Scientific Article

Dental Health and Treatment in a Group of Children with Congenital Heart Disease

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Abstract: *Purposes: The purposes of this study were to: (1) determine the prevalence of dental caries and developmental enamel defects in children with congenital heart (CHD) disease; and (2) evaluate previous dental treatment.* **Methods:** *One hundred and seventy-six 2- to 16-year-old children were examined during their outpatient cardiology appointment. The study group consisted of 86 CHD children. Sixty healthy children formed the control group.* **Results:** *Mean dmft and DMFT scores were 1.57 (±3.01 SD) and 0.77 (±1.42) for the study group and 1.81 (±3.64) and 0.38 (±1.16) for the control group, respectively. Eight out of 86 CHD children and 5 out of 60 healthy children had enamel defects on their permanent teeth. No significant differences were demonstrated between the 2 groups. The care index for primary teeth was 10% for the study group and 3% for the control group. In permanent dentition, the care index was 30% and 16%, respectively.* **Conclusions:** *Children with and without congenital heart disease had similar levels of dental disease. The care index for primary teeth was higher in CHD children, although the overall level was very low.* (Pediatr Dent 2008;30:323-8) *Received May 10, 2007 Last Revision August 23, 2007 | Revision Accepted August 29, 2007*

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Congenital heart disease (**CHD**) is the most common group of congenital abnormalities (**CA**s), accounting for approximately 30% of all CAs. The incidence of CHD is approximately 8 per 1,000 live births.[1] Early diagnosis, advances in neonatal care, and the increasing success rates in surgical management have resulted in the survival of infants with previously fatal CAs. The increase in the survival of children with CHD is a particular challenge for the pediatric dentist, who needs to provide these children with safe and appropriate dental care.

Studies investigating the caries experience of children with congenital heart disease have produced different findings. These studies are summarized in Table 1. The influence of CHD on the developing dentition is not clearly documented, although there are reports in the literature of enamel defects and microdontia in affected individuals.[2,3] Cyanotic children suffer from chronic hypoxia, which has been suggested as one of the causes of disturbance in ameloblastic activity during enamel formation.[4,5]

Unfortunately, a consistent finding is the high level of untreated dental disease in children with CHD.[6,7] For instance, in Berger's study it was found that cyanotic children had more actively carious teeth and the lowest levels of treatment when compared with healthy children.[8]

The aims of this study were to:

1. determine the existing levels of dental caries and developmental enamel defects in children with CHD compared to a control group of fit and healthy children; and
2. evaluate treatment provision in a group of children with CHD.

Methods

The study group consisted of children attending the outpatient clinic of the Pediatric Cardiac Department at Leeds General Infirmary (**LGI**), Leeds, UK, between November 2003 and May 2004. Dental examination of the children participating in the study was performed during the children's regular appointments at the outpatient cardiac clinic. A questionnaire was also given to the parents to complete during their child's dental examination. Ethical approval was obtained from the Research Ethics Committee of Leeds (West), located in the General Infirmary at Leeds, UK.

Children were included in the study group if they were:

1. between 2 and 16 years old with CHD diagnosed during their first year of life;
2. without any concomitant diseases or syndromes, apart from CHD; and
3. at risk of infective endocarditis, according to guidelines produced by the British Society of Antimicrobial Chemotherapy that were current at the time of the study.[9]

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The control group consisted of healthy children who were referred to the outpatient cardiac clinic for investigation of a heart murmur and who were subsequently diagnosed without any heart disease. Healthy children who were regularly followed-up by the cardiology team due to family heart problems (eg, cardiomyopathy) were also included. Control group children were examined during their clinical appointments at LGI's outpatient cardiac clinic in the same standardized way as the study group. Written consent was obtained from all parents and from all children who were older than 5 years of age.

All the children who participated in the study were examined by a single investigator in a separate consultation room. The oral examination was performed according to World Health Organization guidelines for oral health surveys.[10]

Training of the investigator was carried out for caries diagnosis according to the British Association for the Study of Community Dentistry (**BASCD**) criteria and for the diagnosis of developmental enamel defects according to the modified developmental defects of enamel index.[11,12] Training was tested against a previously calibrated dentist.

Each child's age, sex, and race were recorded. Socioeconomic status also was recorded using the Townsend index—an index of material deprivation.[14]

Decayed, missing, and filled teeth were recorded for primary (dmft) and permanent (DMFT) teeth of children in both groups. To assess intraexaminer reproducibility, 10% of the children examined were re-examined by the investigator during their recall appointments.

All data from the dental examination and answers to the questionnaire were analyzed using SPSS for Windows statistical software (v. 11.5, SPSS Ltd, London, UK). A nonpaired comparison of the data was made using the 95% confidence interval of the difference of the means for metric data or of the difference in proportions for categorical data. To calculate the P-value for statistically significant results,[13] the Mann-Whitney and chi-square tests were also employed in cases where the 95% confidence intervals showed a statistically significant difference.

Table 1.	LITERATURE REVIEW OF STUDIES REPORTING DENTAL CARIES IN CHILDREN WITH HEART DEFECTS*					
Author (year)	**N**	**Age (ys)**	**Dmft (mean)**	**DMFT (mean)**	**Caries free**	
Berger[8]	57 CHD 57 control	8-10	**Cyanotic:** higher incidence of dt, DT, MT; lowest levels of treatment			
Urquhart and Blinkhorn[29]	134 CHD	4-12	**4-6 ys:** 3.34 **7-9 ys:** 3.26	**10-12 ys:** 5.03		
Pollard and Curzon[20]	100 cardiac 100 control	2-16	**2-4 ys:** 1.81 study 1.63 control **5-9 ys:** 4.32 study† 2.77 control†	**5-9 ys:** 0.58 study 0.45 control **10-16 ys:** 1.81 study 1.62 control	35% study 47% control	
Hallett et al[6]	39 CHD 33 control	1-15	4.2 study† 2.3 control†	0.9 study 0.6 control	31% study 36% control	
Franco et al[7]	60 CHD 60 control	2-16	**2-10 ys:** 3.7 study 3.9 control	**5-16 ys:** 2.7 study 2.0 control		
Hayes and Fasules[30]	209 waiting for cardiac surgery	6 mos- 14 ys	29% with caries 7% with abscess			
Da Silva et al[31]	104 at risk of IE	2-17	2.62	3.97		
Balmer and Bu'Lock [28]	38 at risk of IE	2-16	39% with untreated caries	–	42%	
Stecksen-Blicks et al[21]	41 CHD 41 control	2-11	**dmfs:** 5.2 study† 2.1 control†	**DMFS:** 0.9 study 0.3 control		

* dt=decayed primary teeth; DT=decayed permanent teeth; MT=missing permanent teeth; CHD=congenital heart disease; IE=infective endocarditis.

† Statistically significant difference.

Results

A total of 176 children were examined. No families refused to participate in the study. Twenty-one children were excluded due to concomitant medical conditions, and 9 were excluded because their cardiac diagnosis was made after 1 year of age. Of the remaining 146 children, 86 children composed the study group. The control group consisted of 60 healthy children attending the outpatient cardiac clinic at LGI. Most of these children (80%) had been to the cardiac clinic for the first time to investigate a previously undiagnosed heart condition. After examination from the cardiology team, no heart defect was found and they were discharged with a clear history. The rest (20%) consisted of healthy children who were followed-up by the cardiology team because of family history of congenital or other hereditary heart defects.

Table 2.	MEAN VALUES (±SD) OF DECAYED, MISSING, AND FILLED PRIMARY TEETH (dmft) OF STUDY GROUP CHILDREN WITH CONGENITAL HEART DISEA AND CONTROL GROUP CHILDREN	
	Study group N=76	**Control group** N=47
Age range (ys)	2-15	2-12
Mean age±SD	6.11±3.06	5.26±2.84
Mean dt±SD	0.78±1.52	1.42±3.46
Mean mt±SD	0.63±2.70	0.29±1.07
Mean ft±SD	0.16±0.52	0.06±0.24
Mean dmft±SD	1.57±3.01	1.81±3.64

* There was no difference in any of the means according to the 95% confidence interval.

Table 3.	MEAN VALUES (±SD) OF DECAYED, MISSING, AND FILLED PRIMARY TEETH (dmft) OF STUDY GROUP CHILDREN WITH CONGENITAL HEART DISEA AND CONTROL GROUP CHILDREN	
	Study group N=48	**Control group** N=47
Age range (ys)	5-15	5-15
Mean age±SD	9.42±2.81	10.31±3.11
Mean dt±SD	0.33±0.75	0.31±1.12
Mean mt±SD	0.21±0.77	0±0.00
Mean ft±SD	0.23±0.93	0.06±0.35
Mean dmft±SD	0.77±1.42	0.38±1.16

* There was no difference in any of the means according to the 95% confidence interval.

The mean age of the children in the study and control groups in years was 6.88 (±3.62 SD) and 7.02 (±4.25), respectively with a range of 2 to 15. There was no statistically significant difference in the mean age between the study and control groups. There were no significant differences in the sex, race, and Townsend index scores of the 2 groups.

The results for primary teeth are summarized in Table 2. The mean dmft scores (±SD) for the study and the control groups were 1.57 (±3.01) and 1.81 (±3.64), respectively. The control group had a higher level of untreated decayed teeth, while the study group had a higher level of missing teeth. These differences, however, did not reach statistical significance.

The results for permanent teeth are summarized in Table 3. The mean DMFT score (±SD) for the study group was 0.77 (±1.42) and for the control was 0.38 (±1.16). There were no statistically significant differences between the 2 groups.

The proportions (mean ft/mean dmft) and (mean FT/mean DMFT), expressed as a percentage, represent the care index for primary and permanent dentitions, respectively. The care index for primary teeth was 10% in the study and 3% in the control group. This 7% difference between the 2 groups was found to be statistically significant (95% confidence interval from 2% to 13%, P=.02) for care index. Evidence of untreated decay (dt>0 or DT>0) was found in 33% of the children in the study group. The same level of untreated decay was found for the control group children.

Eight of the 86 study group children and 5 of the 60 control group children were found to have enamel defects on at least 1 permanent tooth. Of these, 1 control group child and 2 study group children had their permanent first molars affected, whereas 2 control group children and all study group children had more than 1 of their permanent incisors affected.

The presence of fissure sealants was investigated in children with erupted permanent first molars. Twenty percent of these control group children and 21% of these study group children had at least 1 fissure sealant on a permanent first molar. Although there were no differences between overall levels of fissure sealants in the 2 groups, further examination of the data for the study group showed that 30% of children with caries and 8% of caries-free children had 1 or more fissure sealants. This difference was statistically significant (P=.02) for fissure sealants.

The kappa score to determine the intraexaminer agreement for the diagnosis of caries was 0.89 (indicating very good agreement) and for developmental enamel defects was 0.75 (good agreement).[15]

Discussion

The study group consisted of a convenience sample of 86 children attending the outpatient cardiac clinic at LGI. Most children were Caucasian, and this reflected the predominant Caucasian population of the Yorkshire region.[16]

One of the inclusion criteria for the study group was an increased risk of the child developing infective endocarditis from dental bacteremia. Increased risk was defined by UK guidelines that were current at the time of the study.[9] These guidelines have changed and radically alter aspects of the management of a number of these patients (ie, the appropriate use of antibiotic prophylaxis).[17,18] The risk status (ie, the lifelong risk) for particular cardiac conditions, however, remains high relative to healthy children. The inclusion criteria for this study, therefore, remain valid even under the revised guidelines.

Both study and control groups had more affluent socioeconomic backgrounds compared to the Yorkshire population, according to the Townsend material deprivation index.[19] This probably reflected the fact that both groups were drawn from children attending their outpatient appointments, which may have selected out families of lower socioeconomic status who tend to have a higher failure rate at recall. There was no difference, however, in the socioeconomic status between the 2 groups.

The control group was particularly suitable because most of the children attended the cardiology clinic for the first

time and, after examination, they were each discharged with a clear history. A further advantage was that the examiner was blinded to the children's medical diagnosis at the time of examination.

No significant differences in caries experience in the primary or permanent dentitions between study and control groups were found. This finding agreed with Franco et al, who found that caries experience in primary and permanent teeth was similar between CHD children and healthy children.[7] By contrast, Hallett et al found that caries experience in the primary dentition was significantly higher for cardiac children.[6] The authors suggested several predisposing factors, including the increased tooth susceptibility to caries from the presence of enamel defects, the chronic intake of sweetened medication, and the more frequent exposure of these children to sweet snack foods due to parental indulgence. Pollard and Curzon also found a significantly higher dental caries experience in 5- to 9-year-old cardiac children.[20] There were no obvious reasons for this significant difference within this narrow age group and the authors suggested that it may also be a chance finding. Stecksen-Blicks et al found in CHD children an increase in caries levels that was associated with long term digoxin treatment.[21]

Overall, the caries level in this study was low in both groups and both dentitions and was, indeed, lower than recent national survey data for the local area (City of Leeds).[22] This may have been due to the socioeconomic bias of the 2 groups and also—certainly compared to some of the older studies—an overall trend in a reduction in caries experience over several years.

Unlike previous studies, this study excluded children with concomitant medical disease. This was to eliminate variables caused by the impact of other medical conditions or a disability on the dentition and may have had the effect of lowering the study group's overall disease level.

The care index, which reflects the restorative care of those who have suffered the disease, was 10% for the study and only 3% for the control group.[23] Although the care index was higher for the cardiac children, it still showed a very limited provision of restorative care to primary teeth. A similarly low care index of 13% was reported for 5-year-old children across England and Wales in the 2001/2002 BASCD survey.[24] These low levels of restorative care for caries in primary teeth are probably a reflection of the reluctance of general dental practitioners nationally to restore primary teeth, especially in medically compromised children.[25]

In 2000, Parry and Khan investigated the views of 271 dental practitioners regarding the treatment of medically compromised children.[26] The median number of CHD children treated by each practitioner in a 5-year period was 2. Only 37% felt confident in providing dental treatment for children with cardiac disease, while 80% of the respondents stated they would benefit from further regular training. A similar low care index was found in the permanent dentition.

The relatively higher care index found in CHD children compared to the control group in this study may be due to the proximity of the cardiac unit to the local teaching hospital and the strong links to the specialist pediatric dentistry department there.

The fact that the missing component (mt) of dmft was higher in the study group may reflect guidance that pulpally involved primary teeth in these children should be extracted rather than restored. It also suggests that these teeth might have been treated late, which may, therefore have resulted in a lengthy exposure of affected children to odontogenic bacteremia prior to treatment. In addition, the higher levels of extracted teeth in this group may lead to an increased incidence of orthodontic problems later in life.

Eight children (9%) in the study and 5 (8%) in the control group had at least 1 of their permanent teeth affected with diffuse or demarcated opacities. This is consistent with previous studies, which have indicated an overall population prevalence rate of 4% to 25%.[27]

Hallett et al reported that significantly more CHD children had at least 1 of their primary teeth affected compared to the controls.[6] The authors suggested that enamel hypoplasia in cardiac children may be due to systemic disturbances, such as cardiac failure and surgical complications associated with cardiac disease.

By contrast, Franco et al did not find significant differences in enamel defects between cardiac and healthy children.[7] The proportion of children affected, however, was much higher compared to the present study. Since 86% of the study group children had suffered mild or moderate CHD, the effect of the disease during enamel formation would be milder compared to children with severe CHD. This might be an explanation for the small number of children found with enamel defects in the study group. It could be also suggested that early intervention and successful management of CHD has reduced the degree and duration of systemic disturbances, such as cyanosis, during the early stages of tooth formation. Therefore, a reduction in the prevalence of enamel defects may be expected in CHD children compared with previous studies.

The low number of children with fissure sealants in both groups was surprising, as a higher level of preventive care, at least for children at risk of infective endocarditis, was expected. The fact that more than half of the cardiac children were caries free may have misled dentists to overlook prevention. Similar findings have been reported by Balmer and Bu'Lock, who found that only 8% of the CHD children had fissure sealants despite regular dental care.[28] Nevertheless, significantly more cardiac children with caries had received fissure sealants compared to caries-free children. This could mean that dentists provided preventive advice and treatment after the occurrence of dental disease.

One of this study's limitations is that the population was one for which specialist pediatric dental support was readily available. This may explain some of the results, such as the

relatively high number of missing teeth and the higher care index in the study population. Therefore, care needs to be exercised in extrapolating results to areas which are more remote from specialist pediatric dental services.

A further limitation is that the sample was not truly random, but is a convenience sample. This may have biased the sample by excluding children who failed to attend the review appointments. It should be noted that both study and control groups had dental disease levels lower than national figures for the Leeds area, thereby making differences between the 2 groups more difficult to identify.

One of the main concerns highlighted by this study is the high number of extracted primary teeth implying late presentation for treatment. Dentists need to monitor children with cardiac disease very closely and be prepared to intervene early if disease is noted. Pulpal involvement of the primary teeth in these children has significant implications, both for the prognosis of the affected teeth and for the general health of the child.

A further issue is the low level of preventive care reflected in the low level of fissure sealants provided to the study group. Children with cardiac disease should be regarded a high priority for dental prevention, and fissure sealants of permanent first molars should be part of their routine care.

Conclusions

Based on this study's results, the following conclusions can be made:

1. There was no significant difference in caries experience or prevalence of enamel defects between children with CHD at risk of infective endocarditis and healthy children.
2. Restorative care for decayed primary teeth was higher in CHD children but still extremely low. Children in this group had high levels of missing primary teeth, implying late presentation for treatment.
3. Preventive treatment based on placement of fissure sealants was extremely low in CHD children but increased if they became high risk for dental caries. Fissure sealants had not been universally provided to all CHD children.

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Abstract of the Scientific Literature

Facemask therapy with and without expansion

This study compared the effects of facemask treatment with and without expansion in patients with skeletal Class III malocclusion. Three groups of 14 children each were included. The facemask with expansion group (FMEXP) consisted of 8 girls and 6 boys, mean age 11 years 1 month, wearing a Delaire-type facemask and a bonded rapid maxillary expansion appliance. The facemask only group (FM) consisted of 8 girls and 6 boys, mean age 11 years 6 month, wearing a Delaire-type facemask and a removable appliance. A retrospective control group of 14 children (7 girls, 7 boys; mean age, 10 years 4 months) was observed without treatment for 10 months. The average treatment times were 8 months for the FMEXP group and 7 months for the FM group. Lateral cephalograms were taken at baseline and at the end of treatment, which was defined by achieving Class I molar occlusion and obtaining a minimum of 2 mm overjet. All radiographs were traced, digitized, and analyzed with the Jiffy Orthodontic Evaluation program (discontinued product). Ten linear and 13 angular measurements were evaluated. Authors concluded that: 1) facemask treatment can be effective; 2) it corrects Class III primarily through skeletal change; and 3) there is little difference between using concurrent expansion vs. no expansion.

Comments: *The maxilla articulates with 9 other bones in the face. It was thought that expansion would disrupt the sutures and enhance the protraction effect. This study showed that protraction alone could achieve excellent anterior-posterior correction. For those patients who are Class III skeletal but who do not have posterior crossbite, an expansion appliance may not be necessary. **RHH***

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