

**EVALUATION OF ART  
RESTORATIONS AND SEALANTS  
UNDER FIELD CONDITIONS  
IN SOUTH AFRICA**

**by**

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**Submitted to partially fulfil the requirements of the  
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## DECLARATION

I, Salome Malegwale Motsei, declare that *Evaluation of ART restorations and sealants under field conditions in South Africa*, which I herewith submit to the University of Pretoria for the MSc (Odont) (Community Dentistry) degree has not previously been submitted by me to any other university.



\_\_\_\_\_  
Salome Malegwale Motsei

30/11/99

\_\_\_\_\_  
Date

## SUMMARY

### EVALUATION OF ART RESTORATIONS AND SEALANTS UNDER FIELD CONDITIONS IN SOUTH AFRICA

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Operative dentistry has for many years adhered to the principle that a restoration is the best treatment for a carious tooth. This has been practically interpreted in the axiom: "*when in doubt, fill*". Cavity designs of restorations were based on the concept of extension for prevention, thus sound tooth structure was removed alongside with decayed material, resulting in large cavities. Only recently has the profession broadened its outlook towards all aspects of oral disease and in recent years, the basic principles of restorative dentistry have been challenged and techniques of minimal intervention such as the Atraumatic Restorative Treatment technique (ART) have been developed that have particular relevance to developing countries. Conventional restorative procedures require the use of dental materials and highly technological dental equipment and instruments which usually require electricity. These conditions make dental restorations costly and available and accessible only in a big city or urbanised area where electricity is regularly supplied. The new philosophy of restorative care is based on the approach of minimal intervention and an early interception of the caries process through the application of glass-ionomers as sealants and atraumatic restorations. This can make dental care possible, accessible and equitable to all members of the society in developing countries.

The aim of this study is to evaluate the outcome of ART restorations and sealants under field conditions. Both are evaluated for retention and the development of secondary caries adjacent to the procedures. The cost for each was also calculated.

A longitudinal study design was followed. ART restorations and sealants were evaluated at intervals of 6 and 12 months. A dental therapist was responsible for the placement and the evaluation thereof. Fuji III and Fuji IX were used for the sealants and restorations respectively.

After 12 months 56,5% of ART restorations were still present in the primary dentition, 84% in the permanent dentition. Of these 85,1% had no defects in primary and 78,6% no defects in permanent teeth. 72,3% of primary and 92% of permanent teeth on which ART restorations were placed had no caries after 1 year. Even though most of the sealants were absent due to poor retention after 12 months (89,6%), 98,9% of the teeth where the sealant was initially placed had no caries. Only 6,3% of sealants present had marginal defects. When the cost of replacing ART restorations and sealants after 12 months based on the number of restorations absent or restorations with marginal/gross defect was added, the cost for an ART restoration and sealants was R19,12 and R24,29 respectively.

The ART technique is strongly recommended for management of small, occlusal carious lesions in primary and permanent teeth. More research and developments are needed to improve the success rate of multiple-surface restorations.

## SAMEVATTING

# EVALUERING VAN “ART” HERSTELLINGS EN FISSUURSEËLING ONDER VELDTOESTANDE IN SUID-AFRIKA

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Die beginsel dat ‘n herstelling die beste vorm van behandeling vir ‘n kariese tand is, word al vir verskeie jare deur herstellende tandheelkunde aangehang. Dit word baie goed verwoord deur die uitdrukking: "*indien in twyfel, herstel*". Kawiteitsontwerp vir tandheelkundige herstellings is gebaseer op die beginsel van uitbreiding vir voorkoming, met die gevolg dat gesonde tandweefsel saam met karies verwyder word wat groot kawiteite tot gevolg het. Onlangs het die professie sy uitkyk teenoor alle aspekte van siekte verbreed en in die afgelope aantal jare is die basiese beginsels van herstellende tandheelkunde uitgedaag en is tegnieke vir minimale intervensie soos die “Atraumatic Restorative Treatment tegniek (ART) ontwikkel spesifiek vir ontwikkelde lande. Konvensionele herstellende prosedures vereis die gebruik van tandheelkundige materiale en hoë tegnologiese toerusting en instrumente wat van elektrisiteit afhanklik is. Hierdie vereistes maak tandheelkundige herstellings duur en stel dit beskikbaar en maak dit toeganklik slegs in stedelike gebiede waar elektrisiteit gereedlik beskikbaar is. Die nuwe filosofie van herstellende tandheelkunde is gebaseer op die benadering dat deur minimale intervensie en vroeë onderskepping die natuurlike verloop van karies deur die aanwending van glasionomeer as seëlmiddel en die plasing van herstellings, gestuit kan word. Dit lei daartoe dat mondgesondheidsorg meer toeganklik en regverdig aan alle lede van die gemeenskap in ontwikkelende lande voorsien kan word.

Die doel van hierdie studie was om die uitkoms van ART herstellings en fissuurseëling onder veldtoestande te evalueer. In beide gevalle is die retensie asook die ontwikkeling van sekondêre karies in verhouding tot die prosedure evalueer. Die koste van elk is ook bereken.

‘n Longitudinale studie-ontwerp is gevolg. ART herstellings en fissuurseëling is evalueer met intervale van 6 en 12 maande. ‘n Tandterapeut was verantwoordelik vir die plasing en evaluering daarvan. Fuji III en Fuji IX is onderskeidelik vir die fissuurseëling en herstellings gebruik.

Na 12 maande was 56,5% van ART herstellings geplaas in die primêre gebit nog teenwoordig, 84% vir die permanente gebit. Hiervan het 85,1% in die primêre en 78,6% in die permanente gebit geen defekte getoon nie. 72,3% van primêre tande en 92% permanente tande waarop ART herstellings geplaas is, het geen karies getoon na 1 jaar nie. Alhoewel die meerderheid van fissuurseëling na 12 maande as gevolg van swak retensie (89,6%) afwesig was, het 98,9% van tande waar die fissuurseël aanvanklik geplaas is geen karies getoon nie. Slegs 6,3% van fissuurseëling nog teenwoordig het marginale defekte getoon. Wanneer die koste om ART herstellings en fissuurseëling wat na 12 maande vervang moes word ook in berekening gebring is, was die koste vir ‘n ART herstelling en fissuurseëling onderskeidelik R19,12 en R24,29.

Die ART tegniek word sterk aanbeveel vir die hantering van klein, okklusale letsels in beide primêre en permanente tande. Meer navorsing en ontwikkeling is egter nodig om die sukses van meervlakherstellings te verseker.

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## LIST OF ABBREVIATIONS

ART	Atraumatic Restorative Treatment
FDI	International Dental Federation
GIC	Glass Ionomer Cement
NOHS	National Oral Health Survey
PRR	Preventive Resin Restorations
RSA	Republic of South Africa
SNI	Service Need Index
USPHS	United States Public Health Service
WHO	World Health Organisation

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## DEFINITIONS

- **Minimal Intervention Techniques**

Minimal Intervention Techniques are part of the philosophy which looks at caries from a "health" point of view instead of from the traditional "disease" point of view. They aim at removing caries that is beyond remineralisation (Frencken and Makoni, 1994). The approach keeps restorations small and prolongs the life of the tooth if applied at an early stage.

- **Atraumatic Restorative Treatment (ART)**

The ART was developed in Tanzania in the mid-1980s and introduced in a clinical setting in Malawi years later (Frencken *et al*, 1994). No drilling instruments are used (Frencken, Makoni and Sithole, 1996) and caries is removed by excavation with hand instruments and the cavities are restored with adhesive dental materials. Local anaesthetic is not required in most cases (FDI World, 1994). The use of GIC as material of choice can lead to caries progression being halted. Instruments needed for ART can easily be carried in a bag or suitcase and it has been accepted as a method for treatment of refugees, displaced people, underprivileged urban people, rural communities, the physically and mentally handicapped, old people, and in environments where access to electricity and high-technology equipment is not possible (Frencken and Makoni, 1994).

- **Glass Ionomer Cement (GIC)**

Elderton (1990) describes GIC as a combination of aluminosilicate glass with an aqueous solution of polyacrylic acid and related polyacids. Some recently introduced glass ionomer cements may contain other acids. GIC bonds chemically to both enamel and dentine. They can be used as restorative materials, fissure sealants, luting cements and lining materials. They have the added advantage of releasing fluoride which can then prevent development of secondary caries. GIC also has the characteristic of attracting fluoride from the oral environment from products such as fluoride mouthrinses and toothpaste which can then be released to the immediate environment to then also assist in preventing dental caries.

- **Fissure Sealant**

This is a procedure where a suitable material is placed in pits and fissures of teeth (premolars and molars) in order to prevent the development of caries.

- **Service Need Index (SNI)**

DISEASE/DISABILITY		
PRESENT		ABSENT
TREATMENT	THERAPY	PROMOTION
<i>Treatment needed</i>	<i>Care needed</i>	<i>No treatment/care needed</i>
Caries	Caries	Caries
Gingivitis		Gingivitis
Malocclusion		Malocclusion
Other	Other	Other

The SNI measures, according to a set of criteria, the prevalence (number of specific cases within a defined population at a single point in time) of caries, gingivitis, malocclusion and other unspecified abnormalities in the oral cavity. The SNI indicates the need for caries treatment (extraction, restoration), the need for care to prevent the occurrence of caries (fissure sealants), and indicates when no need for caries treatment or care exists. It also indicates the need for gingivitis treatment and/or care to prevent the occurrence of gingivitis (medication, gingivectomy, scaling, plaque removal, tooth brushing, oral hygiene instructions). The SNI does not distinguish between oral hygiene "treatment" needed and oral hygiene "care" needed, but indicates when no need for treatment or care exists. The SNI allows for the indication of any condition (not caries, gingivitis, malocclusion) for which treatment and/or care are needed.

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## CHAPTER 1: INTRODUCTION

### 1.1 INTRODUCTION

Numerous studies to determine caries prevalence of different population groups in the Republic of South Africa (RSA) have been carried out in the past (Carstens, Louw and Kruger, 1995; Carstens *et al*, 1993; Chikte, Gugushe and Rudolph, 1989; Cleaton-Jones and Hargreaves, 1988; Moola and Vergotini, 1988). Most of these studies indicated a difference in caries prevalence between ethnic groups, urban and rural groups and between groups living in various geographical areas. Also indicated in these studies is the high prevalence of untreated caries in all the different communities of the RSA. The 1988/89 National Oral Health Survey (NOHS) conducted in the RSA indicated that only 27,9% of 6-year-olds were free of caries experience for the combined urban population of the major metropolitan areas (Du Plessis *et al*, 1994). These results are well short of the World Health Organisation's (WHO) goal of 50% of 6-year-olds free of caries experience by the year 2000. In the RSA, the prevalence of the disease remains high and it seems as if the backlog for caries treatment will continue for a long time to come.

Operative dentistry has for many years adhered to the principle that a restoration is the best treatment for a carious tooth. This has been practically interpreted in the axiom: "*when in doubt, fill*" (Dawson and Makinson, 1992). Cavity designs of restorations were based on the concept of extension for prevention, thus sound tooth structure was removed alongside with decayed material, resulting in large cavities. In the RSA, like in many other countries in the world, restoration as best treatment has been replaced in the public sector by extraction as the only treatment available. This has happened due to limited resources and in what seems to be, an ever increasing demand for caries treatment. In an effort to cope with the need and demand created by free oral health care in the public sector, sometimes oral health professionals have no other choice than extracting "restorable" teeth. This practice is not necessary by choice and has resulted in premature loss of primary and permanent teeth of school-going children, and although the disease has been removed, will create numerous other future problems such as malocclusion.

Conventional dental restorative procedures such as amalgam restorations require the use of dental materials and highly technological dental equipment and instruments which are usually dependant on electricity. These conditions make dental restorations costly and only available and accessible in urbanised areas where electricity is regularly supplied and investment on equipment and materials is can be afforded. Conventional dentistry also requires university trained dentists educated at high cost to serve the needs of a small group of people that can afford private oral health care services. Although conventional dentistry has hardly ever met the dental treatment needs of the majority of people in developing countries, it has until recently been regarded as the only acceptable norm of dental practice.

Only recently has the profession broadened its outlook towards all aspects of oral disease through research and the development of new dental materials. In recent years, the basic principles of restorative dentistry have been challenged and techniques of minimal intervention have been developed that have particular relevance to developing countries. A new philosophy of restorative care of carious lesions is based on an approach of minimal intervention and an early interception of the caries process through the application of sealants as preventive restorations and other preventive measures. Due to modern techniques and materials, there is now a concerted effort to minimise the amount of treatment given to individuals. The philosophy of minimal intervention presently combines new, minimally invasive cavity designs and adhesive restorative systems and is aimed at conserving tooth structure. This new approach should make dental care possible, accessible and equitable to all members of the society in developing countries. To broaden its acceptance, there is a need to scientifically investigate its long term success for management of caries under field conditions. One such approach is the Atraumatic Restorative Treatment (ART) technique. This technique will be discussed in detail in Chapter 2.

## **1.2 PROBLEM STATEMENT**

Despite an increase in the number of posts available to dentists in the public sector in the RSA and the introduction of dental therapists, as well as efforts by oral hygienists in giving health education and implementing specific protection programmes in primary schools, there is still a large unmet need for dental treatment. In using the Service Need Index (SNI) (Holtshousen *et al*, 1995), preliminary results of a survey undertaken during 1995/96 in the

Gauteng province indicate 28,96% of 6-year-olds in need of active caries treatment (n = 13127) in the Pretoria region (Gauteng Oral Health Services, 1997). Similar results were found for the 7- and 8-year-olds; 30,22% (n = 16258) and 30,79% (n = 16757) respectively in the same region of the province.

Results from the 1988/89 NOHS indicated extractions to be the main method of treatment for teeth with active caries. This was confirmed by a survey done in 1996 (Gauteng Oral Health Services, 1996a). The dental therapists in full-time employment in the Gauteng Provincial Administration were asked to indicate one dental procedure on which more than 70% of their working day is spent. 75% of the respondents (n = 20) indicated extractions. A summary of service rendering statistics for the Gauteng Oral Health Services indicates that 45 044 teeth were restored during the 1995/96 financial year (Gauteng Oral Health Services, 1996b). During the same period 196 808 teeth were extracted. The results of an unpublished study on the cost-efficiency of a mobile dental surgery utilised in the West Rand region of the Gauteng province indicated that of the 1477 patients treated by a dentist or dental therapist, 53% were treated by extracting 1026 teeth and 27% by restoring 570 teeth (Smit and Holtshousen; 1999). From a study by De Mûelenaere (1997) in the Gauteng province, it was reported that the most common cause of a midline shift, leading to orthodontic problems, was the premature loss of primary teeth.

The Gauteng province experiences a high prevalence of untreated caries amongst its school-going population due to a limited number of dentists and dental therapists that are available to provide such treatment in terms of conventional dentistry. In order to cope with the backlog and to deal with the increase in demand for such services, the only viable alternative available in terms of conventional dentistry is extractions which will cause a new problem of untreated orthodontic cases in the future. Conventional methods of caries treatment alone are unlikely to eradicate the existing caries in the communities of the Gauteng province.

### **1.3 AIM, GOALS AND PREMISE OF THE STUDY**

#### **1.3.1 AIM**

The aim of this study was to evaluate the outcome of ART restorations and sealants under field conditions.

#### **1.3.2 GOALS**

The goals of this study were:

- to evaluate the retention of ART restorations and sealants placed under field conditions
- to investigate the development of secondary caries adjacent to ART restorations and sealants
- to calculate the cost of this technique under field conditions

#### **1.3.3 PREMISE**

According to Ismail (1996), GV Black was the first to use minimal cavity preparation techniques early in the century when he divided carious pits and fissures into groups based upon the size of the carious lesion (minimal, moderate and large) and the degree of dentine involvement. Black also was the first to describe a technique for preparation of cavities using hand instruments (Black, 1936). He envisaged preventive dentistry when we would understand the aetiology and pathology of dental caries and would be able to combat its destructive effects by systemic medication.

The development of new dental materials and minimal invasive techniques such as ART (Frencken *et al*, 1996; Frencken *et al*, 1997; Frencken, Makoni, Sithole, 1996; Frencken *et al*, 1998) have revised the view of GV Black by creating a viable alternative to conventional dentistry. This alternative provides for the utilisation of less expensive human resources such as dental assistants and primary health care nurses in restoring teeth on site without the use of electricity and expensive dental equipment. By using less expensive human resources that are already employed in a referral system, valuable time of university trained oral health

professionals like dentists and dental therapists can become available for treatment procedures where electricity and specialised dental equipment are required.

The premise of this study is that in adopting the ART technique, it could possibly reduce the backlog of untreated carious lesions in South Africa in school-going children. It should also minimise the use of the method of extraction as a curative service, leading to more children reaching adulthood with a full set of teeth. It will also prevent future problems of premature loss of primary teeth leading to expensive orthodontic treatment.

## **1.4 DELIMITATIONS AND LIMITATIONS OF STUDY**

### **1.4.1 DELIMITATIONS**

The study population for both ART restorations and sealants was delimited to five randomly chosen primary schools in Mamelodi, Pretoria. The age groups ranged from 6 to 14 years and were found in Grade 1 to Grade 4 classes. The SNI (Holtshousen *et al*, 1995) was used to select the subjects suitable for ART. The detail of selecting the sample will be discussed in Chapter 3.

### **1.4.2 LIMITATIONS**

The limitations of the study are:

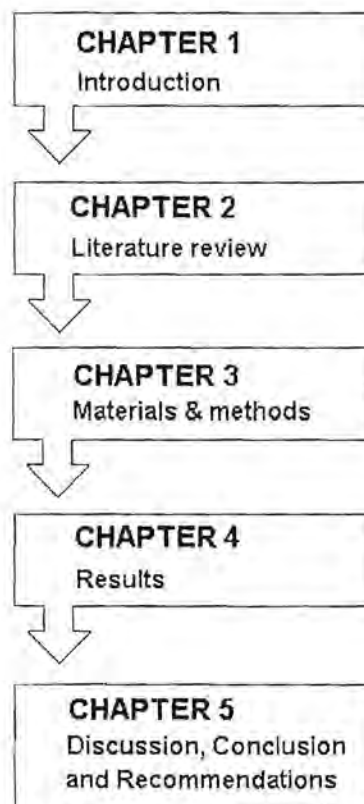
- At the time of the study, there was no published report of research into the ART techniques in South Africa. Since then a study conducted by Mickenautsch *et al* (1999) has been published;
- Loss of patients occurred during the study period due to transferral to other schools;
- Absence of children from school due to illness or other reasons;
- Parents taking their children to either public or private practitioners for routine examinations and those practitioners replacing the ART restorations or sealants;
- Hand fatigue of the operator due to the lengthy duration of using hand instruments;
- Assistance (extra human resources) needed for mixing the material;
- Short period of evaluation;

- No special training in the application of ART procedures;
- No operator effect could be evaluated as only one operator was involved;
- There was no evaluation independence as the same operator was used to place and evaluate the ART restorations and sealants;
- No post-operative sensitivity was evaluated. Patients were only asked whether they felt pain or not.

## 1.5 REFERENCE TECHNIQUE

The Harvard method, described in *Guidelines for the Preparation of Written Assignments* (Academic Information Service, University of Pretoria, 1994), is used in this dissertation.

## 1.6 FRAMEWORK OF DISSERTATION



## 1.7 SUMMARY

This chapter highlighted the importance of researching modern restorative methods based on the minimal intervention approach and early interception of caries. The problem that faces our country is a lack of human resources and facilities to manage the untreated carious lesions, especially in schoolgoing children. The rationale, significance and need for the study encompasses new methods that can be implemented in disadvantaged communities, especially those without electricity supply.

The aims, objectives and premise of the study are based on the ART approach. Delimitations and limitations explained how the study was designed and what unforeseen situations could occur.

The caries status in South Africa, preventive management of caries and minimum invasive management of caries (including the ART technique) will be discussed in Chapter 2.

## CHAPTER 2: LITERATURE REVIEW

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## CHAPTER 2: LITERATURE REVIEW

### 2.1 INTRODUCTION

The world-wide changes in caries prevalence and patterns poses new challenges to find more cost-effective measures to prevent the disease (Barmes, 1990). Appropriate technologies and personnel are particularly important for developing countries where resources are usually scarce. Proven methods already in use in developed countries should be evaluated under different conditions to assess the most effective ways to apply them in developing countries.

For years oral hygienists employed by the Public Oral Health Services in South Africa have been introducing oral hygiene programs at schools in the urban areas with the aim of decreasing the incidence of caries and periodontal disease. Despite these efforts, pit and fissure caries remain the highest for all surfaces (Du Plessis *et al*, 1994). This may be due to the fact that the programme rendered in the primary schools are more effective for smooth than occlusal surfaces. According to Ripa (1985) the occlusal surface of a tooth represents 12,5% of the total surface of a permanent tooth, but accounts for nearly 50% of caries in schoolchildren. In a survey done in the United States in 1979-1980, Ripa, Leske and Varma (1988) reported that a decrease in caries over the years was more on proximal surfaces than on buccolingual and occlusal surfaces and that dental caries in schoolchildren was a disease of the pits and fissures with 83% or more of caries found in these areas. The authors concluded that the development of caries on occlusal surfaces of both primary and permanent dentitions soon after eruption indicated the need for early preventive treatment.

Management of carious lesions is based on the early intervention and interception of the caries process through the application of fluoride, sealant, preventive restorations and other preventive measures (Dawson and Makinson, 1992). Eidelman (1993) encouraged the development of new techniques and attitudes so that operative dentistry is no longer based entirely on the principles of Black. This new approach should concentrate more on preserving the integrity of the tooth than on restoring a cavity (McLean, 1988).

According to Barmes (1990) prevention and intervention should be maximised for all populations and the care provided should respect the basic principles of adequate equality and technology.

This chapter reviews the literature of three possible strategies in dealing with the prevention and management of dental caries in developing countries namely conventional fissure sealant and the use of Glass-Ionomer Cement (GIC) as a fissure sealant or restoration as part of the ART technique. Unlike conventional fissure sealant, ART restorations and sealants do not require electrically driven machinery and are in line with the concept of minimal intervention as described by Elderton (1990).

Before presenting a review of these three strategies, an overview of the caries status in South Africa will be given.

## 2.2 CARIES STATUS IN SOUTH AFRICA

One of the goals of the WHO is that by the year 2000 the DMFT of 12-year-olds should be 3 or less. Most of the studies done in South Africa prior to 1980 and after, indicate that caries in the primary dentition was slowly increasing (Du Plessis *et al*, 1994).

In a study by Cleaton-Jones and Hargreaves (1988) in children aged 10 to 12 years old the lowest caries prevalence was seen in rural blacks, the highest in urban Indian children.

Moola and Vergotini (1988) studied the prevalence of dental caries in coloured pre-school and primary schoolchildren in the Western Cape. The age range for the pre-school children was 2-6 years and for the primary schoolchildren 6-17 years. Prevalence of dental caries in pre-school children was 26,4%. Only 22% of the children were caries-free. This is well below the WHO goal for the 5-6 year-olds which states that by the year 2000 50% should be caries-free.

Chikte *et al* (1989) examined 12-year-old rural schoolchildren from Transkei. A mean DMFT of 1,8 was found with 49% of children caries-free. Seventy-four percent (74%) of the occlusal surfaces were affected by caries with molar teeth responsible for 90% of all teeth

affected (Chikte *et al*, 1990). This emphasises the importance of preventive measures on occlusal surfaces of newly erupted teeth with deep fissures.

During 1988/89 a NOHS was undertaken in the RSA. Du Plessis *et al* (1994) reported on the results of the black population in the major metropolitan areas. The percentage of primary teeth affected by caries at age 6 was high at 66,2%. At age 12 the DMFT was 1,7, emphasising that through prevention these low levels could possibly be maintained. The decayed component of the DMFT for both the 6- and 12-year-olds was high with the missing component in these age groups indicating that extraction was a major form of treatment for caries in South Africa, possibly due to a lack of resources. The missing component also increased with age. The filled component was low, showing that restorations were seldomly used as a caries treatment measure, confirming a lack of resources.

Results from the NOHS also show that only 86,7% of the 6-year-olds and 83,2% of the 12-year-olds had retained all their teeth. At age 6, primary molars were mostly affected. At age 12, molars were more affected with first mandibular molars being more susceptible. Six-year-olds had 29% of teeth needing to be extracted. Twelve-year-olds had 15,7% of teeth in need of extraction. The need for restorations increased with age.

Caries experience of rural coloured children was determined by Carstens *et al* (1993). Six and twelve-year-olds were examined in the South-Eastern Cape. Only 1,36% of the 6-year-olds and 13,84% of the 12-year-olds were caries-free. The dmft for the 6-year-olds was 9,5 and DMFT for the 12-year-olds was 4,70. Only 56,6% of teeth examined for the 6-year-olds were healthy, whereas for the 12-year-olds only 84,4% were healthy. The authors found the caries experience of rural children to be high in this study, unlike Moola and Vergotini (1988) who reported that rural children had lower caries incidence than urban children. The authors concluded that primary oral care services should be implemented as there were no public dental health services available due to lack of transport and finance.

In another study by Carstens *et al* (1995), 6-, 12- and 15-year-old schoolchildren from a rural suboptimal fluoride area were examined in the Northern Cape. The dmft/DMFT were 3,9; 1,81; and 1,6 for the 6-, 12- and 15-year-olds respectively with permanent teeth being

healthier than primary teeth. Northern Cape coloured rural children were found to have more caries than their black and white counterparts.

The caries status of South African children as described poses the question whether techniques where a lack of transport, finance or electricity would not be obstacles for communities to get preventive and restorative care would not solve a lot of the problems experienced at the moment.

The next section deals with the preventive management of dental caries through conventional resin fissure sealant and GIC used as a sealant. The question of sealing in incipient caries will also be discussed briefly.

## **2.3 PREVENTIVE MANAGEMENT OF DENTAL CARIES**

Already at the beginning of the 20<sup>th</sup> century, some methods were used for the prevention of caries in deep and narrow fissures where food is retained. One such procedure was fissure eradication which transformed deep, food retentive crevices on the occlusal surfaces of molars and premolars into wide, non-retentive grooves. A fissure bur was used to widen the narrow fissures so that they could be self-cleansing, allowing ready access for the saliva and toothbrush, thus reducing chances of decay (Bödecker, 1929). The author stated that even if decay occurred in eradicated fissures, it would not progress like it would in fissures that were not eradicated.

The problem with this type of procedure was that it was difficult to assess the depth of a fissure clinically, that is, whether it reached into dentine or not. This technique could also not be used where there was a lack of electricity or rotatory instruments and modern equipment. Sound tooth structure was also unnecessarily removed in most cases.

### **2.3.1 RESIN FISSURE SEALANTS**

A fissure sealant can be defined as a clear or shaded plastic material applied to the chewing surfaces of posterior teeth. It acts as a barrier, protecting caries-prone surfaces from plaque and acids. A combination of fluoride, sealants and good dietary habits provides optimal

caries protection as fluoride acts more effectively on smooth surfaces with fissure sealant protecting the pits and fissures (McCormack-Brown, Clark and McDermott, 1989). According to Newburn (1992) fissure sealants are highly effective on especially newly-erupted teeth.

However, one of the great limitations of fissure sealant is that it is technique-sensitive and is influenced by patient co-operation, diligence of the operator and contamination of the field of operation (Karlzén-Reuterving and Van Dijken, 1995).

According to Waggoner and Siegal (1996) sealants should only be applied on fissures that are at a high risk of developing caries. Ripa (1973) mentions that the following factors should be considered before sealant is applied:

- tooth type
- position of the tooth in mouth
- patient's total preventive regime
- caries susceptibility of the individual

Several clinical studies have been reported on the effectiveness of fissure sealant. Buonocore (1970) reported on a study where fissure sealants were applied on 200 caries-free pits and fissures of primary and permanent molars and premolars. The one year results showed 42% of the control teeth being carious, whereas 97,5% of the sealed teeth were healthy. This study indicated that fissure sealant could be effective in the prevention of caries in both the primary and permanent dentitions.

Lee and Swartz (1971) placed a pit and fissure sealant on human extracted molars and premolars which were caries free. They concluded that the resin appeared to be able to penetrate to the base of the fissures and maintained a close adaptation to the fissure walls.

Ripa (1985) justified the use of fissure sealants in developing communities by analysing data from the United States of America. His conclusions have large implications for the use of sealants:

- The caries decline is not uniform for all tooth surfaces with interproximal and buccolingual surfaces benefiting more from fluoride programmes. Fissure sealants therefore have an important role to play in protecting the occlusal surfaces against dental decay.
- The percentage distribution of occlusal caries is similar in optimally fluoridated and fluoride-deficient communities and therefore fissure sealant would be effective irrespective of the fluoride status of the drinking water.
- The number of children experiencing dental decay remains high despite a decrease in the number of lesions expected. He attributes this mainly to caries on the occlusal surfaces.

According to Ripa (1985) 37% of United States children between the ages of 5 and 17 were caries-free in the 1979-80 survey. Age analysis of this data however shows that while 56,7% of elementary school children had a caries-free permanent dentition, only 17,2% of the 12- to 17-year-olds were without dental decay. By the age of 17, only 11% were caries-free. This decline in caries-free children is caused by decay of the pits and fissures, indicating the need for fissure sealants.

Wendt and Koch (1988) reported on a clinical study to evaluate fissure sealants on occlusal surfaces of first permanent molars during a 10-year period. All completely erupted caries-free permanent first molars were sealed. Results showed a 80% retention after 8 years and 16% partial retention with no caries. The authors concluded that when sealants were correctly placed, the failure rate was low.

Simonsen (1991) reported on retention and effectiveness of dental sealants after 15 years. 68,8% of teeth were sound. He also reported that it was 7,5 times more likely that a pit and fissure on first permanent molars which was not sealed would develop caries or be restored after 15 years.

Most of the resin sealants that are developed are ideal for perfect conditions like a dental clinic or surgery where assistance is available. They are not practical for outdoor settings where assistance and high-technology equipment is not always available. A material such as

GIC to a large extent fulfils the requirements that it could be used outdoors and is not dependent on factors like high technology equipment or are too technique sensitive. The use of GIC as a sealant will be discussed in the next section.

### **2.3.2 GLASS IONOMERS AS FISSURE SEALANTS**

Elderton (1990) describes GIC as a combination of aluminosilicate glass with an aqueous solution of polyacrylic acid and related polyacids. Some recently introduced GIC may contain other acids. GIC bonds chemically to both enamel and dentine. They can be used as restorative materials, fissure sealants, luting cements and lining materials. They have the added advantage of releasing fluoride which can then prevent development of secondary caries. GIC also has the characteristic of attracting fluoride from the oral environment from products such as fluoride mouthrinses and toothpaste which can then be released to the immediate environment to then also assist in preventing dental caries.

GIC also allow for a more conservative cavity form to be used as preparation is limited to the removal of caries only. It is not necessary to prepare undercuts or cario-surface angles for retention as is required for amalgam (Elderton, 1990). As they do not require mechanical retention, drilling equipment is therefore not always needed. They can be mixed and applied by hand, making them suitable for use in ART as a fissure sealant. By using this approach, children show little fear as there is no noise of drilling and no need for local anaesthesia in the majority of cases. Only a few hand instruments are used. When used as a restorative material, less time is consumed due to minimal cavity preparation. However, according to McLean (1988) the early GIC had a limited use due to their lack of toughness. They are brittle, prone to porosity and have poor surface finish. This has however been addressed with the development of better materials.

According to Leinfelder (1993) the use of GIC in dentistry has expanded tremendously since the first report by Wilson and Kent in 1971. According to Simonsen (1996) GIC has in the meantime been accepted as a routine part of the operative dentistry armamentarium.

For a fissure sealant to be effective, it must be firmly attached to enamel pits and fissures. Resin sealants requires enamel to be etched so that the material can penetrate into the etched

enamel to form an effective mechanical bond. Glass ionomer sealants are adhesive and do not need etching therefore making them ideal for use outside an ideal clinical setting, for example at schools.

Several studies have investigated the use of GIC as a sealant. McLean and Wilson (1974) conducted a study using GIC both as a fissure sealant and a restorative material. Eighty-four percent (84%) of the teeth remained fully sealed after one year. In the second year 78% remained fully sealed. A decrease in failure rate as sealant aged was also reported, showing that the treatment was long-lasting in most cases. There was no caries observed on fully covered fissures and on those that had partial loss. The drawback of this study was that fissures were selected for success and not at random.

Seppä and Forss (1991) reported on resistance of occlusal fissures to demineralisation after loss of GIC in vitro. The teeth were divided into three groups. Teeth in Group 1 were left unsealed, Group 2 were sealed with Fuji III and in Group 3 fissures were widened with a narrow flame-type diamond bur, then sealed. Results suggested that fissures sealed with the GIC were more resistant to demineralisation than unsealed ones. Widening fissures made them more prone to demineralisation than natural ones, even when sealant was lost when examined clinically. Lesion formation was not completely inhibited.

Torppa-Saarinen and Seppä (1992) reported on the retention of glass ionomer fissure sealants two years after placement. Fuji III was used in this study. After two years, 38% of the sealants were totally present, 28% partially lost and 34% completely lost. The residual material in fissures seen through the microscope was thought to provide protection even after the sealant was lost.

Simonsen (1996), after reviewing the literature on studies done on glass ionomer as fissure sealant, concluded as follows :

- More controlled clinical trials are needed to compare caries reduction resulting from the use of resin-modified glass ionomer materials, resin sealant and glass ionomer materials.
- Materials research should be directed at the development of new, user-friendly sealant materials which takes advantage of new technology developed over the past few years in resin-modified glass ionomer materials and in dentine bonding systems.

### **2.3.3 GLASS IONOMER CEMENT AS FISSURE SEALANTS AS PART OF THE ATRAUMATIC RESTORATIVE TREATMENT APPROACH**

The 1-year results of GIC in a school oral health programme in Zimbabwe where they were placed according to the ART approach were reported by Frencken *et al* (1996). Complete retention of 60,3% and partial retention of 13,4% was found. According to the authors clinician competency had a major influence on retention. The results for Zimbabwe are in line with those reported by Frencken *et al* (1994) for Thailand namely 73% for deciduous and 78% for permanent teeth. They are however lower than the 82,5% reported by McKenna and Grundy (1987), but higher than the 45% and 37% reported by Torppa-Saarinen and Seppä (1992) and Mejäre and Mjör (1990) respectively.

The 3-year results for the Zimbabwe study were reported by Frencken *et al* (1998). 50,1% of the sealants survived three years with 20,4% being completely retained and 26,1% being partially retained.

Smales, Gao and Ho (1997) reported on the effectiveness of GIC used as fissure sealants as part of the ART approach where finger pressure is used to force the material into the fissures. Results indicate that all glass-ionomers tested with this approach showed a satisfactory penetration of the fissures.

Studies where GIC used as a sealant and conventional resin fissure sealant were compared will now be discussed.

### **2.3.4 A COMPARISON BETWEEN GLASS IONOMER CEMENT USED AS FISSURE SEALANT AND RESIN FISSURE SEALANT**

Williams and Winter (1981) did a study to compare Concise and Nuva-Seal (both resin fissure sealants) with ASPA (GIC). After four years, 87,9% of Concise sealants were still present, compared to 35,9% in the case of Nuva-Seal. 35,4% of ASPA was still present. Even though there was an initial high loss of ASPA at the end of four years, its retention was comparable to that of Nuva-Seal. The authors concluded that the high level of fluoride release in ASPA kept the pits and fissures caries-free even after sealant loss.

Shikombe *et al* (1986) compared Delton to a GIC as a sealant for a period of 3 years. Newly erupted first molars were selected. If the left side was sealed with glass ionomer sealant, the right side was sealed with Delton and vice-versa. Results showed Delton retained for the full 3 years whereas glass ionomer sealant was retained for 6 months only. Once again this study concluded that GIC as a sealant had cariostatic properties even after it had been clinically lost from the tooth.

In a study by Boksmán *et al* (1987) Concise was compared to Fuji III. Six month results showed 92% of Concise to be totally present with only 2% in the case of Fuji III. No new carious lesions were recorded after 6 months. The study was discontinued due to the high loss of glass ionomer sealants.

McKenna and Grundy (1987) did a study to determine whether the retention of glass ionomer sealants when applied by dental auxiliaries was comparable to that of resins as reported. Only first molars were included in the study. They found 82,5% completely retained sealants, 14% partial retention and 3,5% completely lost. Operators were inexperienced final year dental therapy students. The authors concluded that GIC as a sealant was found to be comparable with that of resin sealants.

Mejare and Mjör (1990) reported on a study where retention of glass ionomer sealant (Fuji III) was compared to two resin sealants (Delton and Concise). After 6 - 12 months 61% of Fuji III sealants were lost, 84% after 30 - 36 months. 48% of Delton and 37% of Concise sealants were present after three years. All teeth sealed with GIC remained caries-free, once again indicating that small amounts of retained sealant in the fissures may have continued their cariostatic effects, thus protecting the surfaces from caries. This was also the case in a study by Songpaisan *et al* (1995), who reported that even when glass ionomer sealants were not retained, some caries reduction was observed in teeth sealed with the material.

Karlzén-Reuterving and Van Dijken (1995) performed a three-year follow-up study on glass ionomer and resin fissure sealants. Chemically cured Delton and Fuji III were the materials of choice. Sealants were observed after six months and at one, two and three years after placement. After three years, 27,8% of glass ionomer sealants and 79,2% of Delton sealants were present. None of the Delton sealants were totally lost. After 2 years caries was recorded

in 4,2% of Delton sealed teeth and 1,4% of glass ionomer sealants. Despite the high loss of glass ionomer sealant, caries incidence was low for both groups.

Forss, Saarni and Seppä (1994) found the main disadvantage of GIC to be inadequate retention. In this study Delton was compared to Fuji III. The fact that the dentists involved in the study were more experienced in applying resin sealants than glass ionomer sealants may have affected the results. Resin sealant retention was in line with other reported studies. The authors concluded that more clinical evidence on effectiveness of glass ionomer sealants in caries reduction were needed before they could be recommended for general use.

From these studies it is clear that a conventional fissure sealant has a much better retention than GIC. Most studies however conclude that despite GIC being lost, protection against caries was adequate due to small amounts of GIC remaining behind deep in these fissures.

The question of sealing in incipient caries has over the years led to quite a few investigations. As this might happen when GIC is used as a sealant in field conditions, this issue will be discussed in the following section.

### **2.3.5 SEALING INCIPIENT CARIOUS LESIONS**

Different views prevail over the sealing of incipient carious lesions. Some researchers feel that the sealed-in caries will arrest while others feel that it will irritate the pulp via the dentinal tubules. Some of the studies done on this topic are reviewed here.

Handelman, Washburn and Mopperer (1976) reported that treatment of incipient or moderately advanced caries with a sealant may delay or prevent progression of decay. They felt that the concern of other clinicians over this was unfounded. They stated that the cost-benefit implications of sealing carious and non-carious occlusal surfaces should be noted and compared with the cost of conventional restorative treatment.

Ripa (1985) stated that a tooth with a questionable diagnosis should be sealed as the sealant will prevent that surface from being carious. If the initial diagnosis turned out to be wrong and the tooth was carious, the caries would be arrested and the lesion would not progress.

Elderton (1985) concluded that caries left under fissure sealant tended to arrest and not progress further. As long as the sealant remained intact over the pits and fissures, bacteria had difficulty in surviving.

Swift (1988) reported on several research studies done to determine whether the concern to seal incipient caries was valid. Various methods have been used, including bacteriologic sampling, standardised depth measurements, radiographs and clinical observation. The studies showed a decrease in number of viable micro-organisms in lesions under intact sealants. Sealing in moderate to deep carious lesions was seen not to be appropriate, but there should be no concern or fear of sealing small or questionable carious lesions due to results of studies done. Regular maintenance of sealed incipient lesions is necessary and if defects arise, reapplication should be done.

Handelman *et al* (1981) used adhesive sealants over occlusal carious lesions. They found lesions sealed in tended to become sterile over time. There was a decrease in caries penetration if sealant was found to be intact. In approximately 75% of the cases where caries penetrated, the sealant was found to be defective, but penetration was also minimal. They concluded that fissure sealants could be used to seal incipient caries provided patients were periodically recalled for evaluations. They warned against the method being used as an alternative for restorative care.

Kramer, Zelante and Simionato (1993) reported that research showed that micro-organisms under sealants or restorations decreased in number and pathogenicity as they are sealed off from their food supply for acid production. As long as the sealant remained intact, the number of viable micro-organisms decreased and the lesions finally became sterile.

The use of conventional fissure sealant and GIC used as a sealant have been discussed as possible options for the prevention of caries on occlusal surfaces. Following this, preventive resin restorations (PRR), GIC as restorative material and the ART approach will be discussed as possible minimal invasive options in the management of dental caries once cavitation has occurred.

## 2.4 MINIMUM INVASIVE MANAGEMENT OF DENTAL CARIES

### 2.4.1 PREVENTIVE RESIN RESTORATIONS

According to Eidelman (1993) the reasoning behind PRR was the conservation of sound tooth structure whilst eliminating caries at the same time as well as controversy amongst researchers over whether to intentionally seal dental caries which may spread to irritate the pulp. This involves removal of caries from the infected pit or fissure with a small round bur or excavator. No attempt is made to include fissures which are non-carious. Composite or GIC are used to restore the fissure followed by sealing these fissures with a resin fissure sealant.

PRR are indicated in areas where enamel caries is suspected, but not in interproximal areas (Elderton, 1985; Crawford, 1988), where deep occlusal caries is present and where the pulp is involved (McConnachie, 1992).

Liebenberg (1994) stated that PRR are to be used as long as there is controversy over sealing incipient caries. Even though it was stated that the number of micro-organisms decreased after sealant application, some authors felt that micro-organisms could get nutrients from the pulp via the dentinal tubules.

McConnachie (1992) developed criteria for the placement of PRR:

- if explorer catches on occlusal surface
- in deep pits and fissures which may be carious at the base
- opaque, chalky appearance along pits and fissures

According to Städtler (1993) advantages of PRR include:

- minimal removal of occlusal tooth surface
- micro-leakage occurs in minimal cases as compared to amalgam restorations
- aesthetically pleasing
- can be done without local anaesthetic with minimal discomfort
- permanent quality

In a five-year study by Städtler (1993) he found retention to be lower in younger children than older ones due to a difficulty in keeping a dry operating field in the younger ones. It was also more difficult to keep a dry operating field with more posterior teeth (molars) than premolars. Regular check-ups were important in maintaining PRR.

#### **2.4.2 GLASS IONOMER CEMENT AS A RESTORATIVE MATERIAL**

Several studies have investigated the use of GIC as a restorative material. Only two are described briefly.

Hicks, Flaitz and Silverstone (1986) state that the ability of a restorative material to resist micro-leakage and recurrent caries around its margins determines the success of the restoration to a larger extent. The same study also reported on secondary caries formation in vitro around glass ionomer restorations. The results showed a substantial amount of fluoride taken up by enamel and cementum adjacent to glass ionomer restorations. There was an indication that fluoride released from GIC was not lost over time, but became incorporated into the mineral component of enamel and cementum. This caused a decrease in caries incidence and the remineralisation of clinically undetectable white lesions. The authors found the material to be technique-sensitive with respect to water adsorption and dehydration.

Forsten and Karjalainen (1990) placed glass ionomer restorations in proximal cavities of primary molars. Evaluation was done 5 - 14 months after placement. Eighty-four percent (84%) of KetacFil and 77% of Ketac-Silver were found to be acceptable. No secondary caries was noted in both materials. Failures were due to fracture or loss of retention. They concluded that glass ionomer cement offered a useful alternative to amalgam and composites for restoring proximal caries in primary dentition.

Since then GIC has become an acceptable material for use in restorative dentistry and new developments have increased their durability. The next section will deal with ART as a method where GIC is used as a restorative material under conditions where rotary instruments dependant on electricity are unavailable.

### **2.4.3 THE ATRAUMATIC RESTORATIVE TREATMENT TECHNIQUE**

#### **2.4.3.1 A HISTORY OF ATRAUMATIC RESTORATIVE TREATMENT**

The ART was developed in Tanzania in the mid-1980s and introduced in a clinical setting in Malawi some years later (Frencken *et al*, 1994). No drilling instruments are used (Frencken *et al*, 1996) and caries is removed by excavation with hand instruments and the cavities are restored with adhesive dental materials. Local anaesthetic is not required in most cases (FDI World, 1994). As indicated in a previous section, the use of GIC as material of choice can lead to caries progression being halted. Instruments needed for ART can easily be carried in a bag or suitcase and it has been accepted as a method for treatment of refugees, displaced people, underprivileged urban people, rural communities, the physically and mentally handicapped, old people, and in environments where access to electricity and high-technology equipment is not possible (Frencken and Makoni, 1994).

A manual aimed at oral health care workers explaining the treatment of patients with ART, was published and previewed during the WHO's Year of Oral Health celebration in Geneva on April 7th 1994 (WHO, 1994). This was followed in 1995 when ART was formally introduced by way of a workshop to the English-speaking Caribbean (Adewakun, 1995). A Caribbean edition of the ART manual was produced for the workshop. A new version of the manual was published by Frencken *et al* (1997) which will assist people who intend using ART in training courses as well as in the field and/or clinic. Quoting Frencken *et al* (1997) the manual states that "ART is based on modern knowledge about minimal intervention, minimal invasion and minimal cavity preparation for carious lesions; it should be considered as part of the total package of oral health care which is based on a philosophy of promoting health and preventing disease".

#### **2.4.3.2 STUDIES DONE ON ATRAUMATIC RESTORATIVE TREATMENT**

Two major studies to investigate ART under field conditions have been undertaken in Thailand and Zimbabwe. Results have been reported and published on a regular basis. The results of these two studies are summarised in this section.

**a) Thailand**

The six-month results of this study were reported by Pitiphat *et al* (1993). All ART restorations were placed by a dentist and 2 dental nurses on both primary and permanent molars of children and adults using ChemFil. Of the 93 restorations evaluated, 87% of one-surface and 56% of multi-surface restorations were intact for the primary and permanent dentitions combined. The majority of failures were found in primary teeth in multi-surface restorations. Five percent (5%) of the restorations had slight marginal leakage.

Frencken *et al* (1994) reported on the 1-year results of this study. For the primary dentition 79% of one-surface and 55% of multi-surface restorations in primary dentition were still classified as being successful. For the permanent dentition 93% of one-surface and 67% of multi-surface restorations in permanent dentition were successful. In the permanent dentition the majority of restorations were one surface only. At this stage of the study one-surface restorations placed in the permanent dentition were found to be more successful.

The 2-year results were reported by Pitiphat *et al* (1994). For the permanent dentition the success rate for one and more than one surface restorations were 86 and 69% respectively, for the primary dentition 65 and 45% once again confirming a greater success in one surface restorations in the permanent dentition.

Phantumvanit *et al* (1996) reported on the longevity of one surface ART restorations in the permanent dentition after three years which was reported as 71% compared to 93% after 1 and 83% after 2 years. At this stage a comparison was also made between ART and amalgam restorations. The authors concluded that the survival rates compared well to those of amalgam (98, 94 and 85% after 1, 2 and 3 years)

Phantumvanit *et al* (1996) concluded that after 3 years of evaluating ART, survival rate decreased with time but that ART made control of caries easily accessible to all people irrespective of their economic and living conditions and that ART could also be applied by trained oral health personnel such as dental assistants and oral hygienists, not only by operators who can handle rotatory drilling equipment.

**b) Zimbabwe**

The first results from this study were reported by Frencken *et al* (1996) on the 1-year results of ART. This project was started as an oral health service and promotion programme in six secondary schools in Greater Harare, Zimbabwe. The programme was carried out by dentists and newly qualified dental therapists. ChemFil Superior was used as a restorative material. Most of the restorations were one-surface. Survival after one year was 93,4% with 85% being scored as good. Failures were attributed to unacceptable marginal defects (2,8%), total loss (1,9%) and excessive wear (0,9%). No secondary caries was observed in the restorations, but caries was observed in 0,5% of sealed pits and fissures. The authors found survival of ART restorations to be high. Success rate of the ART restorations after two years was 89%; only 0,5% of restorations showed secondary caries. Complete retention of sealants was 43%. Only 4% of sealed surfaces had secondary caries.

The 3-year results of this study were reported by Frencken *et al* (1998). 68,5% of ART restorations were evaluated as being good, 6,1% had slight marginal defects and 8,1% had slight wear. 85,3% of ART restorations survived after three years. Failures were attributed to unacceptable marginal defects (8,1%), total loss (6,1%) and excessive wear (2,5%).

Frencken *et al* (1998) concluded that after evaluating ART for 3 years in Zimbabwe through this approach preventive and restorative care has been made available to groups who have not received these types of services before.

**c) Other studies**

During the International Association for Dental Research meeting in Nice in 1998, results from studies conducted in China and Brazil were reported. These are summarised briefly.

Lo *et al* (1998) reported on the 9-month evaluation of ART using Ketac-molar. 95% of ART were found to be intact.

Gao *et al* (1998) reported on the 6 months results of ART where Ketac-Molar and Fuji IX GP were used. No restoration failures were reported.

Fuji IX and Fuji Plus were used by Rodrigues *et al* (1998) on a six-month evaluation of ART. The authors concluded that Fuji IX was an acceptable material for use in Class I restorations whereas Fuji Plus was a promising material for Class II restorations.

Fuji IX was used as an experimental restorative material in Brazil by Franca *et al* (1998). Most successful restorations were found in Class V (90%), Class I (75,3%), Class III (72,9%), Class IV (55,6%) and Class II (39,1%). The authors recommended that Fuji IX was indicated for use in Class I, III and V restorations.

The only other study on ART in South Africa apart from this one was reported by Mickenautsch *et al* (1999). ART restorations were placed as part of the services delivered from a mobile dental unit to children in farm schools in the Johannesburg area. Fuji IX and KetacMolar were the materials used for one surface restorations and as sealants on primary and permanent molars. The success rate for ART restorations after 1 year was reported as 93,6% (93,1% for Fuji IX and 94% for KetacMolar). A 75% retention for the sealant was reported for the same period.

Before closing this chapter, the advantages and disadvantages of ART as reported by various authors are mentioned briefly.

#### **2.4.3.3 ADVANTAGES OF THE ART**

According to Frencken *et al* (1996), ART has the following advantages:

- The ART is a non-threatening oral procedure. This characteristic has the great advantage of making oral care more popular among the population, in particular the young. Fear-inducing situations caused by threatening dental equipment are not involved and there is no noise from a drill or from suction equipment. The maximum number of instruments in the mouth at any one time is similar to that used for an oral examination, the mirror in one hand and a work instrument in the other. ART is therefore patient-friendly.
- ART makes it possible to reach people who otherwise never would have received any oral care. The technique allows oral care workers to leave the clinic and to visit people in their own living environments, e.g. in senior citizen homes, institutions for the handicapped, villages in rural and suburban areas in economically less developed countries and in their

own homes. From a health point of view, these possibilities must be considered a huge advantage.

- ART supports health education and promotion programmes, particularly in areas where oral care relies heavily on pain relief through extraction and oral health education. Using ART, a comprehensive package of education/promotion, prevention, curative treatment, and pain relief can be established and delivered to the population through a low-cost outreach oral health programme.
- ART uses easily available and relatively inexpensive hand instruments rather than expensive electrically driven dental equipment.
- It is a biologically friendly approach involving the removal of only decalcified tooth tissues, which results in relatively small cavities and conserves sound tooth structure.
- There is limitation of pain, resulting in a minimal need for local anaesthesia.
- The glass ionomer material adheres chemically to tooth structure, reducing the need to cut sound tooth structure for retention of the restorative material.
- GIC leaches fluoride, which prevents secondary caries development and probably remineralises carious dentine.
- ART combines restorative and preventive care. The material that is used for the ART adheres to both dentine and enamel (restorative) and also releases fluoride to surrounding tissue (preventive). The material also seals pits and fissures adjacent to the restoration which are caries prone.
- ART simplifies infection control. Hand instruments can easily be cleaned and sterilised after every patient.

#### **2.4.3.4 DISADVANTAGES/LIMITATIONS OF THE ART**

- The long-term survival rates for glass ionomer ART restorations and sealant are not yet available. The longest study reported so far is of three years duration (Phantumvanit *et al*, 1996; Frencken *et al*, 1998).
- The technique's acceptance by oral health care personnel is not yet assured. Some dental researchers were not comfortable with the conclusion that they could go ahead and use the ART technique in developed and underdeveloped countries as freely as was indicated. It was felt that more work needed to be done before they could be

comfortable with such a recommendation. There was not enough evidence for the ART to be used on anything but an experimental basis at the present time. The ethical aspect of this type of treatment, especially in developing countries, had to be taken into consideration (Holmgren and Pilot, 1996).

- At the moment ART's use is limited to small- and medium-sized, one-surface lesions because of the low wear resistance and strength of existing glass ionomer materials (Van Amerongen, 1996).
- The possibility exists for fatigue from the use of hand instruments over long periods. This could occur when a clinician is required to undertake many ART restorations. With this limitation the likelihood that caries will be left in a cavity is enhanced (Van Amerongen, 1996).
- Hand mixing might produce a relatively unstandardised mix of glass ionomer, varying among operators and different geographical and climate situations (Van Amerongen, 1996).
- Materials currently used generally do not have very high values of strength and resistance to wear compared to other restorative materials. Consequently the restoration has to be rather small to avoid bulk fracture and changes in occlusion. The material also shrinks during the chemical reaction (Van Amerongen, 1996).

## 2.5 SUMMARY

This chapter reviewed literature concerning the current caries status in Southern Africa, the preventive management of dental caries pertaining to occlusal surfaces using resin fissure sealants and glass ionomers, minimal invasive procedures including preventive resin restorations and GIC restorations. Incipient caries being sealed over with fissure sealants was also discussed and the views of different researchers presented. Studies on glass ionomer restorations comparing them to composites and amalgams were also briefly presented in this chapter.

Following this a short overview of the development of ART and studies done using this technique were discussed. It lays the foundation for the project discussed in this dissertation as GIC used both as restorative and sealant material were discussed.

Where GIC was used as a sealant, retention in general wasn't good. Despite this, few of these teeth developed any caries leading to the conclusion that some of this cement remains behind in the fissures. Because of the characteristics of GIC, this may be advantageous to the prevention of caries in the fissures of a tooth.

From the studies done using the ART approach to place restorations it seems as if ART is less successful on the primary dentition than on the permanent dentition. One surface restorations also seem to be more successful when ART is the treatment of choice. This was found in both the Thailand and Zimbabwe studies.

Chapter 3 discusses the materials and methods used in the project. This involves the initial screening phase, the treatment phase, and the 6- and 12-months evaluation phases. This chapter will also discuss the planning, development and implementation of the project including criteria used to evaluate the ART restorations and sealants.

## CHAPTER 3 : MATERIALS AND METHODS

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## CHAPTER 3: MATERIALS AND METHODS

### 3.1 INTRODUCTION

According to Frencken and Makoni (1994) in developing countries dental caries is either left virtually untreated or if treatment is performed at all, it will probably lead to the extraction of the tooth. Reasons for this include lack of or an uneven distribution of oral health personnel and/or financial constraints limiting the purchase of instruments and equipment. This is very much the case for the majority of patients in South Africa as well.

Dawson and Makinson (1992) define minimal intervention techniques as those advocating the use of adhesive dental materials, remineralisation techniques and monitoring of initial caries with the aim of arresting early surface lesions in an attempt to shift the philosophical emphasis from the previously presented axiom which was "*When in doubt, fill*" to that of "*When in doubt, institute preventive measures and monitor*". Smales and Gerke (1990) mention that oral health should be considered in terms of a dentition that is functionally adequate, aesthetically pleasing and free from discomfort and disease.

Du Plessis *et al* (1994) in describing the results of the 1988/89 South African NOHS, advocates that primary oral health care strategies which would provide an alternative to extraction of decayed teeth in children have to be promoted.

During the 73<sup>rd</sup> General Session of the International Association for Dental Research held in Singapore in 1995, a symposium entitled "Minimal Intervention Techniques for Dental Caries" was presented in which ART and the use of GIC as fissure sealants were discussed. This study, started in 1996 in Mamelodi, Pretoria, was aimed at evaluating the retention and development of secondary caries in relation to ART restorations and sealants placed on erupting first and second permanent molars under field conditions in South African schoolchildren who in general do not have access to dental services. The minimal intervention approach was used in this study. This chapter describes the planning, development and implementation of the study.

### 3.2 SELECTION OF THE SAMPLE

A biostatistician from Statomet, University of Pretoria, was consulted regarding the selection of the sample.

All children in Grades 1 to 4 in 11 primary schools in Mamelodi were examined using the SNI developed by Holtshousen *et al* (1995). The purpose of this index is:

- to give an indication of the need for dental treatment and oral health care in a schoolgoing population.
- to monitor the oral health status of a schoolgoing population in an acceptable manner, realising that it is not possible to do such monitoring at every school on an annual basis.

Children were selected to form part of the study based on the needs for caries treatment and the need for fissure sealant components of the SNI. According to Holtshousen *et al* (1995) the criteria for these components are:

#### **Need for caries treatment:**

- A tooth is sound if it shows no evidence of untreated clinical caries.
- The stages that precede cavitation, as well as other conditions similar to early stages of caries, are excluded because they cannot be reliably diagnosed.
- Caries is recorded as present when a lesion in a pit and/or fissure, or on a smooth tooth surface, has a detectable softened floor, undermined enamel or softened wall.
- A tooth with a temporary restoration is also recorded as having caries.
- When any doubts exist, caries should not be recorded as present.
- A restored tooth with secondary caries is scored the same as a decayed tooth.

#### **Need for fissure sealant:**

- Deep and discoloured pits and fissures are an indication for fissure sealant.
- Four or more carious lesions or filled teeth are an indication of caries susceptibility and this child should be considered for fissure sealant.
- If the tooth which is considered for fissure sealant has been in the mouth for less than 2 years it is indicated for fissure sealant.
- If 2 or more of these criteria are met, the child will be considered for fissure sealant.

From the 11 primary schools, five were selected based on similar average scores for the caries component of the SNI. These scores ranged between 31,9 and 32,1% of children in need of caries treatment and these schools served as the total population from which teeth suitable for ART restorations and sealants were selected. Only Grade 1 to Grade 4 children participated in the study because of the higher caries risk (erupting first and second molars) in these age groups.

Carious primary and permanent molars were chosen using the caries treatment component of the SNI as described earlier. Molars with large, open carious lesions with part of the crown missing and which would possibly require pulp protection or local anaesthesia were not included in this study.

Differentiation was made between primary and permanent teeth based on the age of the child. Only one surface restorations were done on both primary and permanent teeth in line with research findings discussed in Chapter 2 that one surface restorations using the ART approach are more successful than multiple surface restorations.

### **3.3 STUDY DESIGN**

A longitudinal study design was followed. ART restorations and sealants were evaluated at intervals of 6 and 12 months. Variables included for evaluation were:

- Retention of the material 6 and 12 months after placement
- Development of secondary caries adjacent to ART restorations or sealants
- Input cost of ART procedures in terms of human resources, dental materials, consumables, time and transport

### **3.4 EVALUATION CRITERIA**

An examination form (see Appendix) was used to record the initial treatment performed for each tooth as well as the status of the procedure/tooth when followed up 6 and 12 months after placement. With the criteria used in the Thailand (Frencken *et al*, 1994) and Zimbabwe (Frencken *et al*, 1996) reports on the 1-year follow-up results as a reference, a separate set of

criteria to evaluate retention of the material and development of secondary caries adjacent to the ART restorations and sealants were developed for this study. The comparison of these criteria are described in Table 1. Reasons for developing a separate set of criteria are:

- to keep the criteria simple and understandable and to attempt to develop one set of criteria which could be used for both ART restorations and sealants.
- to represent the various combinations of retention of procedures performed and development of secondary caries.

A Williams probe consisting of a sickle and periodontal probe was used to detect marginal and gross defects in the restorations. A marginal defect was recorded when a defect could be seen clinically, but the periodontal part of the probe could not penetrate the defect whereas with gross defect the periodontal probe could penetrate the defect. A score of 7 or 8 was given if the tooth was still present in the mouth but there was no clinical visible sign of the ART restorations and sealants. A score of 9 was given if the tooth had been extracted/exfoliated since the previous visit or if another procedure had been done on the tooth by another oral health worker in between evaluation periods.

**Table 1:** Comparison of criteria used in Thailand, Zimbabwe and South Africa

	THAILAND CRITERIA (Frencken <i>et al</i> , 1994)	ZIMBABWE CRITERIA (Frencken <i>et al</i> , 1996)	SOUTH AFRICAN CRITERIA
0	Present, correct	Present, good	Tooth not included in study
1	Present, slight marginal defect, needs no replacement	Present, slight marginal defect for whatever reason, at any one place which is less than 0,5 mm in depth; no repair is needed	Present with no defect; no caries
2	Present, marginal defect, needs replacement	Present, marginal defect for whatever reason, at any one place which is less than 0,5 mm, but less than 1,0 mm; repair is needed	Present with marginal defect; no caries
3	Present, gross defect, needs replacement	Present, gross defect of more than 1,0 mm in depth; repair is needed	Present with gross defect; no caries
4	Not present, needs treatment	Not present, restoration has (almost) completely disappeared; treatment is needed	Present with no defect; caries
5	Not present, other treatment performed elsewhere	Not present, other restorative treatment has been performed	Present with marginal defect; caries
6	Tooth absent because of exfoliation	Not present, tooth has been extracted	Present with gross defect; caries
7	Tooth absent because of extraction	Present, wear and tear gradually over larger parts of the restoration but is less than 0,5 mm at the deepest point; no repair is needed	Procedure absent; no caries
8	Wear and tear, needs no replacement	Present, wear and tear gradually over larger parts of the restoration which is deeper than 0,5 mm; repair is needed	Procedure absent; caries
9	Wear and tear, needs replacement	Unable to diagnose	Tooth excluded

#### **Notes on criteria:**

Code 0 for the Thailand and Zimbabwe studies can be considered equivalent to Code 1 for this study.

Code 4 for Thailand and Zimbabwe studies is more or less equivalent to Code 7/8 for this study.

Codes 5, 6 and 7 for Thailand and Codes 5 and 6 for Zimbabwe are equivalent to Code 9 for this study which excludes teeth due to exfoliation, extraction or some other type of treatment having been done on the specific tooth.

Codes 4, 5, 6 and 8 for this study refer to teeth that had a procedure done and had developed caries, therefore requiring further treatment.

The criteria for this study could be applied to both ART restorations and sealants whereas the Thailand and Zimbabwe studies both used different criteria to evaluate the restorations and sealants separately.

### **3.5 HUMAN RESOURCES**

The initial examination for selecting children to be included in the study was done by an oral hygienist and a dental therapist. A dental assistant was responsible for the sterilisation of the instruments and general administration. The recording on the SNI forms was done by the teachers after the procedure was explained to them. A dental therapist was responsible for the placement of ART restorations and sealants and the evaluation thereof after the specified periods.

### **3.6 CALIBRATION**

The clinicians were calibrated on the SNI by a community dentistry specialist from the Gauteng Oral Health Services. The official manual available at the time of the study for the ART approach was used to guide the clinician in the placement of ART restorations and sealants (WHO, 1994).

### 3.7 CONSENT

Authorisation forms were sent to parents through their children to inform them about the treatment needs of their children. Consent was given through parents signing the forms and sending them back to the school (see Appendix).

A letter was sent to the principal for consent of the school to participate in the study (see Appendix).

Co-operation was obtained from:

- the Subregional Head of the Central North Oral Health Services
- the dental staff of the Mamelodi I and II dental clinics

### 3.8 INSTRUMENTS

Instruments that were used in the study are:

- mirror
- Williams probe
- tweezers
- excavator
- chisel
- glass slab and spatula
- carver

Excavators used in this study were not new, but were still sharp enough to adequately remove caries according to guidelines explained in the ART manual (WHO, 1994). Instruments were not re-sharpened during the treatment phase. Instruments were provided by the Mamelodi II Dental Clinic.

### 3.9 EQUIPMENT

Equipment used included:

- regular chairs for the operators and assistants
- portable dental chair for the patient to lie on
- a table for the placement of the required instruments and material
- a basin for washing hands
- treatment was done under classroom light (bulbs) - no other special light was used
- evaluation of procedures was done under classroom light

### 3.10 MATERIALS

- Fuji III was used for the ART sealant in erupting teeth.
- Fuji IX was used for the ART restorations.
- Consumable supplies included sterilising agents, paper towels, soap, rubber gloves, face masks, cotton wool rolls, cotton wool pellets, wedges, plastic strips, articulation paper and petroleum jelly.
- Stationery: Examination forms, pens and survey forms.

Both the Fuji III and Fuji IX were initially difficult to mix, but with time and more experience in handling the materials, it became better. At the beginning of the treatment phase, there might have been material that was used to restore or seal that was either too soft or too dry.

Fuji III was chosen as a sealant material as it was the only glass ionomer indicated as a sealant available at the time. This material was also used in the following studies:

- Forss *et al* (1994) found 13% of Fuji III sealants totally present, 15% partially lost and 72% totally lost after two years. Results showed that Fuji III was inferior to Delton, however, no difference in caries increment on sealed surfaces was noted.
- Torpa-Saarinen and Seppä (1992) used Fuji III on newly erupted molars. After a year, 45% were totally present, 35% partially lost and 20% totally lost. The results suggested that residual material in the fissures may have provided protection after sealant loss.

- Karlzen-Reuterving and Van Dijken (1995) found 72,2% retention, 16,7% partially lost and 11,1% totally lost after one year.

### 3.11 METHODS

The methods described below were those used in this study. They were based on the methods described in the manual which was previewed during the WHO's Year of Oral Health celebration in Geneva on April 7th 1994 (WHO, 1994). The most recent version (third edition) of the manual was published in 1997 (Frencken *et al*)

#### 3.11.1 ATRAUMATIC RESTORATIVE TREATMENT RESTORATIONS

- (i) Cotton wool rolls were placed on the buccal and lingual (palatal) surface of tooth to be treated.
- (ii) Plaque was removed with cotton wool pellets and the tooth was then dried with dry cotton wool pellets.
- (iii) In cases where the cavity was too narrow for the excavator, it was widened with a chisel.
- (iv) Carious dentine was removed using the different sizes of the excavators, depending on the size of the cavity.
- (v) After all caries was removed, the cavity was then cleansed with wet cotton wool pellets, then dried with dry ones.
- (vi) The wet cotton wool rolls were replaced with dry ones as soon as they became too wet to keep a dry working area.
- (vii) The material was then mixed as described in the ART manual (WHO, 1994).
- (viii) The cavity was conditioned as described in the ART manual (WHO, 1994).
- (ix) Material was placed into the cavity in small amounts, using the blunt side of the carver. The round surface of the excavator was used to condense the mixture deeper into the cavity.
- (x) Excess material was removed with carver, occlusion was checked with articulation paper and petroleum jelly applied.
- (xi) The cotton wool rolls were removed.

(xii) The patient then asked not to eat for an hour.

### 3.11.2 ATRAUMATIC RESTORATIVE TREATMENT SEALANT

- (i) Cotton wool rolls were placed on the buccal and lingual/palatal surface to isolate and keep dry the tooth to be treated.
- (ii) Plaque and debris were removed with wet cotton wool pellets.
- (iii) An explorer was used to remove debris in deep pits and fissure.
- (iv) The cavity was conditioned as described in the ART manual (WHO, 1994).
- (v) The pits and fissures were washed twice to clean off the conditioner and then dried with dry cotton wool pellets.
- (vi) The wet cotton wool rolls were replaced with dry ones.
- (vii) The glass ionomer was then mixed and applied in all pits and fissures with the blunt side of the carver. They were slightly overfilled.
- (viii) Index finger was smeared with petroleum jelly and used to press the sealant deeper into fissures.
- (ix) Visible excess material was then removed with an excavator.
- (x) After waiting two minutes for the material to set, occlusion was checked and excess material removed with carver.
- (xi) A new layer of petroleum jelly was applied and then the wet cotton wool rolls were removed.
- (xii) The patient was asked not to eat for at least an hour.

**Note:** The schoolchildren had their lunch break at 11:00 a.m. Some of the restorations and sealants were completed around the lunch break. Even though these children were asked not to eat for an hour, there is a possibility that some could not stand the hunger pangs and may have eaten before the one hour had elapsed. This might have contributed to some failures.

### 3.12 TRANSPORT

Transport was provided by the Mamelodi II Dental Clinic to carry the team members and equipment between the clinic and the schools concerned.

### **3.13 FINANCES**

Equipment, instruments and materials were provided by the Pretoria Region of the Gauteng Oral Health Services. Human resources were part of the Mamelodi II Dental Clinic and the time needed for the project were considered part of the normal working hours for the dental team.

### **3.14 TIME SCHEDULE**

Initial screenings at the 11 primary schools were done during February and March 1996. Treatment of children was completed during August 1996 with the follow-up visits 6 and 12 months after placement completed during February and August 1997.

### **3.15 SUMMARY**

In this chapter the materials and methods used in the project were discussed. This involved the initial screening phase, the treatment phase, and the 6- and 12-months evaluation phases. This chapter also discussed the planning, development and implementation of the project including criteria used to evaluate the ART restorations and sealants.

Results of this study will be discussed in Chapter 4.

## CHAPTER 4: RESULTS

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## CHAPTER 4: RESULTS

### 4.1 ANALYSIS OF THE SAMPLE

Initially 1849 children were examined and based on the SNI component for dental caries and fissure sealant explained in Chapter 3, a total of 382 children were chosen for the study. Of these 196 (51,3%) were boys and 186 (48,7%) girls. Their ages varied from 6 to 14 with the mean age being 8,01 years. Treatment need as determined by the SNI ranged from 31,9% to 32,1% for the five schools from which the sample was selected.

The majority of caries in the sample was present on the occlusal surfaces of primary and permanent molars. Based on results presented of the Thailand and Zimbabwe studies (reviewed in Chapter 2), only one surface restorations were placed in the primary and the permanent dentition.

Table 2 shows the number of ART restorations and sealants placed at baseline and evaluated after 6 and 12 months respectively for the primary and permanent dentition. No sealants were placed in the primary dentition.

**Table 2 :** ART restorations and sealants placed and evaluated after 6 and 12 months

Dentition	Procedure	Teeth treated at baseline	Teeth evaluated after 6 months	Teeth evaluated after 12 months
Primary	ART restorations	443	391 (88,3%)	364 (82,2%)
Permanent	ART restorations	63	56 (88,9%)	55 (87,3%)
	ART sealants	552	489 (88,6%)	463 (83,9%)

Out of 443 ART restorations placed on primary molars, 88,3% and 82,2% respectively were still available for evaluation 6 and 12 months after placement. This represents a lost to follow-up of 11,7% and 17,8% for the 6 and 12 month evaluations respectively.

For the 63 ART restorations placed on permanent molars, 88,9% and 87,3% were present for evaluation after 6 and 12 months, a lost to follow-up of 11,1% and 12,7% for the 6 and 12 month evaluations respectively.

For 552 ART sealants placed only on permanent teeth, 88,6% were evaluated after 6 months (a loss of 11,4%) and 83,9% after 12 months (a loss of 16,1%).

The lost to follow-up could be attributed mainly to absenteeism of the child on the day of evaluation or children having moved to other schools and areas, a big problem encountered with this type of research in South Africa.

## 4.2 RETENTION AND SECONDARY CARIES

Table 3 presents the number of ART restorations and sealants present 6 and 12 months after they were placed at baseline. Not included in this table are the teeth which were excluded (Code 9) due to extraction, exfoliation or some other type of treatment having been done on them (see Chapter 3 for explanation of codes).

**Table 3:** Cross-sectional data on ART restorations and sealants from baseline up to 12 month visit

Dentition	Procedure	6 months evaluation			12 months evaluation		
		n	Present	Absent	n	Present	Absent
Primary	ART restorations	361	263 (72,9%)	98 (27,1%)	285	161 (56,5%)	124 (43,5%)
Permanent	ART restorations	55	52 (94,5%)	3 (5,5%)	50	42 (84%)	8 (16%)
	ART sealants	489	134 (27,4%)	355 (72,6%)	462	48 (10,4%)	414 (89,6%)

For the 361 ART restorations evaluated after 6 months placed in the primary dentition 72,9% were present. Of the 285 evaluated after 12 months, 56,5% were present. For ART restorations placed in the permanent dentition, 94,5% of the 55 restorations evaluated after 6 months were still present. After 12 months 84% of the 50 restorations evaluated were present. It can be noted from this table that more ART restorations were retained on permanent teeth than on primary teeth after 6 as well as 12 months. This is in line with the

findings from the Thailand study where ART restorations were done on primary and permanent teeth.

For the ART sealants placed in the permanent dentition, only 27,4% and 10,4% were retained after 6 and 12 months respectively. It must be mentioned that this only applies to sealant still being clinically present, no comment can be made on what amount remained behind within the pit or fissure which cannot be observed visually.

For the purpose of evaluating the retention and development of caries in relation to the ART restorations and sealants in more detail, only the 6 and 12 month results for the teeth present at both evaluation periods will be presented in the next sections (longitudinal group).

#### 4.2.1 EVALUATION OF ATRAUMATIC RESTORATIVE TREATMENT RESTORATIONS

The breakdown for the various criteria used for evaluating the 364 and 55 ART restorations placed in the primary and permanent dentitions respectively 6 and 12 months after placement are given in Table 4. All of these teeth were available for evaluation at both visits.

**Table 4 :** Evaluation of ART in the primary and permanent dentition after 6 and 12 months

Code	Status of ART restorations	Caries status	Primary dentition		Permanent dentition	
			6 months	12 months	6 months	12 months
1	Present, no defect	No caries	220	137	49	33
2	Present, marginal defect	No caries	16	20	2	6
3	Present, gross defect	No caries	2	4	0	2
4	Present, no defect	Caries	0	0	0	0
5	Present, marginal defect	Caries	0	0	0	1
6	Present, gross defect	Caries	0	0	0	0
7	Absent	No caries	24	45	2	5
8	Absent	Caries	72	79	1	3
9	Tooth excluded		30	79	1	5
		<b>TOTAL</b>	<b>364</b>	<b>364</b>	<b>55</b>	<b>55</b>

From Table 4 some of the scores were grouped together to give more detailed results on the retention and development of caries in relation to the procedure performed. These results are found in Table 5.

The number of teeth with Code 9 (excluded due to extraction, exfoliation or some other type of treatment having been done on them) were subtracted from the total number of teeth present at the visit to give the number of teeth evaluated. The number of teeth on which the ART was still present, irrespective of its status was obtained by combining codes 1 to 6 while codes 7 and 8 combined gives an indication of the number of ART restorations being absent.

For the number of restorations being present, its status could be determined as having no defect by combining codes 1 and 4, marginal defect (codes 2 and 5) and gross defect (codes 3 and 6). The criteria for determining for marginal and gross defect were explained in Chapter 3.

The number of teeth where caries had developed in relation to the ART restorations was calculated by combining codes 4 to 6 and 8 while the combination of codes 1 to 3 and 7 gives an indication of the number of teeth where no caries had developed in relation to the restoration.

The procedure was considered to be a failure if any code was awarded to it except code 1 (present, no defect, no caries) or code 9 (excluded).

From Table 5 the retention of ART restorations both at 6 and 12 months for primary teeth was 71,3% and 56,5% respectively. For the permanent dentition, retention at 6 and 12 months was 94,4% and 84%. No defects were found on 92,4% and 85,1% of primary teeth after 6 and 12 months. For the permanent dentition no defects were found on 96,1% after 6 months and 78,6% of restorations after 12 months. Marginal and gross defects on primary dentition were 6,7% and 0,8% after 6 months and 12,4% and 2,5% after 12 months. For the permanent dentition marginal and gross defects were 3,9% and 0% after 6 months and 16,7% and 4,8% after 12 months.

For the primary dentition caries in relation to the ART restorations after 6 and 12 months was 21,6% and 27,7% respectively, whereas in the permanent dentition it was 1,9% and 8% for the same periods.

**Table 5:** Evaluation of ART in the primary and permanent dentition after 6 and 12 months

	Primary dentition				Permanent dentition			
	6 months		12 months		6 months		12 months	
	n	%	n	%	n	%	n	%
Total number of teeth present	364	-	364	-	55	-	55	-
Number of teeth excluded (Code 9)	30	8,2	79	21,7	1	1,8	5	9,1
Number of teeth evaluated	334	91,8	285	78,3	54	98,2	50	90,9
Number of teeth evaluated	334	-	285	-	54	-	50	-
Number of restorations absent (Codes 7, 8)	96	28,7	124	43,5	3	5,6	8	16,0
Number of restorations present (Codes 1-6)	238	71,3	161	56,5	51	94,4	42	84,0
Number of restorations present	238	-	161	-	51	-	42	-
With no defects (Codes 1, 4)	220	92,4	137	85,1	49	96,1	33	78,6
With marginal defects (Codes 2, 5)	16	6,7	20	12,4	2	3,9	7	16,7
With gross defects (Codes 3, 6)	2	0,8	4	2,5	0	0	2	4,8
Teeth with caries (Codes 4-6, 8)	72	21,6	79	27,7	1	1,9	4	8,0
Teeth without caries (Codes 1-3, 7)	262	78,4	206	72,3	53	98,1	46	92,0
Failed restorations (Codes 2-8)	114	34,1	148	51,9	5	9,3	17	34,0

If either of codes 2 to 8 were awarded to the procedure during follow-up visits, it was considered to be a failure. For the primary dentition 34,1% and 51,9% of restorations could be classified as such after 6 and 12 months respectively, For the permanent dentition 9,3% of ART restorations were considered to be a failure after 6 months, 34,0% after 12 months.

#### 4.2.2 EVALUATION OF ATRAUMATIC RESTORATIVE TREATMENT SEALANTS

The breakdown for the various criteria used for evaluating the 463 sealants in the permanent dentition 6 and 12 months after placement are given in Table 6. All of the teeth mentioned in the table were available for evaluation at both visits.

From Table 6 some of the criteria were grouped together in the same way as was explained under the previous section to give results on the retention and development of caries in relation to the procedure. These results are found in Table 7.

**Table 6 :** Evaluation of sealants in the permanent dentition at 6 and 12 months

Code	Status of ART sealants	Caries status	6 months	12 months
1	Present, no defect	No caries	127	45
2	Present, marginal defect	No caries	3	3
3	Present, gross defect	No caries	0	0
4	Present, no defect	Caries	0	0
5	Present, marginal defect	Caries	0	0
6	Present, gross defect	Caries	0	0
7	Absent	No caries	330	409
8	Absent	Caries	3	5
9	Tooth excluded		0	1
TOTAL			463	463

**Table 7:** Results for ART sealants after 6 and 12 months for the permanent dentition

	6 months		12 months	
	n	%	n	%
Total number of teeth present	463	-	463	-
Number of teeth excluded (Code 9)	0	0	1	0,2
Number of teeth evaluated	463	100	462	99,8
Number of teeth evaluated	463	-	462	-
Number of sealants absent (Codes 7, 8)	333	71,9	414	89,6
Number of sealants present (Codes 1-6)	130	28,1	48	10,4
Number of sealants present	130	-	48	-
With no defects (Codes 1, 4)	127	97,7	45	93,8
With marginal defects (Codes 2, 5)	3	2,3	3	6,3
With gross defects (Codes 3, 6)	0	0	0	0
Teeth with caries (Codes 4-6, 8)	3	0,6	5	1,1
Teeth without caries (Codes 1-3, 7)	460	99,4	457	98,9
Failed sealants (Codes 2-8)	336	72,6	417	90,3

Of the 463 sealants evaluated 6 and 12 months after placement, only 28,1% and 10,4% were still present. Of these 97,7% had no defect after 6 months with the remaining 2,3% a marginal defect. After 12 months these had dropped to 93,8% for no defect with the remaining 6,3% with marginal defect.

After 6 months 99,4% of teeth treated had no caries, the corresponding figure being 98,9% after 12 months. In teeth where caries had developed, sealant was totally absent when observed clinically.

After 6 months, 72,6% of sealants could be regarded as failed, 90,3% after 12 months. A sealant was considered to be a failure if any of codes 2 to 8 was awarded to it during evaluation.

## 4.3 COST OF PROGRAMME

### 4.3.1 MATERIAL AND CONSUMABLES

**Table 8:** Cost of material and consumables used in the study

Item	Units consumed	Cost per unit	Total cost
<b>Material:</b> Fuji III	3	R448,00	R1 344,00
Fuji IX	3	R156,84	R470,52
<b>Subtotal:</b>			<b>R1 814,52</b>
<b>Consumables:</b> Gloves	100	R0,39	R39,00
Broncocide disinfectant	31	R13,12	R406,72
Face masks	68	R0,16	R10,88
Cotton wool rolls	1 box	R73,85	R73,85
Paper towels	5	R5,34	R26,70
Soap	5	R0,88	R4,40
<b>Subtotal:</b>			<b>R561,55</b>
<b>Total:</b>			<b>R2 376,07</b>

### 4.3.2 TRANSPORT COST

Travelling expenses per kilometre was charged at R1,10. For the individual schools, the total number of kilometres travelled (to and from the school) was as follows:

Uoane: 10 km

Ntshabohloko: 14 km

Mmangoloane: 12 km

Refentse: 12 km

Shirinda: 18 km

Total kilometres travelled: **66 km**

Cost for transport: 66 km x R1,10 per km = **R72,60**

### 4.3.3 COST OF HUMAN RESOURCES

**Table 9:** Total cost of a dental therapist to the Public Oral Health Services calculated as an average of junior and senior ranks

Average basic cost	Benefit: 29,7% of basic cost	Housing benefit	Total cost
R52 048	R15 458	R10 524	<b>R78 030</b>

From Table 9 the salary per hour for a dental therapist was calculated for 200 working days and 8 hours per day:

$$R78\ 030/200\ \text{days} = \mathbf{R390,15/day}$$

$$R390,15/8\ \text{hours per day} = \mathbf{R48,77/hour}$$

### 4.3.4 TIME

Total time to treat the individuals at the schools:

Uoane:	6 hours
Ntshabohloko:	12 hours
Refentse:	6 hours
Mmangoloane:	6 hours
Shirinda:	12 hours
<b>Total:</b>	<b>42 hours</b>

At some of the schools, chairside assistance could be provided, but at others it was not available. Treatment time for ART sealants without assistance took 12 minutes on average (5 per hour), while the ART restorations without assistance took 15 minutes (4 per hour) to complete.

### 4.3.5 COST PER PROCEDURE

To calculate cost per procedure, parameters such as time, material and consumables, travel and salary of the operator were taken into account. These results are give in Table 10.

The cost for ART restorations and sealants were found to be almost similar taking into account labour cost, material, consumables and transport.

**Table 10:** The calculation of cost per procedure

	ART RESTORATIONS	ART SEALANTS
Number of procedures performed at baseline:	506	552
<b>Labour cost:</b>		
Dental therapist cost per hour (Table 9):	R48,77	R48,77
Time to complete procedures at baseline:	Calculated at 4 restorations per hour: 126,5 hours needed	Calculated at 5 sealants per hour: 110,4 hours needed
Total cost:	R6 169,41	R5 384,21
Cost per procedure:	<b>R12,19</b>	<b>R9,75</b>
<b>Material:</b>		
Total cost (Table 8):	R470,52 (Fuji IX)	R1 344,00 (Fuji III)
Cost per procedure:	<b>R0,93</b>	<b>R2,43</b>
<b>Consumables:</b>		
Total cost (Table 8):	506 restorations/1058 total procedures x R561,55 = R268,57	552 sealants/1058 total procedures x R561,55 = R292,98
Cost per procedure:	<b>R0,53</b>	<b>R0,53</b>
<b>Transport cost:</b>		
Cost of transport:	506 restorations/1058 total procedures x R72,60 = R34,72	552 sealants/1058 total procedures x R72,60 = R37,88
Cost per procedure:	<b>R0,07</b>	<b>R0,07</b>
<b>Total costs per procedure:</b>		
Operator cost:	R12,19	R9,75
Materials:	R0,93	R2,43
Consumables:	R0,53	R0,53
Transport:	R0,07	R0,07
Total:	<b>R13,72</b>	<b>R12,78</b>

#### 4.3.6 ADDITIONAL COST

The cost to replace the failed ART restorations and sealants was calculated and added to the original cost to determine the final cost per procedure for this project. Restorations that were absent as well as those restorations with either marginal or gross defects were classified as "failed" (see Tables 5 and 7). Of course after the initial treatment has failed several other treatment options are possible e.g. extraction of a deciduous tooth if it is close to exfoliation, referral to a clinic for conventional procedures, etc. For the purpose of this exercise (Table 11), it was assumed that the original procedure would be repeated to calculate a cost where replacement was somehow taken into consideration.

**Table 11:** Actual cost per procedure

	ART RESTORATIONS	ART SEALANTS
Cost per procedure (Table 12):	R13,72	R12,78
Procedures absent after 12 months:	132	414
Procedures with marginal/gross defects after 12 months:	33	3
Total to be replaced:	<b>165</b>	<b>417</b>
Number of teeth present after 12 months:	419	463
Number of Procedures to be replaced calculated from procedures placed at baseline:	$165/419*506=199$	$417/463*552=497$
Initial cost of procedure:	$506*R13,72=R6\ 942,32$	$552*R12,78=R7\ 054,56$
Cost for replacement:	$199*R13,72=R2\ 730,28$	$497*R12,78=R6\ 351,66$
Total cost:	R9 672,60	R13 406,22
Cost per procedure:	$R9\ 672,60/506=R19,12$	$R13\ 406,22/552=R24,29$

In the following section results from this study will be compared to other studies where ART was investigated.

#### 4.4 COMPARISON WITH OTHER STUDIES

For the purpose of comparison, only the Thailand and Zimbabwe studies as reviewed in Chapter 2 will be taken into consideration.

##### 4.4.1 SIX MONTH STUDIES

Table 12 compares the survival rate of ART restorations after 6 months for Thailand (Pitiphat *et al* (1993) with this study.

**Table 12:** Comparison of 6 month retention data for ART restorations to Thailand

	Pitiphat <i>et al</i> (1993): Thailand	This study	
	Primary/Permanent dentitions combined	Primary dentition	Permanent dentition
1 surface restoration	87%	71,3%	94,4%
>1 surface restoration	56%		

The only report on 6 month data was published by Pitiphat *et al* (1993) for the Thailand study. These results were for the primary and permanent dentitions combined with 1 surface and more than one surface restorations reported separately. The results showed that 87% of one-surface and 56% of multi-surface restorations were still in good condition. Compared to this study where only 1 surface restorations were done for either dentition, retention after 6 months was 71,3% for primary and 94,4% for permanent teeth.

The results from this study for ART restorations after 6 months compares favourably with Thailand as a mixed dentition was used in both studies. No 6 month evaluation on ART sealants was reported for the Thailand study.

#### 4.4.2 TWELVE MONTH STUDIES

Twelve month data was reported for both the Thailand (Frencken *et al* ,1994) and Zimbabwe studies (Frencken *et al* ,1996). The results from these studies are compared to the results from this study presented in Tables 13 and 14. As only 1 surface restorations were done in this study, only these results are mentioned for Thailand and Zimbabwe.

**Table 13:** Comparison of 12 month retention for ART restorations to Thailand and Zimbabwe

Primary dentition		Permanent dentition		
Thailand (Frencken <i>et al</i> ,1994)	This study	Thailand (Frencken <i>et al</i> ,1994)	Zimbabwe (Frencken <i>et al</i> ,1996)	This study
79%	56,5%	93%	93,4%	84%

From Table 13 it will be noted that for Thailand 79% of ART restorations were classified as successful after 12 months for the primary dentition. This is much higher than the success rate for this study, found to be 56,5%. For the permanent dentition retention for ART restorations in Thailand was reported as 93%, for Zimbabwe 93,4%. Once again it was found to be lower for this study which was 84%. Possible explanations for these differences are discussed in Chapter 5.

Retention for the ART sealants for this study was much lower than reported for Thailand and Zimbabwe. (10,4% compared to 78 and 60,3%) Explanations for these differences are also discussed in Chapter 5.

**Table 14:** Comparison of 12 month retention data for ART sealants for the permanent dentition to Thailand and Zimbabwe

Thailand (Frencken <i>et al</i> ,1994)	Zimbabwe (Frencken <i>et al</i> ,1996)	This study
78%	60,3%	10,4%

## 4.5 SUMMARY

In this chapter the results for ART restorations and sealants were presented for the 6 and 12 month evaluation periods. The initial sample of the children involved was described and the input and output results of the project reported. An attempt was made to calculate the cost of these procedures taking into account all variables.

Results from this study were also compared with the results of the two major studies done on ART restorations and sealants in Thailand and Zimbabwe. Although both of these studies were done over a 3-year period, only the 1-year results were taken into consideration for comparison.

In Chapter 5 the explanations and implications of the results of this study will be discussed.

## CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

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## **CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS**

This chapter will give a critical evaluation and appraisal of the total information gathered from this study. It concentrates on the results for ART restorations and sealants as found in this study and relate them to other studies done previously. Recommendations are made for future research on ART as well based on the results of this study.

### **5.1 DISCUSSION**

382 Children were involved in this study. 506 ART restorations were placed at baseline, 443 in primary molars and 63 in permanent molars. 552 ART sealants were placed in the permanent dentition only. This project was started in August 1996 with baseline evaluations and treatment completed over a period of three weeks. The attrition rate from baseline for ART restorations in primary teeth was 11,7% after 6 months and 17,8% after 12 months. For the permanent teeth attrition was 11,1% after 6 months and 12,7% after 12 months. For the ART sealants attrition was 11,4% and 16,1% respectively after 6 and 12 months. Possible reasons for this can be attributed to children who have moved to other schools and children who were absent during the follow-up examinations.

#### **5.1.1 ATRAUMATIC RESTORATIVE TREATMENT RESTORATIONS**

The criteria used to assess the success of ART restorations in this study were designed around retention of the restorative material and the development of caries in relation to the procedure performed. The results of the longitudinal group for this study after one year indicate that for the primary dentition 71,3% of the ART restorations were still present after 6 months with 92,4% of these showing no defects. After 12 months 56,5% of the ART restorations were still present of which 85,1% had no defects.

In the permanent dentition for the 6 and 12 month evaluations, 94,4% and 84% of ART restorations were present with 96,1% and 78,6% showing no defects after 6 and 12 months

respectively. Both the 6 and 12 month results are lower than those found in the Thailand and Zimbabwe studies (see Chapter 4).

#### 5.1.1.1 REASONS FOR DIFFERENCE IN RESULTS

Possible reasons for the difference in results between this study and the Thailand and Zimbabwe studies will now be discussed.

- **Instruments**

Instruments used in this study were not sharpened. For hand instruments to be effective, they have to be sharpened regularly (WHO, 1997). A blunt hand instrument needs excessive force to be effective, leading to hand fatigue sooner than expected. The ART manual used in this study (WHO, 1994) calls for a hatchet or hoe to be used to widen the entrance of the cavity. Since these were not available for this study, a chisel was used instead.

- **Training**

The 3-year Zimbabwe study (Frencken *et al*, 1998) mentioned operator effect as a confounding factor. A statistically significant difference was reported in the survival of ART restoration and sealant retention between dentists and dental therapists in Zimbabwe which may be overcome by therapists undergoing more training on the ART technique.

In retrospect, for this study, the researcher didn't receive sufficient training in the ART technique prior to the study. The ART restorations and sealants were practised on ten children selected from one of the schools eliminated from the study. These children were selected and treated according to the ART manual available at the time (WHO, 1994). The third edition of the manual (WHO, 1997), advises those who intend to use the ART technique to follow a training course and not rely on the manual as a self-instruction guide only.

- **Materials**

Fuji IX was used for the ART restorations in this study. ChemFil Superior was used in the Zimbabwe study and ChemFil in Thailand. This could have attributed to a difference in results when comparing these studies.

- **Criteria**

A set of criteria was developed for this study to evaluate retention of the material and the development of caries adjacent to ART restorations and sealants. The Zimbabwe and Thailand studies used a different set of criteria for evaluating the ART sealants and restorations separately. Although conclusions could be made from this study based on the criteria used, it makes comparison with the Zimbabwe and Thailand studies difficult and could also have contributed to the difference in results.

- **Application and mixing times**

The third edition of the ART manual (WHO, 1997) states that the mixing of the material should be completed within 20-30 seconds. If more than 30 seconds are and the mixture looks dry, it has to be discarded. These time limitations were not mentioned in the earlier version of the manual which was used as a guide for this study.

Both the old and new versions of the ART manual advise that an hour should elapse before eating so that the material can set properly. Some of the children were treated less than an hour before their lunch time. At the end of the procedure, they were told not to eat for an hour but this may not have been practical as by the time the hour had elapsed it meant that they had to be back in their classes. It is therefore possible that some of the children might have eaten before the hour had elapsed leading to a higher failure of ART restorations.

- **Selection of patients**

- Selection criteria: For this study selection of children was based on the SNI (Holtshousen *et al*, 1995) where other studies had used the DMFT and DMFS caries indices. This might have affected results as criteria for the selection of teeth and fissures might have differed between the various studies.
- Surfaces: In this study as well as the Zimbabwe study only used one-surface restorations were evaluated. In the Thailand study one and more than one-surface restorations were evaluated.

### 5.1.1.2 REASONS FOR FAILURE OF RESTORATIONS

This section deals with possible reasons for the high failure of the ART restorations in this study.

- **Incomplete removal of caries**

As the instruments were never sharpened during this study, excessive force had to be used to remove caries, leading to hand fatigue. This in turn could have led to not all caries being removed, making it difficult for the material to adhere to the tooth structure. Fear of pulp exposure as well as nervousness amongst the children, making it difficult to work on them, could also have contributed to not all caries being removed or inferior ART restorations being placed.

- **Mixing and application of material**

As the operator was inexperienced in the handling of the material, it is possible than it took more time for it to be mixed to the right consistency. Increased mixing time leads to the material becoming dry and adhering poorly to the tooth structure. Initially material was used which was a bit soft and runny after mixing, thus taking more time to set and exposing it to contamination from saliva.

Bowen, Eichmiller and Marjenhoff (1992) reported that GIC materials were limited in their use by their low tensile strength, low abrasion resistance, low impact and fracture resistance and poor finishability. Materials better suited for ART conditions should be developed to increase their success.

Smales *et al* (1997) advocates the use of the finger-pressing method to fill the cavity as the pressure pushes the material to the deep corners and thus leaving no voids. According to the authors the fissures also offer better penetration with this method.

### 5.1.2 ATRAUMATIC RESTORATIVE TREATMENT SEALANTS

Of the 463 sealants evaluated 6 and 12 months after placement, only 28,1% and 10,4% were still present, a loss of 71,9% and 89,6% respectively. Of these 97,7% had no defect after 6 months with the remaining 2,3% presenting with a marginal defect. After 12 months this had dropped to 93,8% with no defect with the remaining 6,3% presenting with a marginal defect. After 6 months 99,4% of teeth treated had no caries, the corresponding figure being 98,9% after 12 months. In teeth where caries had developed, sealant was totally absent when observed clinically.

The retention of ART sealants in this study after 12 months (10,4%) compare very unfavourably to the Thailand (78%) and Zimbabwe (60,3%) studies for the same evaluation period.

Possible reasons for this high failure in ART sealants in this study include:

- **Sealed teeth already in occlusion**

If the ART sealant is placed in teeth which are already in occlusion, there is a high risk of them failing due to the pressures of mastication during chewing. This may have resulted in 71,9% of ART sealant already being absent after 6 months.

- **Material used**

The material used in this study (Fuji III) was the only glass ionomer indicated for use as a sealant available at the time of this project. This material has since been proved not to be a good material for this purpose (see Chapter 2). In the Thailand study ChemFil was used as an ART sealant; ChemFil Superior in Zimbabwe.

Mejäre and Mjör (1990) also used Fuji III in their study and this resulted in 84% of sealants being totally lost after a year, compared to 89,6% for this study. Boksman *et al* (1987) reported after six months only 2% was totally present, 4% partially present and 94% of Fuji III was totally lost. When McLean and Wilson (1974) introduced GIC used as a sealant, they recommended that they be used for fissures which were more than 100  $\mu\text{m}$  in width and that the cement should be used in bulk. This is not practical as it is difficult to estimate the width

of the fissures clinically. The practical solution would be to improve the flow characteristics of GIC to allow thinner layers to be applied.

- **Mixing and application of material**

Besides failure due to the material chosen, premature loss of ART sealant could also have been due to inadequate adhesion of the cement to the enamel surface as the cement may have been exposed to saliva before it had completely set. Material applied to the fissures could have been either too soft or too hard due to lack of operator experience in handling the material. This would predispose it to surface degradation and early loss of sealant (Mejäre and Mjör, 1990). The high failure of ART sealants in this study could also have been due to material applied to fissures that were too shallow.

## 5.2 CONCLUSIONS

The goals of this study were:

- to evaluate the retention of ART restorations and sealants placed under field conditions;
- to investigate the development of secondary caries adjacent to ART restorations and sealants; and
- to calculate the cost of this technique under field conditions.

Evaluation after 12 months showed a lower retention of ART restorations and sealants when compared to the Thailand and Zimbabwe studies (see Chapter 4). Possible reasons for this were described in the previous section.

Retention was especially low for ART sealants. Despite this 99,4% and 98,9% of sealed teeth were caries-free teeth after 6 and 12 months respectively. This is in line with other studies where a similar result was found (see Chapter 2). Weak evidence suggests that protection from caries continues even after the GIC sealant is lost. The low retention rates for this study suggest problems with the clinical technique, material used and/or training and motivation or ability of the operator. The results found in this study might indicate that GIC should not be used as a fissure sealants. It should be noted that other studies reported better results due to the different and better materials which were used (see Chapter 2).

Operator training in ART procedures is strongly suggested in the most recent ART manual as well (WHO, 1997). This was a major limitation of this study. From the Zimbabwe study (Frencken *et al*, 1998) it was found that one of the dental therapists performed significantly worse than the other 3 operators (one dental therapist and 2 dentists), despite the fact that all these operators had received the same training on ART procedures. It could be concluded from the Zimbabwe study that the clinical application process, being influenced mainly by the training quality of the field personnel, determines the effectiveness of the ART restoration and sealants just as much, maybe even more than the material chosen.

Calculation of the cost for placement of an ART restoration and sealant included operator cost, materials, consumables and transport. This calculation, taking into account these factors, resulted in a cost of R13,72 for an ART restoration and R12,78 for an ART sealant. When the cost of replacing ART restorations and sealants was added to the initial cost of placement, based on the number of restorations absent or restorations with marginal/gross defect after 12 months, cost increased to R19,12 for ART restorations and R24,29 for ART sealants.

Preliminary results of a survey undertaken during 1995/96 in Gauteng indicated 28,96% of 6-year-olds in need of active caries treatment in the Pretoria region. Similar results were found for the 7 and 8-year olds; 30,22% and 30,79% respectively in the same region of the province (Gauteng Oral Health Services, 1997). Du Plessis *et al* (1994) concluded from the results of the 1988/89 NOHS that it was beyond the capabilities of the present oral health care workers to treat caries in all age groups. This is where the ART approach may have an impact.

Pretoria is an urban area with most of the surrounding areas having access to electricity, water supply and dental clinics. As stated above, the human resources are insufficient to deal with caries in a clinical setting, even though preventive programmes are implemented at schools and children are transported to clinics for dental treatment. If areas of high caries incidence are identified and prioritised, a difference could be made in treating dental caries by using the ART approach when the existing human resources are used. If a high caries incidence school or area is identified and an ART programme is established in that school until all the high risk individuals have been treated, a breakthrough could be made. This will mean that

schoolchildren will no longer have to be transported to clinics for treatment as they could then be treated on the school premises with the clinics remaining responsible for mainly addressing more complex oral health problems.

The rationale of ART to make basic oral health care available to the masses has the advantage of saving time and thus more people can be treated in one day compared to a traditional clinical setting. By using the ART approach, extraction as treatment of choice should also change. As ART can be performed almost anywhere, housebound and institutionalised patients can also be treated more effectively.

The ART approach needs to be given a chance before it can be considered as an alternative caries treatment modality. Factors such as local anaesthetic being used only on specific cases reduces the fear and anxiety of patients, especially children and will make this approach more user friendly and acceptable. If oral hygienists and dental assistants could be trained in using the ART technique, this could also alleviate the human resources problem thus addressing high risks patients more effectively.

## **5.3 RECOMMENDATIONS**

### **5.3.1 RECOMMENDATIONS FROM THIS STUDY**

The ART technique is strongly recommended for management of small, occlusal caries lesions in both primary and permanent teeth with the permanent dentition showing better results. More research and development is however needed to improve the success rate of multi-surface restorations if materials can be developed comparable to resins and amalgams.

To obtain quality restorations, oral health workers must undergo a thorough training course on ART before applying the technique. It would be ideal if this technique could be introduced in the curricula of dental training hospitals so that the recently qualified students would be able to apply it. Mobile health care systems should be an instrument to introduce this technique to under privileged areas and expose students to environments where they would apply the ART technique effectively in order to gain experience.

ART should also be used more in general dental practice. Refresher courses should be presented to dental practitioners to introduce them to this technique. Feedback from such practices would be beneficial in determining the effectiveness of ART in this setting.

If the Gauteng Oral Health Services would start a project where high risk patients are treated with this technique over a specified period of time and a control group is used, results could be better interpreted on the effectiveness of the ART technique by comparing it to the existing service provided.

Internationally recognised criteria for the evaluation of ART should be used in future studies, giving results which will be more acceptable all over the world where these methods are applied.

In order for the ART to be successful and be used internationally, prejudice against this technique has to be overcome. People have to believe in the technique before they use it because if they do not, the ability and motivation to work effectively would be reduced and thus lead to an increase in the failure of the ART procedures.

An interesting new development which could increase the effectiveness of ART is the introduction of Carisolv, a non-invasive tissue-preserving chemical solution which removes the infected layer of the carious lesion (Ericson *et al*, 1999). Non-cutting scraping instruments are then used to remove the caries, leaving a clean cavity. By using Carisolv in conjunction with the ART approach, the problem of leaving caries behind could be solved. Studies should be undertaken to investigate the use of Carisolv as part of the ART approach.

### **5.3.2 RECOMMENDATIONS FOR FUTURE RESEARCH**

The proceedings of the ART symposium held in 1998 as part of the General Session of IADR were published recently. The International Dental Federation (FDI) has requested a review of ART which was published during 1999 (Mjör and Gordon, 1999). In these publications recommendations are made concerning future research on ART. These are summarised briefly.

- According to Mjör and Gordon (1999) it is important to standardise the criteria for evaluation. They suggest the United States Public Health Service (USPHS) criteria which according to the authors are easy, quick and relevant for evaluating materials as part of any treatment approach.
- Mjör and Gordon (1999) also suggest that in future the ART approach should be evaluated over periods longer than 3 years in populations with higher caries incidence. These studies should have control groups and the USPHS criteria should be used for evaluation.
- Holmgren and Frencken (1999) also emphasise the importance of future ART field trials over time periods longer than 3 years, the evaluation of new ART materials on more than one surface restorations, more extensive evaluation of ART in the primary dentition, ART studies in populations with higher caries scores and the evaluation of ART in different settings such as clinics in developed countries.
- Another suggestion for future research is the comparison between ART and more traditional treatment modes such as amalgam in field conditions and in general dental practice (Holmgren and Frencken, 1999) as well as extended research on ART used as a fissure sealant.
- Holmgren and Frencken (1999) also suggest the inclusion of analysis of cost-effectiveness in future ART studies. The effect of possible incomplete caries removal when using hand instruments as part of ART and the effect thereof on the bonding of the material to tooth structure also needs further attention. The importance of the operator in ART cavity preparation needs to be researched in both *in vivo* and *in vitro* studies.
- Holmgren and Frencken (1999) also stress that the recommendation after the 1995 symposium to strive towards improved materials for use in ART should be continued. The acceptance and adoption of ART by different groups also needs more attention in an attempt to reduce barriers for oral health procedures. The different approaches in training different levels of oral health workers to perform ART procedures should also be evaluated.

## 5.4 SUMMARY

This chapter briefly summarised the results of the ART restorations and sealants placed in this study, the effect they had and whether it was successful or not. Possible reasons were given for the high failures when compared to the Thailand and Zimbabwe studies. Recommendations as a result from this study as well as recommendations for future research on ART were also discussed.

The ART approach has a definite place in future for restorative care if projects evaluated over periods longer than 3 year are done and compared to other studies of the same duration where different materials were used. GIC should be improved aimed at increasing the effectiveness of ART. The use of ART in conjunction with other non-invasive materials and procedures such as Carisolv should greatly improve its effectiveness as well as lead to a general acceptance of this approach for application in different settings such as schools, old age homes, institutions and even private practice.

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## APPENDIX

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# EXAMINATION FORM

Name \_\_\_\_\_ Card no. (1)

Reg. No. (2)     School (6)   Sex (8)

1 = Male  
2 = Female

**VISIT 1:**

Date (9)       Age (15)

D D M M Y Y

17 16 15/55 14/54 24/64 25/65 26 27

(17)     (21)

(25)     (29)

47 46 45/85 44/84 34/74 35/75 36 37

**VISIT 2:**

Date (33)       Age (39)

D D M M Y Y

17 16 15/55 14/54 24/64 25/65 26 27

(41)     (45)

(49)     (53)

47 46 45/85 44/84 34/74 35/75 36 37

**VISIT 3:**

Date (57)       Age (63)

D D M M Y Y

17 16 15/55 14/54 24/64 25/65 26 27

(65)     (69)

(73)     (77)

47 46 45/85 44/84 34/74 35/75 36 37



**SCHOOL ORAL HEALTH SERVICES**

To the parent(s)/guardian(s) of ..... Gr/Std.....  
(Name of child)

Your child's mouth has been superficially examined and it appears that he/she may need dental care in respect of the following:

Caries  Fissure Sealant  Other   
 Oral Hygiene  Orthodontics

NB-If he/she is currently receiving dental treatment by a dentist, ignore this notice.

**PLEASE COMPLETE EITHER SECTION A OR B AND RETURN FORM TO THE SCHOOL**

**A PRIVATE DENTIST**

I, the parent/guardian of the abovementioned child undertake to take .....  
him/her to a private dentist at my own expense. *Signature of parent/guardian*

**B SCHOOL ORAL HEALTH SERVICES**

I, ID No....., hereby apply for SCHOOL ORAL HEALTH SERVICES for the abovementioned child through the school principal who will determine according to personal/financial criteria if my child qualifies for such services.

**MEDICAL HISTORY**

Does your child suffer from or has he/she suffered from any of the following (tick  the appropriate block):

Rheumatic fever	Yes <input type="checkbox"/> No <input type="checkbox"/>	Diabetes	Yes <input type="checkbox"/> No <input type="checkbox"/>
Epilepsy	Yes <input type="checkbox"/> No <input type="checkbox"/>	Heart lesion	Yes <input type="checkbox"/> No <input type="checkbox"/>
High blood pressure	Yes <input type="checkbox"/> No <input type="checkbox"/>	Bleeding tendency	Yes <input type="checkbox"/> No <input type="checkbox"/>
Porphyria	Yes <input type="checkbox"/> No <input type="checkbox"/>	Jaundice	Yes <input type="checkbox"/> No <input type="checkbox"/>
Allergy	Yes <input type="checkbox"/> No <input type="checkbox"/>	Radiation to head/neck	Yes <input type="checkbox"/> No <input type="checkbox"/>

Is your child presently on medical treatment or medication. If so, supply details

.....

.....

.....

DATE OF BIRTH  AGE

Any other conditions (specify)

.....

I, the undersigned parent/guardian of the abovementioned child certify that:  
 (i) the abovementioned information is correct;  
 (ii) I am willing to furnish personal/financial information to the school principal;  
 and I hereby give permission for my child to be treated by a suitably qualified person.

Home address

.....

.....

.....

Phone No. Home .....

Work.....

.....  
*Signature of parent/guardian* *Date*

**C APPROVAL BY SCHOOL PRINCIPAL**

I am convinced that the financial circumstances of the parent(s)/guardian(s) concerned are such that this pupil qualifies for SCHOOL ORAL HEALTH SERVICES.

.....  
*Signature of School Principal* *Date*

**SCHOOL STAMP**



TRANSCVAALSE PROVINSIALE HOSPITALE

Telegrafiese Adres  
Telegraphic Address.....

Telefoon N<sup>o</sup>.....  
Telephone No. ....



TRANSVAAL PROVINCIAL HOSPITALS

HOSPITAAL  
HOSPITAL

IN ANTWOORD VERMELD ASB.  
IN REPLY PLEASE QUOTE  
G.T. 1  
No. ....

Alle korrespondensie moet aan die  
Superintendent gerig word.  
All communications to be addressed to  
the Superintendent.

.....  
*Oral Health Services*  
.....  
*Private Bag X498*  
.....  
*PRETORIA 0001*  
.....

*The Principal*

*Dear Sir/Madam/Miss*

*It gives me pleasure in advising you that Central Transvaal Region Oral Health Services of the Transvaal Provincial Administration aims to render a comprehensive preventive oral health service at schools. It comprises of:*

- 1. Screening of pupil's mouths*
- 2. Oral health education*
- 3. Daily brushing routines by Grade One and Grade Two pupils under the supervision of a teacher*
- 4. A weekly fluoride rinsing programme under the supervision of oral health personnel*

*You are kindly requested to give your full co-operation in the abovementioned matter when approached by one of our staff members. It is to the benefit of each child if he/she can learn more about oral health and oral hygiene in such a way.*

*Yours faithfully*

**DEPUTY REGIONAL DIRECTOR  
ORAL HEALTH SERVICES  
CENTRAL TRANSVAAL**