Acta Odontologica Scandinavica, 2013; 71: 1418–1422

informa
healthcare

ORIGINAL ARTICLE

Survival of primary molar restorations in four birth cohorts—A retrospective, practice-based study

TAINA KÄKILEHTO[1], SINI VÄLIMÄKI[2], LEO TJÄDERHANE[2,3], HANNU VÄHÄNIKKILÄ[2], SINIKKA SALO[4] & VUOKKO ANTTONEN[2,3]

[1]*Municipal Health Centre, Dental Teaching Unit, City of Oulu, Finland,* [2]*University of Oulu, Institute of Dentistry, Finland,* [3]*Oulu University Hospital, Oulu, Finland, and* [4]*Municipality of Oulu, Finland*

Abstract

Objective. Paediatric restorative dentistry continues being a challenge in everyday clinical practice. Practise-based survival analysis covering entire age cohorts offer an epidemiological approach to this issue in studying survival of restorations in primary teeth. The aim of this study was to compare survival of restorations in primary molars in 1985, 1990, 1995 and 2000 age cohorts associated with some population-related factors. ***Material and methods.*** Data from dental records of the entire cohorts were obtained from the Health Centre of Kemi, Finland covering the period 1989–2009. The longevity of the restorations was illustrated using the Kaplan-Meier survival curves and tested with log-rank test and Cox proportional hazards regression analysis. The retrospective caries risk definition for individuals was based on the early restorations in the first permanent molars. ***Results.*** Total number of the placed restorations was 2755. Survival of the restorations was the shortest in the 1995 cohort and the longest in the 1985 cohort ($p < 0.001$). The greatest deterioration was between the cohorts in 1990 and 1995. Survival was also shorter for the children at high risk for caries compared with the low risk children ($p < 0.001$). ***Conclusions.*** Survival of the restorations shortened distinctly towards the younger cohorts and was also shorter for the high risk compared with the low risk children. Due to the variety of materials in paediatric dentistry, handling them carefully according to manufacturers' instructions must be emphasized to avoid failures of restorations due to technical reasons. Also, non-invasive treatment must always be given together with invasive treatment.

Key Words: *primary molar, restorations, survival, Kaplan Meier, caries risk*

Introduction

In clinical practice paediatric restorative dentistry continues to be a challenge. In primary teeth, dental caries progresses approximately twice as fast as in permanent teeth [1]. Although the life-span of primary teeth in the oral cavity is short compared to that of permanent teeth, long survival of restorations in primary teeth is both economic and patient-friendly. Ideally a restoration lasts until the tooth exfoliates.

Until the 1990s, amalgam was commonly used in restorative treatment of primary teeth in Finland. Popularity of amalgam, however, collapsed quickly when its possible health and environmental effects became a topic of general interest. Therefore, within a few years significant changes took place in use of restorative materials in paediatric dentistry and the selection of tooth-coloured restorative materials and their use expanded in Finland [2]. Conventional glass ionomer (GIC) has been a widely used alternative for amalgam in restorations because of its cariostatic potential [2]. However, its failure rate was considerable [3]. Resin-modified glass ionomers (RMGIC) and compomers, both cariostatic and durable, have become popular in paediatric restorative dentistry and have been found to be nearly as durable as amalgam [4].

Studies have suggested that children with several caries lesions at the time of restoration placement are at higher risk for replacement of restorations than those who have only a few decayed teeth [5]. Also damaged, restored tooth surfaces tend to become decayed more easily than sound surfaces [3]. Also those with early childhood caries (ECC) often have high caries experience also later in life [6]. Due to an

Correspondence: Vuokko Anttonen, University of Oulu, Institute of Dentistry, POB 5281, 90014 Oulu, Finland. Tel: +358 40 7137079. Fax: +358 8 5375560. E-mail: vuokko.anttonen@oulu.fi

(Received 11 June 2012; accepted 22 December 2012)

ISSN 0001-6357 print/ISSN 1502-3850 online
DOI: 10.3109/00016357.2013.766359

intensive prevention programme, children's caries experience decreased substantially in Finland during the 1970s and 1980s [7]. However, in the 2000s there have been indications of the deterioration of dental health among the young [8]. Polarization of dental caries among children also still exists [9].

Several methods have been used to assess the risk for getting decay. One commonly used indicator for assessing high and low caries risk is the number of decayed, missing and filled teeth. Caries lesions in three or more primary teeth [9] or in more than two surfaces of second primary molars may predict high caries risk [10]. Also a restoration due to caries in any first permanent molar during the year of eruption indicates a high risk of need for restorations in the rest of the molars [11].

The majority of the recent studies on longevity of restorations focus on clinical longevity of specific dental materials during the follow-up period, e.g. glass ionomer cement (GIC) and resin-modified glass ionomer cement (RMGI). Such studies usually have limited size study groups [12,13]. When the entire history of teeth in an entire age cohort is available from dental records, longevity of restorations can be examined by using the Kaplan-Meier survival analysis [14]. Longitudinal or retrospective, practice-based studies can give true information about the longevity of restorations. There are longitudinal studies on the longevity of restorations in adult cohorts, but none on longevity of primary teeth restorations in different age cohorts.

The aim of this practice-based study was to investigate the longevity of restorations in the first and second primary molars in 1985, 1990, 1995 and 2000 age cohorts using Kaplan-Meier survival analysis. The second aim was to analyse the association of caries risk and longevity of restorations in primary teeth.

The hypothesis was that survival of primary molar restorations may be poorer in more recent than earlier cohorts. Also it was hypothesized that caries risk affects survival of primary molar restorations.

Material and methods

In this epidemiological retrospective practice-based study the data were collected by data-mining [14] from the electronic dental records of four age cohorts in the Municipal Health Center of Kemi, Finland, covering the period 1989–2009. The cohorts studied were those born in 1985–1987 (cohort 1985), 1990–1992 (cohort 1990), 1995–1997 (cohort 1995) and 2000–2002 (cohort 2000). The follow-up period was in other age cohorts until the tooth shedding, but for those in the youngest cohort only up to 5–7 years.

The study sample included digitally recorded tooth-wise information on children's caries status in each examination, i.e. all incidences of caries lesions and restorations placed or replaced as well as materials used (amalgam or tooth-coloured). The sub-types of the tooth-coloured materials were not specified. Neither was the size (number of surfaces) of the restorations included in analyses. The treatment decisions as well as treatment were carried out by clinical practitioners without calibration (practise-based study). The proportion of children with no treatment history at 7 years in each cohort was calculated as well as number of extractions due to caries during the follow-up period.

In this study, a retrospective risk determination was used. A patient was assessed to be at high risk for dental caries if any restoration was placed in any of his/her first permanent molars during their year of eruption [11]. The mean value of 6.4 years was used as the age of eruption for the permanent first molars if the actual eruption age was not recorded in data files [15].

Statistical analysis

Non-parametric Kaplan-Meier survival curves (CDF curves) were drawn separately for each cohort illustrating replaced restorations in primary molars combining the first and the second molars. The Cox proportional hazards model was used to obtain hazard ratios (HR) and 95% CI for the association of the survival of the restorations and some predictor variables (age cohort, caries risk and gender).

In survival analysis of the restorations the follow-up starts from the date of its placement and ends in its replacement or repair or the tooth extraction. The replacement of a restoration leads to the end of survival. In real life, the exact survival time for each restoration is not always definable and consequently the restoration placement or replacement is recorded censored. If the initial placement date of restoration is missing, data are called left censored. Data are called right censored when restoration survives longer than followed or the restored tooth has naturally exfoliated. By using Kaplan-Meier method all observations, including the censored ones, are taken into account and losing any information is prevented [16].

Statistical analyses were carried out by using the SAS Windows (v. 9.2 SAS Institute Inc., Cary, NC) statistical software program. The statistical significance in differences of restoration survival times between groups was compared by using the log-rank test. The difference was considered to be statistically significant when the p-value was less than 0.05.

Results

The total number of the children was 4488 (2226 boys and 2262 girls). The proportion of children in each age cohort ranged from 20–30% of the total number in the study group (Figure 1). The proportion of children with intact teeth at 7 years varied from ~ 70% in the 1985 cohort to 80% in the 1995 and 2000 cohort (Table I). The number of extractions was small (42 in the 1985 cohort, 101 in the 1990 cohort, 37 in the

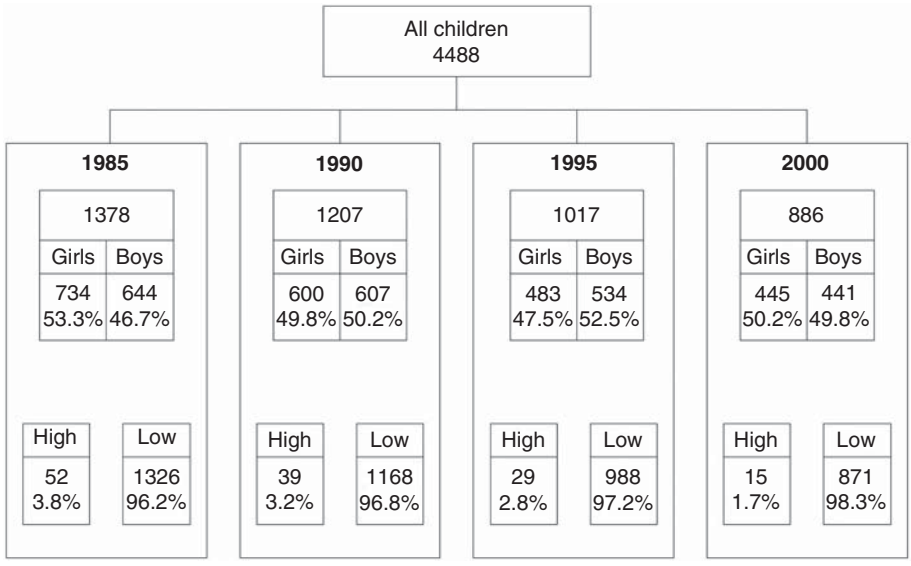

Figure 1. Number of the children by age cohort showing their distribution by gender and by the caries risk group (high/low).

1995 cohort and 16 in the 2000 cohort). The number of placed restorations in primary molars was 2755. Almost all fillings were tooth-coloured and the number of amalgam fillings was almost non-existent. Restorations in the 1995 cohort had the shortest and in the 1985 cohort the longest survival times. The greatest deterioration in the longevity happened between the cohorts in 1990 and 1995 (Figure 2). The differences in survival between the cohorts were statistically significant ($p < 0.001$). Pairwise comparisons showed statistical significance in differences between all cohorts. Survival times of the primary molars combined (Figure 3) as well as their restorations were significantly shorter in the high caries risk group compared with the low risk group ($p < 0.001$) (Figure 4A). The difference was most distinct in the 1995 cohort (Figure 4B).

Compared with the 1985 age cohort where the survival of the restorations was the best, risk for replacement increased significantly towards the more recent cohorts (1990 HR = 6.5 (3.9–10.9), 1995 HR = 19.1 (11.7–30.9) and 2000 HR = 10.5 (6.3–17.5)). The Cox regression analysis also revealed that gender caused no significant risk for survival of restorations. However, risk for failure of restorations was almost 3-fold for those with high caries risk compared to those with low risk (HR = 2.86 (2.02–4.07)).

Discussion

This practise-based epidemiological study showed that survival times of restorations placed in primary teeth are shorter in the more recent than in the earlier cohorts. The survival of the restorations in the 1985 age cohort was almost 100%. Survival of restorations dropped significantly between the cohorts 1990 and 1995. The restorations survived for a significantly shorter time in primary teeth of children at high risk for dental caries compared with those at low risk. Similar findings have also been reported by Trachtenberg et al. [5]. Longevity of only primary first and second molars were analysed because other primary teeth had very few restorations.

The strengths of this study are the study sample including the entire age cohort with frequent examinations at individual level and a follow-up period covering the whole history of all placed restorations for all other except the 2000 age cohort. Due to the retrospective nature of the study, there were no missing values. Data were collected from one public dental health centre with 100 dentists working in it during the study period, all following similar principles of treatment protocol for all cohorts. To the best of our knowledge, there are no previous epidemiological follow-up studies on longevity of primary tooth

Table I. Proportion of caries-free children at age 7 years in different age cohorts.

	Intact teeth at 7, Cohort			
	1985	1990	1995	2000
n (%)	955 (69.3)	883 (73.2)	813 (79.9)	709 (80.0)

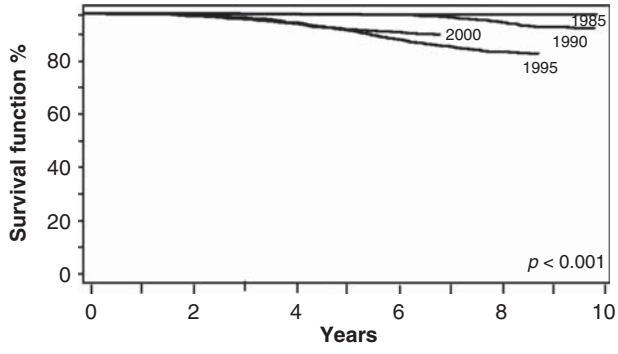

Figure 2. Kaplan-Meier survival curves for the restorations in the primary molars in the cohorts 1985, 1990, 1995 and 2000.

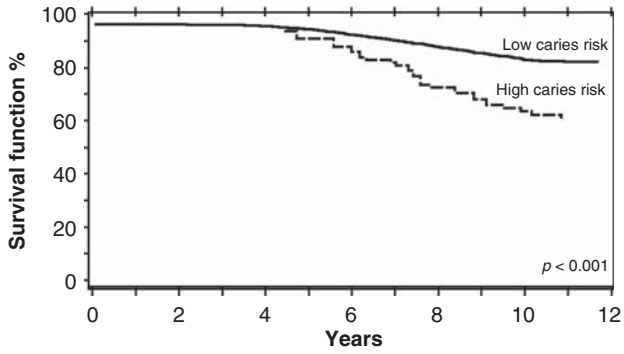

Figure 3. Survival of primary molars caries-free in high and low caries risk groups.

restorations in different age cohorts with a similar protocol. Conventional glass ionomer cements and resin-modified glass ionomer cements have been the major restorative materials in Kemi during the follow-up period. The weakness of this study was the lack of specification of the tooth-coloured materials.

In the 1985 age cohort hardly any fillings were replaced by a new one—that could have been the practice at that time, also children born at that time experienced the golden era of oral health promotion. At that time amalgam was still somewhat in use for primary molar restorations. In the 1995 cohort the number of the restorations needing replacement in primary molars was distinctly greater compared to the other cohorts. Since this was not a clinical study the actual reasons for placing the restorations are not known. However, it is known that in the 1990s the dietary habits started to become more unfavourable and snacking and soft drink consumption started to increase [17]. The change in dietary habits may have affected the high incidence of caries lesions needing primary and secondary restorations in the 1995 cohort. At that time also regular check-ups were replaced by an individual recall system; prolonged examination intervals have been shown to be associated with higher caries experience, maybe also with a higher replacement rate of fillings [18]. The risk children with several caries lesions usually remain at high risk for caries and, hence, for replacement of primary restorations [5]. Because changing oral health behaviour is difficult, it is typical that the factors favouring development of caries lesions persist also after restoring the tooth and secondary caries are likely to develop. Caries control and regular recalls must be emphasized for risk individuals, i.e. for children with restorations.

The practises in restorative work have undergone changes during the last decades [19]. Due to vast use of GIC and RMGIC materials preparations can be kept small; whereas the earlier 'extension for prevention' philosophy resulted in large restorations. On the other hand, larger restorations may be more vulnerable for secondary caries and replacements. The information about the size of the restorations could not be included in the analyses of the present study but, because of the large size of the study sample there are most likely a variety of sizes of the restorations in all cohorts and the effect of cavity size variations on the survival rates can be speculated to be minimum.

The use of amalgam in paediatric dentistry has been very low in Finland since the 1990s and in this study the use of amalgam was practically non-existent, making this study descriptive of the post-amalgam era. This was also found in the recent study by Forss and Vidström [20]. After amalgam the conventional glass-ionomer was a common choice to use in paediatric dentistry. A huge selection of restorative products introduced during the past two decades in paediatric dentistry can also partly explain the difference in the poorer survival of restorations between cohorts 1990 and 1995 [2]. It has been shown that the clinician's ability to handle any restorative material contributes significantly to their longevity [21].

In this study the high caries risk patients were determined retrospectively on the basis of the caries

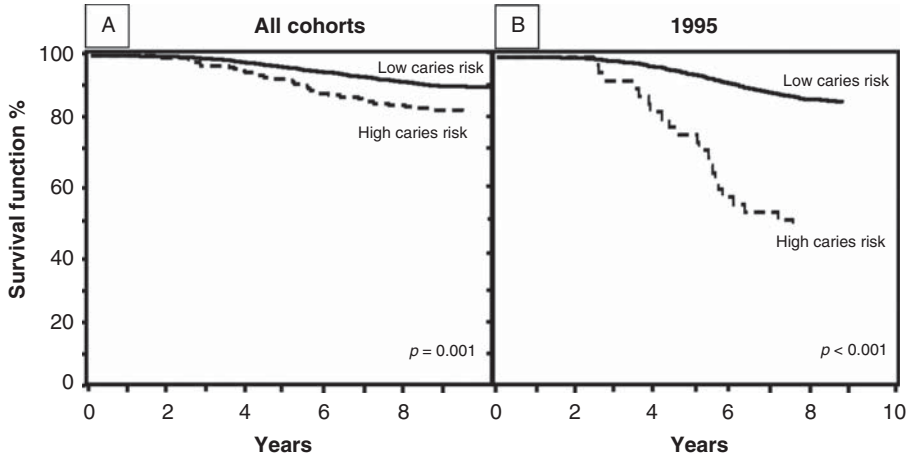

Figure 4. Kaplan-Meier survival curves for the restorations in the primary molars by risk groups in the combined cohorts (A) and in the 1995 cohort (B).

increment in the first permanent molars during their year of eruption, as originally reported by Virtanen et al. [11]. Because dental records of all patients were available up to the year 2009, this was a simple way to determine the caries risk. The determination was also showed to be valid since the children at high caries risk had significantly shorter survival of primary molars caries free than children at low risk, as demonstrated also in earlier studies [5]. The risk assessment based on DMF could also have been used, but it would have been more dependent on the decision of the cut-off values for high and low risk. Several studies have based the risk definition on DMF, each using different tooth- or surface-specific DMF values [5,9,10].

Indications for restoring teeth have changed during the past decades; earlier even initial lesions were restored [19]. This may be behind the reduction on the percentage of the determination of the high risk patients from 1985–2000 in this study. However, the impact of differences in caries diagnostics and treatment decisions between the cohorts on the findings of this study can be considered minimal, as the survival of the restorations in the later cohorts, those with the lowest percentages of high-risk patients, were the shortest. Also the significant increase in the number of restorations from 1985 to 1990 and again from 1990 to 1995 indicates that less stringent criteria in caries diagnostics would exist. Such differences would also have affected other methods of risk assessment, e.g. those based on DMF.

This epidemiological study investigated survival of primary molar restorations in four birth cohorts (1985, 1990, 1995 and 2000) using Kaplan Meier analysis. The entire cohort could be followed because almost all children use dental care free of charge provided by the municipality in Finland. In conclusion, survival of the primary molar restorations shortened distinctly towards the younger age cohorts, being the shortest in the 1995 cohort; the reason for this could not be specified, but is the topic in future studies. However, survival of the restorations was shorter for the high risk compared with the low risk children. This emphasizes the need for non-invasive treatment in addition to invasive treatment to those with dental caries in primary teeth. In the post-amalgam era a variety of materials are used in paediatric restorative dentistry; therefore, following manufacturers' instructions is emphasized to avoid technical reasons for failures of restorations.

Declaration of interest: The authors report no conflicts of interests. The authors alone are responsible for the content and writing of the paper.

References

[1] Mejare I, Stenlund H. Caries rates for the mesial surface of the first permanent molar and the distal surface of the second primary molar from 6 to 12 years of age in Sweden. Caries Res 2000;34:454–61.

[2] Forss H, Widström E. The post-amalgam era: a selection of materials and their longevity in the primary and young permanent dentitions. Int J Paediatr Dent 2003;13:158–64.

[3] Qvist V, Laurberg L, Poulsen A, Teglers PT. Eight-year study on conventional glass ionomer and amalgam restorations in primary teeth. Acta Odontol Scand 2004;62:37–45.

[4] Qvist V, Poulsen A, Teglers PT, Mjör IA. The longevity of different restorations in primary teeth. Int J Paediatr Dent 2010;20:1–7.

[5] Trachtenberg F, Maserejian NN, Tavares M, Soncini JA, Hayes C. Extend of tooth decay in the mouth and increased need for replacement of dental restorations: the New England Children's Amalgam Trial. Pediatr Dent 2008;30:388–92.

[6] Grindefjord M, Dahllöf G, Nilsson B, Modeer T. Stepwise prediction of dental caries in children up to 3.5 years of age. Caries Res 1996;30:256–66.

[7] Nordblad A, Suominen-Taipale L, Rasilainen J, Karhunen T. Oral health care at Health Centres from the 1970's to the year 2000. In Finnish with English Summary. Saarijärvi, Finland: Gummerus; STAKES Reports (National Institute for Health and Welfare, NIHW) 278/2004:44.

[8] Suni J, Pienihäkkinen K, Alanen P. Molars remaining healthy among. 1985 and 1990 cohorts in Lahti and Vantaa – analysis of survival. English abstract. Finn Dent J 2008;8:22–6.

[9] Vehkalahti M, Tarkkonen L, Varsio S, Heikkilä P. Decrease in and polarization of dental caries occurence among child and youth populations, 1976-1993. Caries Res 1997;31:1–5.

[10] Skeie MS, Raadal M, Strand GV, Espelid I. The relationship between caries in the primary dentition at 5 years of age and permanent dentition at 10 years of age – a longitudinal study. Int J Paediatr Dent 2006;16:152–60.

[11] Virtanen J, Bloigu R, Larmas M. Effect of early restorations of permanent molars on filling increments of individual teeth. J Dent 1997;1:17–24.

[12] Chadwick B, Evans D. Restoration of class II cavities in primary molar teeth with conventional and resin modified glass ionomer cements: a systematic review of the literature. Eur Arch Paediatr Dent 2007;8:14–21.

[13] Marks L, Faict N, Welbury R. Literature review: restorations of class II cavities in the primary dentition with compomers. Eur Arch Paediatr Dent 2010;11:109–14.

[14] Käkilehto T, Salo S, Larmas M. Data mining of clinical oral health documents for analysis of the longevity of different restorative materials in Finland. Int J Med Inform 2009;78:e68–74.

[15] Gordon PH. Craniofacial growth and development. In Welbury RR, editors. Paediatric dentistry. New York: Oxford University Press; 2001. p 12.

[16] Leempoel PJB, Vant Hof MA, De Haan AFJ. Survival studies of dental restorations: criteria, methods and analyses. J Oral Rehabil 1989;16:387–94.

[17] Luopa P, Lommi A, Kinnunen T, Jokela J. Welfare of the adolescents in Finland in 2000s, School health survey. Helsinki, Finland: Yliopistopaino; 2010. ISBN 978-952-245-285-6. Available online at http://www.thl.fi/thl-client/pdfs/91431fe2-cfa6-4909-9363-75eda1839dc3.in Finnish accessed on June 19 2012.

[18] Suominen-Taipale AL, Widström E, Sund R. Association of examination rates with children's national caries indices in Finland. Open Dent J 2009;16:59–67.

[19] Vidnes-Kopperud S, Tveit AB, Espelid I. Changes in the treatment concept for approximal caries from 1983 to 2009 in Norway. Caries Res 2011;45:113–20.

[20] Forss H, Vidström E. Materials and longevity of restorations in Finland. Finn Dent J 2011;11:26–31.

[21] Qvist V, Laurberg L, Poulsen A, Teglers PT. Class II restorations in primary teeth: 7-year study on three resin-modified glass ionomer cements and a compomer. Eur J Oral Sci 2004; 112:188–96.