasons for failure of restorations in anterior teeth were more often attributed to technical reasons (preparation/application technique, properties of the material used) than to recurrence of disease. In primary molars a different picture was seen where recurrent caries

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<th>TABLE 1 - Descriptive statistics for a study on treatment outcomes after treatment under general anaesthesia</th>
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<tr>
<td><strong>NUMBER OF CHILDREN</strong></td>
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<td>- at 1-year recall</td>
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<td><strong>AGE (mean number of years ± SD)</strong></td>
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<td>- whole group</td>
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<td>- children that completed the study</td>
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<tr>
<td><strong>GENDER DISTRIBUTION (number of boys/number of girls)</strong></td>
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<td>- children that completed the study</td>
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<td><strong>Caries experience at baseline (before general anaesthesia)</strong></td>
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* = Wilcoxon matched-pairs signed ranks test

**FIG. 1** - Changes in dmfs-subindices and number of initial lesions between baseline and 1-year recall examination.
- tooth surfaces;
- ms=surfaces extracted due to advanced decay;
- fs=filled surfaces; ins=surfaces with initial lesions

**FIG. 2** - Status of sound surfaces present at baseline after 1-year follow-up period (* = p-values <0.05 for difference between control and test group).

**FIG. 3** - Status of initial lesions present at baseline after 1-year follow-up period (* = p-values <0.05 for difference between control and test group).
at the margins of the restorations was a frequent finding.

Oral hygiene and gingival condition. The data on oral hygiene and gingival condition are presented in Table 3. At baseline, children from both groups had a comparable extent of plaque accumulation adjacent to the gingival margins as well as degree of gingival inflammation (p > 0.05). At the 1-year recall, oral hygiene and gingival condition showed significant improvement (p<0.01) in both groups of children but no intergroup difference could be detected.

Microbial load. At baseline, children from both groups had comparable mean counts of S. mutans as well as lactobacilli (Table 3). At the 1-year recall, the total counts of S. mutans (both in tongue-loop and plaque samples) were significantly lower than at baseline (p<0.01), in both groups of children without inter-group differences in reduction (Table 3). The mean number of lactobacilli, however, did not change neither in children from the test or control group. Changes in the detection frequency of S. mutans and lactobacilli were also found. An average increase of 15% was seen in the number of samples without S. mutans at the 1-year recall visit and this in both groups of children and both sample types (plaque/tongue-loop). In the case of lactobacilli, the opposite picture was seen.

Factors significant for dmfs-increment. Univariate analysis showed that none of the variables examined had a significant effect on the variation in dmfs increment that was observed. When variables significant at the 20% level were included in a multiple analysis, none reached significance.

Discussion

Most of the children included in this study experienced a considerable increase in dmfs-score during the 12-months follow-up period. When comparing this increase with data from an earlier studied group of 4 and 5-year old children, visiting the university school health care centre, the increase was 4 to 5-fold higher [Carvalho et al, 1998]. The increase in caries experience score in the present study was almost completely attributable to an increase in the ds-component. Although the increase was not significantly different between the standard and test group, results were always in favour of the test-group children. Caries activity remained high in both groups.

A considerable drop-out rate was seen in both groups of children. This confirms earlier reports [Benitez et al, 1994; Berkowitz et al, 1996]. No difference in drop-out rate was seen between the children from the control group and those participating to the intensive preventive follow-up program (test group). The compliance of parents was generally low. This should be taken into consideration when specific programs are designed for this patient population.

More than 60% of the initial lesions present at

![Table 2](image-url)
baseline progressed to the stage of cavitation and this in both groups of children. Benitez and co-workers [1994] reported their experience with a preventive approach for the treatment of incipient nursing bottle caries in small children. Their program consisted of instructions on oral hygiene and dietary habits and fluoride gel applications. The study was discontinued after three months because of an important increase in the number and severity of the lesions and poor compliance of the parents with the study protocol. Taking into consideration these findings, it is important to realise that initial lesions present in highly caries-active children should be handled with caution since a preventive approach will often lead to failure. A restorative approach will be preferred, certainly when dental treatment under local anaesthesia is difficult or impossible because of limited co-operation.

Restorative treatment showed considerable failure rates. Restorations on anterior teeth presented problems with retention. This underlines the need for a continued search for better adapted materials and techniques for the aesthetic restoration of primary anterior teeth. As a result of this follow-up study, a modified technique for the restoration of primary front teeth, including the covering of a large part of the buccal surface, was introduced [Donly and Browning, 1992; Piyapinyo and White, 1998]. In the molar region, retention was not the main problem but disease recurrence was. In the literature high success rates have been reported for stainless steel crown restorations on primary molars. The complete covering of the remaining tooth structure reduces retention problems and prevents disease recurrence [Roberts and Sheriff, 1990]. A recent evaluation of treatment efficacy of preformed metal crowns versus amalgam restorations in primary molars requiring multisurface restorations, showed a more favourable outcome for preformed metal crowns with greater longevity and reduced treatment need [Randall et al, 2000]. It is not clear whether results are comparable when crowns were placed under general anaesthesia.

Children from both groups showed a reduction in the extent of plaque accumulation at the 1-year recall examination, without significant differences between both groups. A more thorough analysis of
the results showed that the SBI/PI-score in the standard group was 0.50 at baseline and 0.75 at the 1-year recall visit, while for the test group this was 0.58 and 0.66 respectively. The decrease in the extent of plaque accumulation was not followed by a decrease of the SBI-scores in the standard group. A possible explanation for this could be that children from the control group brushed their teeth very well prior to the dental visit but not constantly through the year. These findings could also reflect an effect of the regular professional mechanical tooth cleaning sessions in the children from the test group. Results indicate the need for specifically trained personnel to take care of this group of children. At present dental hygienists are not recognised in Belgium.

Microbiological findings showed that the dental rehabilitation of the children resulted in a significant reduction in S. mutans counts and their detection levels, and this in both groups. A similar picture was described in a recent study by Litsas et al. [1998]. These authors reported that full-mouth rehabilitation alone of 2-5 year old children with nursing caries under general anaesthesia resulted in a statistically significant decrease in S. mutans levels 3 months later (maximum period tested). In the present study the mean counts of S. mutans at the 1-year recall examination were below 3x10^5 cfu/mL which is often considered as the threshold level in saliva for caries development [Zickert et al, 1987]. The individualised preventive program apparently did not result in an additional reduction. In this respect, it is interesting to be reminded of an earlier report where it was shown that S. mutans levels were not affected until 3 years after institution of an intensive preventive program, despite the fact that caries activity decreased during the first year of that program [Carlsson et al, 1988].

It is also interesting to point out that lactobacilli counts were not affected by the total dental rehabilitation. The elimination of retention sites by treating the lesions was not enough to reduce bacterial numbers. Restoration of the lesions increased the surface area of foreign material (restorations) and possibly offered an opportunity for (re)colonisation. Although lactobacilli counts are influenced by the frequency of sugar consumption [van Houte, 1980], no decrease was seen in the test group despite a considerable reduction in the frequency of sugar consumption by these children (data not shown). As Carlsson [1989] suggested, a much more drastic change in the diet is probably necessary to affect counts of lactobacilli.

Multiple logistic regression did not yield a single factor that was related to the variation in dmfs-increment that was seen. The low number of children that completed the study could be responsible for this. The poor results obtained in this intensive preventive follow-up program for children with established rampant caries underline the importance of primary prevention. Recently Kowash et al [2000] demonstrated the effectiveness of dental health education in preventing the occurrence of nursing caries. Parents and children were regularly visited by trained dental health educators, commencing at or soon after the time of eruption of the first deciduous teeth.

Conclusions

The present study showed that caries activity continued to be a problem for most children with rampant caries after they received total dental rehabilitation and this despite an improvement in oral hygiene and microbial load reduction. Failure rates of restorative treatment were considerable and as a result of this survey an adaptation of the techniques used was introduced. The intensive follow-up program presented here was not able to influence treatment outcome but a longer follow-up period and larger groups of children are necessary to reach definitive conclusions. When designing programs for this patient group, a high drop-out rate should be expected. All of these findings underline the importance of the primary prevention of rampant caries in young children.

References


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