Factor analysis in relation to survival rate of proximal ART restorations in primary molars

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Chapter 1

Introduction

Introduction

Dental caries is the most common dental disease dental practitioners have to deal with in the child-patient. In recent years, the prevalence of dental caries has been increasing in developing countries due to increasing urbanization, intake of cariogenic foods and inadequate availability of resources to carry out preventive measures for dental caries (1, 2, 3). The industrialized countries, on the other hand, have had a sustained decline in the prevalence of this disease in the last couple of decades, a result of strong public health measures that have been taken to combat the disease (2, 4).

Dental caries is commonly associated with tooth sensitivity, dental infections and dental pain, besides the invasive nature and the cost of its management (5). In a child, all these factors can lead to dental anxiety, interference with the nutritional state of the child, loss of sleep, behavioural disturbance and poor dental aesthetics, in addition to other physical, social and psychological effects. Indeed these factors can also lead to reduced coping capacity, uncooperative behaviour and avoidance by the child of the necessary dental care (6, 7).

Aetiology and prevention of dental caries

Dental caries is a multi-factor process encompassing cariogenic diet, oral hygiene, immune defence of the host, dental integrity and cariogenic bacteria inter-play. *Mutans Streptoccoci* (S*. mutans* and *S. sobrinus*) and *Lactobacilli* bacteria are known to be associated with this process (8). They reside in the dental biomass (plaque) that they help to form on the surfaces of teeth. Within this biomass they produce acids as by-products of their metabolic activities and which form part of the aetiological factors of dental caries (9). As the dental caries process depends on the length of time the tooth surface is exposed to these acids, it is the old and undisturbed plaque that has the potential of initiating caries (10). It is, therefore, important to employ correct preventive measures for dental caries and to promote appropriate strategies on oral health that are geared to helping the poor communities to prevent the accumulation of plaque on the tooth-surfaces in order to avoid the occurrence of dental diseases.

ART and the management of dental caries

The main aim of treating dental caries is to prevent new decay and arrest existing carious lesions (11). In the case of children, this treatment will result in the prevention of pain, discomfort and early loss of the primary dentition. There is still lack of consensus amongst dental professionals on the indications for restoring or extracting a diseased primary tooth. This is due to new knowledge that is continuously being generated on the aetiology, progression and management of dental caries (11, 12, 13).

Dental caries is the result of the activities of the cariogenic bacteria acting under an oral-environment conducive to its initiation and progression. The presence of the cariogenic bacteria within, for example dentine, is therefore, a pertinent factor to consider when planning restoring a carious lesion (14). Being able to differentiate the infected and demineralised dentine from the sound and un-demineralized dentine can form an important aspect of dental restorative treatment. Indeed this aspect forms the basis of the "maximal prevention and minimal invasive" concept of managing dental caries (15, 16, 17, 18, 19). The atraumatic restorative treatment (ART) approach utilizes this concept to prevent and treat dental caries, while glass ionomer cement (GIC) is the preferred restorative material with this technique because of its biocompatibility,

biometrical and fluoride-releasing properties. These unique features of the GIC are conducive to achieving a good material/cavity surface seal and in the healing process of the affected dentine underneath the restoration. Additionally, the fluoride in the GIC has positive effects in reducing the number of cariogenic bacteria in the vicinity of a restoration placed using the material, besides the enhancement of the remineralization process of the affected dentine (20).

Since the ART approach uses hand instruments to excavate the carious materials in the dental cavity, the technique does not require electricity, running water, expensive dental equipment or local anaesthetic (21, 22). This approach can, therefore, be a formidable alternative dental technique for use in underserved communities. However, in its application, the ART approach carries an inherent potential iatrogenic damage that sometimes occurs on the tooth to be restored and to other teeth adjacent to it (23, 24). Yet, ART is a practical approach to use when dealing with uncooperative children, patients with special health care needs and in other situations where traditional dental drilling does not work (25, 21, 22, 26).

Previous research works on the ART approach have reported higher survival rates for the class I restorations when compared to multi-surface restorations (27, 28, 29, 30, 31, 32). Recent studies using the high viscosity GIC (Ketac Molar glass ionomer) have reported varied survival rates of restorations placed using this approach. Some of the survival results of the restorations placed in the primary dentition using these high viscosity materials have been as low as 43.4% for the class I restorations and 12.2% for the proximal restorations after 36 months (33). Other results for the survival rate of proximal restorations placed using Fuji IX GIC have been reported to be 30% after 12 months and 24.6% to 25.9% after 30 months (34, 35). The low survival rates for the proximal ART restorations could be due to their susceptibility to fractures and marginal failures (36), besides the problems associated with the initial cavity selection, material manipulation and patient-related factors (37).

In their use as pit and fissure sealants, these high viscosity glass ionomer materials have also produced reasonably good survival results for pit and fissure sealants, for example, 72% in some instances (38) and also very poor results of 13.4% in others (39), when applied using the ART approach. However, the majority of the reported outcomes for a sealant placed using the ART approach have shown evidence of their greater potential in preventing dental caries, particularly, the occlusal caries. This phenomenon appears to occur even with the reduced retention rate of these sealants when related to the conventional sealants (40).

Dental caries and the Kenyan child-population

Approximately 43.7% of the Kenyan population is made up of children below 14 years, most of whom (80%) are born into poverty and suffer twice as much from dental diseases as their affluent peers (41). In spite of the high fluoride levels in much of the Kenyan drinking water, the prevalence rate of dental caries in Kenya is estimated to be between 57% and 63.5% in the 3-5 year-olds (42, 43). Most of the carious lesions occur probably due to poor oral hygiene and increased availability of cariogenic foods to the children (44). With the unfavourable dentist to population ratio of 1:378,000 in the Kenyan public sector, and with 80% of the dentists caring for the urban centres (10% of the country's population excluding the disadvantaged adults and children in the urban

slums) (41, 45), the country remains underdeveloped and under-capacitated in the dental health sector.

The ART approach could complement the existing meagre preventive and curative dental programmes in Kenya (46, 47). Through past research, the ART approach has demonstrated its potential benefits in managing dental caries, particularly, for children living in poor rural communities (48, 49, 50), dentally anxious patients and patients with special health care needs. Consequently, due to the lack of modern sophisticated dental equipment for use in the provision of dental health care to the majority of the population in the less developed nations, like Kenya, the ART approach appears to have a place in the provision of preventive and restorative dental health care in these nations. There is, therefore, a need for further research to find solutions in improving the applications of the ART approach and improvement of the longevity of the restorations made using the technique. The results from such researches will aid in enhancing wider application of this technique in these indications and in multiple-surface carious lesions, where the survival rates of the restorations are reportedly very low.

Aims of the thesis

The objective of this thesis is to evaluate some of the factors influencing the survival rate of proximal ART restorations placed in the primary molars of 6 to 8 year-olds. These factors are:

a. the size of the prepared dental cavity,
b. the method of tooth-isolation applied during treatment,
c. the experience of the operator and the assistant,
d. the GIC-brand and the handling conditions, including the ambient temperature during the restoration process,
e. the consistency of the first post-restoration meal consumed,
f. the residual caries factor, the presence of cervical marginal gaps and the oral health situation of the participants,
g. the effect on the restored tooth of the sealant placed together with the restoration,
h. and the effects of premature loss of the restoration.

During the period of study, proximal ART restorations were placed in primary molars of 6 to 8 year-olds over a period of three weeks. The initial evaluation of the restorations (within the first two hours of post-placement) was done clinically and also radiographically. They were evaluated radiographically for their marginal-adaptation and for the presence of residual caries. The clinical evaluation included assessment of the quality and survival rate soon after placing them (within 2 hours), after one week, one month, five months, one year, one and a half years and two years. The results of the evaluations were documented and analyzed using various statistical tests intended to determine the factors having the greatest influence on the survival rate of these restorations.

The structure of this thesis

Besides **Chapter 1** which introduces the thesis, the rest of the structure of the thesis has been divided into 9 chapters. **Chapter 2** discusses the design of the study in general, the important data about the study area and the number of schools and the school-children eligible to participate in the study. The chapter also deals with the main objective and specific objectives of undertaking the study, the pre-study calculation of the study-population, the randomization process of the schools, the selection of the study

population and the randomisation of the study-group to various treatment options. Additionally, the chapter gives details of the restoration process of the proximal cavities that had been selected, the different personnel that participated in the study and their training and calibration process, the materials used, the collection of the data and the statistical tests that were used to obtain the results of the study. **Chapter 3** gives details of the selection process of the appropriate proximal cavities for restoration using the ART approach and the difficulties encountered during the selection. **Chapter 4** deals with the influence of the sizes of the prepared proximal cavities on the survival rate of the ART restorations. Pre-operative and post-operative radiographic evaluations of the proximal cavities selected, the clinical measurements of the prepared cavities are also described and the relationship of these factors to the survival rate of the proximal restorations placed in these cavities. **Chapter 5** gives detailed procedures in the use of rubber dam and cotton roll tooth-isolation methods while restoring the proximal ART restorations. A determination on how these two methods influenced the survival rate of these proximal restorations is also made in this chapter. The effects of the 'experienced' and 'inexperienced' operators and assistants on the survival rate of the proximal restorations is analyzed in **Chapter 6**, including their combined influence on the survival rate of these restorations after two years of follow-up. The chapter also examines the survival rate of the restorations in relation to the experience of the operators and the assistants, as they went through the transitioning process of the three-week operative stage during which time the teeth were restored. Through this analysis, a determination is made and discussed as to whether there were any further gains in experience by this workforce over the three-week period.

The influence of the GIC-brands used in restoring the proximal cavities on the survival rate of the restorations is dealt with in **Chapter 7**. Additionally, the chapter examines and discusses the effects on the survival rate of the proximal restorations of the mixing and the restoration times of the GIC materials, the room temperature at the time of completing the restoration and the consistency of the next meal taken by the child after the placement of the restoration. In **Chapter 8**, the influence of oral hygiene, residual caries and cervical marginal gaps on the survival rate of the restorations is evaluated and discussed. **Chapter 9** examines and discusses the survival rate of the sealants placed on the remaining surface of the tooth that had received a proximal restoration using the ART approach, and the effects of the sealants on the integrity of the tooth restored and survival of the proximal ART restorations. **Chapter 10** looks at the effects of the GIC restoration on the integrity of the surfaces of the restored cavity after an early loss of the restoration. **Chapter 11** generally discusses the combined effects of the different aspects of the study on the integrity and the survival rate of the proximal ART restorations. It also gives a summary of the overall impact of this study, the conclusions drawn from it and the recommendations made for future research work.

References

1. Miura H, Araki Y, Haraguchi K, Arai Y, Umenai T. Socioeconomic factors and dental caries in developing countries: a cross-sectional study. Social Science and Med, 1997; 44: 269 - 272.
2. Pakhomov GN. Future trends in oral health and disease. Inter Dent J 1999; 49: 27 - 32.
3. Petersen PE. Priorities for research for oral health in the 21st Century - the approach of the WHO Global Oral health Programme. Community Dent Health 2005; 22: 71 - 74.
4. Marthaler TM, O'Mullane DM, Vrbic V. The prevalence of dental caries in Europe 1990 - 1995. Caries Res 1996; 30: 237 - 255.
5. Kleinknecht RA, Klepac RK, Alexander LD. Origins and characteristics of fear of dentistry. J Am Dent Assoc 1973; 86: 842 - 8.
6. Fayle SA, Welbury RR, Roberts JF. British Society of Paediatric Dentistry, A policy document on the management of caries in primary dentition. Inter J Paediatr Dent 2001; 11: 153 - 7.
7. Thomas CW, Primosch RE. Changes in incremental weight and well-being of children with rampant caries following complete dental rehabilitation. Paediatric Dent 2002; 24: 109 - 113.
8. Loesche WJ. Role of *streptococcus mutans* in human dental decay, Microbiol Rev. 1986; 50: 353 - 380.
9. Stephan RM. Intra-oral hydrogen-ion concentrations associated with dental caries activity. J Dent Res 1944; 23: 257 - 266.
10. Wenzel A, Fejerskov O, Kidd E, Joyston-Bechal S, Groeneveld A. Depth of occlusal caries assessed clinically, by conventional film radiographs, and by digitized, processed radiographs. Caries Res 1990; 24(5): 327 - 33.
11. Foley J. Alternative treatment strategies for carious primary teeth: an overview of the evidence. Eur Arch Paedtriatr Dent, 2006; 7: 73 - 80.
12. Levine RS, Pitts NB, Nugent ZJ. The fate of 1,587 un-restored carious deciduous teeth: a retrospective general dental practice based study from Northern England. Br Dent J, 2002; 193: 99 - 103.
13. Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry- a review, FDI Commission Project 1 - 97. Int Dent J, 2000; 50: 1 - 12.
14. Rickett DNJ, Kidd EAM, Beighton D. Operative microbiological validation of visual, radiographic and electronic diagnosis of occlusal caries in non-cavitated teeth judged to be in need of operative care. Br Dent J 1995; 179: 214 - 220.
15. Smith AJE, Chimiba PD, Kalf-Scholte S, Bouma J. Clinical pilot study on new dental filling material and preparation procedures in developing countries. Community Dent Oral Epidemiol, 1990; 18: 309 - 12.
16. Burnahl B. Minimally invasive dentistry. AGP Impact 1997; 25: 24 - 5.
17. Beeley JA, Yip HK, Stevenson AG. Chemo-mechanical caries removal: a review of the techniques and latest developments. Br Dent J, 2000; 188: 427 - 30.
18. Ericson D, Zimmerman M, Raber H, Gotrick B, Bomstein R, Thorell J. Clinical evaluation of efficacy and safety of a new method for chemo-mechanical removal of caries: a multi-centre study: Caries Res 1999; 33: 171 - 7.
19. Al-Sehaibany F, White G, Reiney JT. The use of caries detector to show demineralized dentine. J Clinical Paed Dent 1996; 20: 293 - 298.
20. Wiegand A, Buchalla W, Attin T. Review on fluoride-release restorative materials – fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater 2007; 23(3): 343 - 346.

21. Schriks MCM, van Amerongen WE. A traumatic perspective of ART: Psychological and physiological aspects of treatment with and without rotary instruments. Community Dent Oral Epidemiol 2003; 31(1): 15 – 20.
22. van Amerongen WE, Rahimtoolah S. Is ART really atraumatic? Community Dent Oral Epidemiol 1999; 27: 431 - 5.
23. Rahimtoola S, Amerongen WE. Comparison of two tooth-saving preparation techniques for one-surface cavities. J Dent Child, 2002; 69: 16 - 26.
24. Lenters M, Amerongen WE, Mandari GJ. Iatrogenic damage to the adjacent surfaces of primary molars, in three different ways of cavity preparation. Eur Arch Paediatr Dent, 2006; 7: 6 - 10.
25. Frencken JE, Holmgren CJ. How effective is ART in the management of dental caries. Community Dent Oral Epidemiol 1999; 27: 423 - 430.
26. Frencken JE. Oral health care project for refugees set up. FDI Dental world 1992; (2): 20 - 21.
27. Frencken JE, Makoni F, Sithole WD, Hackenitz E. 3-year survival of ART restorations and glass ionomer sealants in a school oral health programme in Zimbabwe. Caries Res 1998; 32: 119 - 126.
28. Ho TFT, Smales RJ, Fang DTS. A 2-year clinical study of two glass ionomer cements used in the atraumatic restorative treatment (ART) technique. Community Dent Oral Epidemiol 1999; 27: 195 - 201.
29. Kalf-Scholte SM, Amerongen WE van, Smith AJ, Haastrecht HJ van. Atraumatic restorative treatment (ART): a three-year clinical study in Malawi - comparison of conventional amalgam and Art restorations. J Public Health Dent 2003; 63: 99 - 103.
30. Phantumvanit P, Songpaisan Y, Pilot T, Frencken JE. Atraumatic restorative treatment (ART): a three-year community field trial in Thailand - survival of one-surface restorations in the permanent dentition. J Public Health Dent. 1996; 56 (3): 141 - 145.
31. Frencken J, Holmgren C. Atraumatic Restorative Treatment for Dental Caries. Nijmegen, The Netherlands: STI b.v.; 1999.
32. Holmgren CJ, Lo EC, Hu D, Wan H. ART restorations and sealants placed in Chinese school children - results after three years. Community Dent Oral Epidemiol. 2000; 28: 314 - 320.
33. van Gemert-Schriks MCM, van Amerongen WE, Ten Cate JM, Aartman IHA. Three-year survival of single-and two-surface ART restorations in a high caries population. Clin Oral Invest 2007; 11(4): 337 - 342.
34. Roeleveld AC, van Amerongen WE, Mandari GJ. Influence of residual caries and cervical gaps on the survival rate of class II glass ionomer restorations. Eur Arch Paediatr Dent 2006; 7(2): 85 - 91.
35. van de Hoef N, van Amerongen WE. Influence of local anaesthetic on the quality of class II glass ionomer restorations. Inter J Paediatr Dent 2007; 17(4): 239 - 247.
36. Mjör IA. The reasons for replacement and the age of failed restorations in general dental practice. Acta Odontol Scand 1997; 55: 58 - 63.
37. Yip HK, Smales RJ, Ngo HC, Tay FR, Chu FC. Selection of restorative materials for Atraumatic Restorative Treatment (ART) approach: a review. Spec Care Dentist 2001; 21(6): 216 - 21.
38. Holmgren CJ, Lo EC, Hu D, Wan H. ART restorations and sealants placed in Chinese school-children – results after three years. Community Dent Oral Epidemiol, 2002; 28: 314 - 70.
39. Vieira AL, Zanella NL, Bresciani E, Barata T, Silva SM, Machado MA, Navarro MF. Evaluation of glass ionomer sealants placed according to the ART approach in a

community with high caries experience: I year follow-up. J Minim Interv Dent, 2009; 2(3): 178 - 187.
40. Uribe S. Sealants recommended to prevent caries. Evid Based Dent, 2004; 5: 95 - 4.
41. National Oral Health Policy and Strategic Plan 2002 - 2012 document, June 2000, Kenya.
42. Masiga M, Holt RD. he prevalence of dental caries and their relation to social class amongst nursery-school children in Nairobi, Kenya. Inter J Paed Dent 1993; 3: 135 - 140.
43. Ng'ang'a PM., Valderhaug J. Dental caries in primary school children in Nairobi, Kenya. Acta Odontol Scand 1992; 50: 269 - 272.
44. Frencken J, Manji F, Mosha H. Dental caries prevalence amongst 12-year-old urban children in East Africa. Community Dent Oral Epidemiol 1986; 14: 94 - 98.
45. Yip HK, Smales RJ, Ngo HC, Tay FR, Chu FC. Frencken J, Manji F, Mosha H. Dental caries prevalence amongst 12-year-old urban children in East Africa. Community Dent Oral Epidemiol 1986; 14: 94 - 98.
46. Phantumvanit P, Songpaisan Y, Pilot T, Frencken JE. Atraumatic Restorative Treatment (ART): A three-year community field trial in Thailand - Survival of one-surface restoration in permanent dentition. J. Pub. Health Dent. 1996; 56(3): 141 - 145.
47. Mallow PK, Durward CS, Klaipo M. Restoration of permanent teeth in young rural children in Cambodia using the atraumatic restorative treatment (ART) technique and Fuji II glass ionomer cement. Inter J Paediatr Dent 1998; 8: 35 - 40.
48. Vargas CM, Ronzio CR, Hayes KL. Oral health status of children and adolescents by rural residence, United States. J Rural Health, 2003; 19(3): 260 - 8.
49. Lopez N, Simpser-Rafalin S, Berthold P. Atraumatic restorative treatment for prevention and treatment of caries in an underserved community, 2005; 95(8): 1338 - 1339.
50. Mandari GJ, Frencken JE, van't Hof MA. Six-year success rates of occlusal amalgam and glass ionomer restorations placed using three minimal intervention approaches. *Caries Res*. 2003; 37: 246 - 253.