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Abstract

The ageing of the world population has been accompanied by a rapid increase in the number of dentate elderly. Older individuals are a higher caries risk group, increasing the demand for dental treatment. The success of Atraumatic Restorative Treatment (ART) has been investigated especially in children. It could be suitable for patients in nursing homes or house-bound elderly but very little research has been done on its use in adults. Objective: to compare the survival of ART and a conventional technique (CT) for managing caries as part of a preventive and restorative programme for older adults. Methods: In this randomised clinical trial, 99 patients with caries were randomly allocated to receive either ART or conventional restorations. The survival of restorations was assessed one year after restoration placement by an independent examiner. Results: Ninety patients and 270 restorations, i.e. 128 ART and 142 conventional restorations were assessed. The restoration survival rates were 93.0% and 96.4%, respectively. Conclusions: ART was found to be as effective as a conventional restorative approach to treat older adults after 1 year. ART can be a useful tool to provide dental care for frail and fearful individuals who might not access dental treatment routinely.

Keywords: Dental Atraumatic Restorative Treatment, Geriatric Dentistry, Root Caries, Aged, Randomized Controlled Trial, Dental Restoration Failure.

Introduction

Older patients might be at higher risk for dental caries, especially as they become more frail, more dependent and more cognitively impaired (Chalmers 2006). High prevalence rates of coronal and root caries are found in older groups in many countries around the globe (Petersen and Yamamoto 2005). This could be explained by a shift to a high caries risk group as people age because of factors such as xerostomia, denture wear, diet, inability to perform adequate oral hygiene and exposed root surfaces (Bahrami, Vaeth et al. 2008).. The impact of oral diseases on general health and quality of life and the significance of oral health promotion have been emphasized by the World Health Organization, through a document entitled 'Active Ageing' (World Health Organization 2002). Furthermore, some studies have shown links between extensive tooth loss and reduced chewing performance, with a negative impact on food choices (Walls, Steele et al. 2000; Sheiham and Steele 2001). Thus, maintaining healthy teeth is paramount to promote quality of life, health and dignity into old age.

Despite the high dental disease prevalence among the elderly, dental uptake by this population is very low (Slade, Spencer et al. 1993; Woods 2010). Several barriers affecting older people's access to dental treatment have been reported.

Institutionalized elderly have a higher prevalence of dental disease and more untreated dental conditions (McMillan, Wong et al. 2003). They might be on a lot of medications which can cause dry mouth, might depend on a carer to provide daily oral hygiene measures, and have more problems accessing dental care. They are usually neglected and are a group of older adults most at need of dental care (Chalmers, Carter et al. 2002; Frenkel, Harvey et al. 2008; Hawkins 2008). For some of the reasons listed above, conventional dental treatments might not be accessible or even suitable for them. Therefore, an alternative technique that could prove to be acceptable by elderly patients, cost-effective and easy to administer should be considered (reference your other paper here).

The Atraumatic Restorative Treatment (ART) technique was pioneered in Africa in the 1980's to treat underserved communities. The ART approach involves the excavation of cavitated carious lesions with hand instruments and restoration of the cavities with a glass-

ionomer restorative material. ART has several characteristics that could make it a suitable alternative for treating the elderly: reported good restoration survival rates (Mandari, Frencken et al. 2003; van 't Hof, Frencken et al. 2006), patient-friendly nature and cost-effectiveness (Frencken, Makoni et al. 1998; Mickenautsch, Munshi et al. 2002; Farag and Frencken 2009). Yet, very few studies have been done on the use of the technique in the elderly. The first study published was done in Finland and homebound elderly using community services were treated with the ART technique (Honkala and Honkala 2002). The study undertaken in Hong Kong reported on survival rates of ART compared to a conventional technique and the participants were nursing home residents (Lo, Luo et al. 2006). Although sample sizes were limited in both studies and dropped even further after 6 months and a year, the results were promising. Studies using larger sample sizes and different groups of elderly (e.g., community dwelling and independent) are necessary to confirm the suitability of the technique to treat caries in older patients.

Therefore, the aim of this study was to evaluate the survival of ART and conventional restorations to treat older patients after a year.

Materials and Methods

Study design

This was a randomized controlled trial using a parallel design.

The study protocol was approved by the Cork Dental School and Hospital Ethics Committee and consent was obtained from each patient prior to clinical examination.

Patients were independently living and primarily recruited in a Geriatric Day Care Hospital and in a community centre near the Cork University Dental School and Hospital, Ireland. The inclusion criteria for entering the study were: be over 65 years of age; present with a dentinal carious (coronal or root) lesion with no painful symptomatology and; be able to perform usual daily activities such as tooth-brushing. Patients who presented with carious teeth with a history of pain, cavities resulting from attrition, erosion or abrasion, with no caries, and teeth that were periodontally involved (Grade III mobility), and therefore had a poor prognosis were excluded.

Participants were enrolled by a research assistant and examined by two calibrated dentists (Kappa score= 0.88). They were randomly assigned to receive either ART or Conventional Treatment (CT) with the use of a computer generated randomisation list, provided by a statistician involved in the study. The allocation sequence was concealed from the primary researcher treating the participants in sequentially numbered, opaque, sealed envelopes. The dentist who performed all the restorations was trained in the ART technique by the WHO Collaborating Centre. **Recruitment of patients, treatment and restoration assessment were undertaken from January 2010 to December 2012.**

Sample size calculation

In order to detect a difference of 10% in restoration survival between groups, which was regarded as clinically significant, with a 5% significance level and a power of 80%, a sample size of 129 restorations per group was required, allowing for a 30% drop out rate.

Clinical examination and data collection

A proforma was used to collect details of age, gender, place of residence (e.g., independently living, dependent on home help), medical history and dental habits. Patients were also asked a question about self-perceived dry mouth. The format of this question was: “How often does your mouth feel dry?” with answers ranging from never, sometimes, often, and always.

Clinical examinations were performed and, details of caries, restorations and teeth present were recorded using the International Caries Detection and Assessment **System** (ICDAS) system. The following criteria, recommended by the ICDAS committee, were used for the detection and classification of caries:

- 1-Colour (light / dark brown / black);
- 2-Texture (smooth, rough);
- 3-Appearance (shiny or glossy, matte or non-glossy);
- 4-Perception on gentle probing (soft, leathery, hard); and
- 5- Cavitation (loss of anatomical contour).

Plaque scores were recorded using the MPS index (Marchini, Vieira et al. 2006). The criteria for plaque score were: 1) difficult to detect plaque, 2) small quantities of barely visible plaque, 3) moderate quantities of plaque and 4) large quantities of continuous plaque. The index registers an overall level of plaque score of all teeth.

A basic “dental care package” was delivered to all patients and it constituted of tailored oral hygiene instructions and scaling/polishing of teeth before restoration placement using either ART or CT.

Restorative Intervention

The ART approach consisted of opening of the cavity with an enamel hatchet, removal of soft carious tissue with excavators, conditioning of the cavity with polyacrylic acid for 20 seconds, washing and drying with cotton pellets and restoration with a high-viscosity glass-ionomer cement (GC Fuji IXTM). Moisture control was achieved with the use of cotton wool rolls and saliva ejector. The chair-side assistant hand-mixed the glass-ionomer according to manufacturers’ instructions and it was placed in the cavity using the “press-finger” technique whenever the type of cavity allowed. Excess material was removed with a carver after checking the occlusion and the restoration was coated with petroleum jelly. In the case of proximal cavities, plastic bands and wooden wedges were used when necessary.

The conventional treatment procedure consisted of local anaesthesia when necessary, use of rotary instruments for access and removal of all carious tissue, conditioning of the cavity with a polyacrylic acid for 20 seconds, washing and drying with cotton pellets and a resin-modified glass-ionomer (GC Fuji II LCTM) to restore it. Isolation was achieved using cotton wool rolls and saliva ejector. Matrix bands and wooden wedges were used in proximal cavities if necessary. The material was light-cured for 20 seconds and the restoration was polished with soflect discs after checking the occlusion. The final restoration was then coated with G-coat plus according to manufacturers’ instructions.

Evaluation

Patients were reviewed on two occasions, at 6 months and 1 year the restorations had been placed. The assessment of the restorations was performed by a dentist who was not involved in restoration placement and did not know which technique had been used. The ART criteria were used to assess the survival of restorations (Table 1). Codes 0, 1 and 2 were considered

success and 3, 4, 5, 6, 7 and C, failure. Where a patient was lost to follow up at the 1 year review, they were excluded from the analysis.

Data Handling

All data were entered in SAS® (Version 9.2) after being hand checked by the principal investigator. Survival at 12 Months was determined from the 6 and 12 month assessments. Data were reported descriptively.

Results

The trial profile is illustrated in Figure 1. Ninety-nine patients participated in the trial, 46 males and 53 females, with a mean age of 73.2 (SD: 6.8). In total, 300 restorations were placed, 137 ART in 51 patients and 158 conventional restorations in 48 patients, with an average of 2.8 ART (SD: 1.83) and 3.2 conventional (SD: 2.62) restorations placed per patient. Most of the patients reported some degree of dry mouth, with 25.3% of them answering their mouth felt dry frequently or always.

The measure of plaque scores at baseline showed that 54.1% of the patients presented large quantities of continuous plaque, 20.4% had moderate quantities of plaque and 25.5% showed little or barely visible plaque.

The large majority of restorations were on one surface only (89.7%). Figure 2 illustrates the tooth surfaces treated per group.

After 12 months, 90 patients and 270 restorations could be assessed, 128 ART (46 patients) and 142 conventional restorations (44 patients). Five patients in the ART group and four in the conventional group were lost to follow up.

Survival (You might consider)

Table 1: Survival Rates, ART versus Conventional after 1 Year

	ART	Conventional
Restorations present and in good condition.	106 (86.2%)	126 (88.7%)
Slight marginal defect or wear, but without need for replacement.	8 (6.4%)	11 (7.7%)
Restorations partially or completely missing and one restored tooth had been extracted.	7 (5.7%)	4 (2.8%)
Overall Survival Rates	92.7%	96.5%

Note: One restoration presented with secondary caries in the ART group.

After one year, 86.2% (106) ART restorations were present and in good condition, and 6.4% (8) presented with a slight marginal defect or wear, but with no need for replacement. 5.7% (7) restorations were partially or completely missing and one restored tooth had been extracted. In the Conventional group, 88.7% (126) of the restorations placed were present and in good condition and, 7.7% (11) had an acceptable marginal defect. Four restorations (2.8%) were missing in this group and one tooth had been extracted. This resulted in 92.7% and 96.5 % survival rates for ART and conventional restorations, respectively. Just one restoration presented secondary caries and that was in the ART group. Figure 3 shows the restorations which failed by surface.

Discussion

This is the first randomized clinical trial comparing the use of ART and a conventional restorative approach to treat independently living older patients, thus providing high level of evidence. Ninety-nine patients received 300 restorations, and although every effort was made to recall patients to be reviewed, nine of them were lost to follow up either because they were either too sick at the time of the appointment or had passed away. This resulted in a 10% drop out rate which is still low considering the age group of the patients treated. Previous studies have reported 48% and 25% drop out rates when treating senior adults (Honkala and Honkala 2002; Lo, Luo et al. 2006).

Patients presented 15 teeth present on average. Initially, it had been considered excluding patients with less than 6 teeth present, but after a pilot study was undertaken, the importance of maintaining any number of teeth that were considered healthy or restorable was recognized and it was decided to include patients with as few as 3 teeth.

Dry mouth is a common finding in elderly patients and in this trial, most of them reported some degree of dry mouth. It is known that low salivary flow rates can be associated with increased caries incidence (Astrom, Ekback et al. 2012) and secondary caries has been shown to be one of the main causes of restoration failure (Mjör 1997; Wilson, Burke et al. 1997). Therefore, treatment of xerostomia in older patients should be an important part of their treatment planning, in order to reduce caries incidence and improve restoration longevity.

The presence of plaque was recorded at baseline and 74.5% of the patients presented moderate to large amounts of plaque present. There didn't seem to be a clear association between plaque scores at baseline and restoration failure in this study maybe because failure rates were so low. Nevertheless, plaque is an important caries risk factor, and as such is related to restoration survival. Older patients might not be familiar with oral hygiene procedures or might not know how to perform them correctly. Therefore, preventive programmes with oral hygiene instructions could be beneficial to this population.

Restoration failure was very low in both groups despite the fact that 1 year might not be enough follow up time to allow more definitive conclusions to be drawn in favour of either technique. Thus, studies with longer follow up periods are highly necessary. Even though only 9 and 5 restorations failed in the ART and conventional groups, respectively, it is possible to speculate some of the reasons and factors related to restoration failure.

Restoration on the lingual surfaces were more likely to fail in the conventional group compared to the ART group. Difficulty in achieving moisture control in some patients,

particularly when restoring cavities in the lingual aspect of teeth could help explain this finding. As only relative isolation was used, some patients found it difficult to tolerate cotton wool rolls on the floor of their mouths and also to keep their mouths open for long. Resin-modified glass ionomers might be more moisture sensitive than conventional glass ionomers, and in areas where moisture control proves problematic, the latter might be a more suitable material. Visualization is another issue in these areas possibly interfering with proper caries removal and moisture control.

On the other hand, restorations on proximal surfaces were more prone to failure in the ART group. In older patients, lone standing teeth or spaces present in between teeth are a common finding. However, access and caries removal in proximal areas might be easier to accomplish with rotary instruments compared to ART instruments, especially in cases where a contacting tooth is present.

Restorations on the root surface accounted for 40% and 33.3% of the failures in the ART and conventional groups, respectively. The size of the cavity might have had an effect on the survival of restorations on the root surface, even though cavity size was not measured in this study. It is known that root caries lesions often spread by covering a larger surface area, sometimes encircling the entire root, instead of deep penetration (Fejerskov, Luan et al. 1991; Smith, Preston et al. 2005). This might make the restorative procedure more difficult, resulting in not ideal restorations. Again, prevention and closer follow up in older patients is extremely important and may affect treatment success.

In conclusion, ART seems to be a suitable approach to treat older patients with survival rates similar to conventional restorative approaches after 1 year. Longer follow up studies are necessary to confirm these findings so that ART can become a recommended treatment for caries in older adults.

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Table 1- ART Criteria

Code	Criteria
0	Present, in good condition
1	Present, slight marginal defect (\leq 0.5 mm), no repair is needed
2	Present, slight wear (\leq 0.5 mm), no repair is needed.
3	Present, gross marginal defect, repair is needed.
4	Present, gross wear, repair is needed.
5	Not present, restoration partly or completely missing
6	Not present, restoration replaced by another restoration.
7	Tooth is missing
8	Restoration not assessed, patient is not present
C	Caries present

Figure 1- CONSORT Flow Diagram

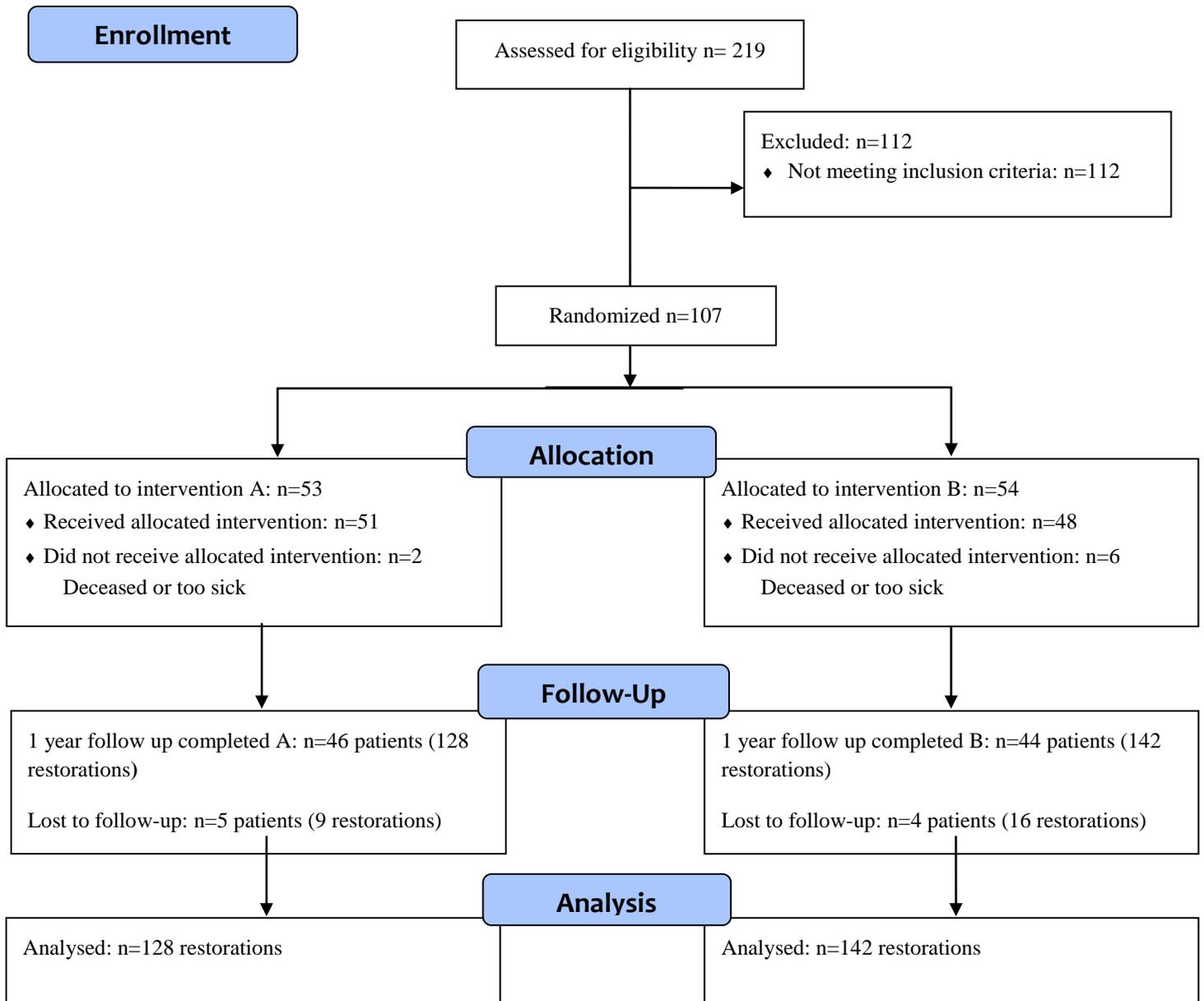


Figure 2- Tooth surfaces treated by group

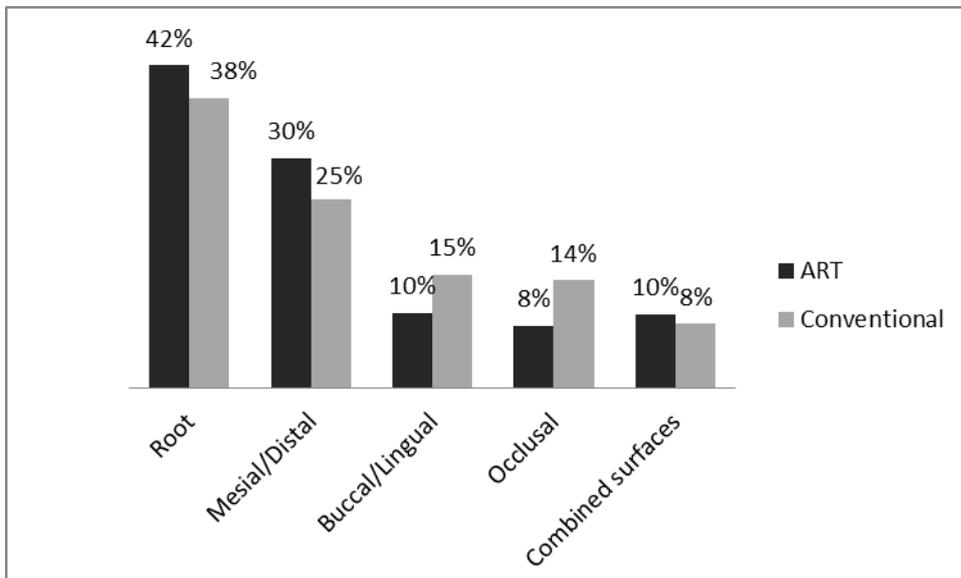


Figure 3- Failed restorations by surface

