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ARTICLES

Research Articles

Effect Of Different Bleaching Methods On Stained Composites 22
Yousef M. and Abo El Naga A

Effect Of Polymerization Techniques And Cleaning Solution On Flexural Resistance Of Acrylic Resin Chemically Activated 28
Derly Tescaro Narciso de Oliveira, Margarete Teresa Gottardo de Almeida, Maria Cristina Rosifini Alves Rezende, André Pinheiro de Magalhães Bertoz, Renato Bigliazzi and Francisco Antonio Bertoz

Knowledge And Oral Health Related Behavior Among Visually Impaired Subjects In Jazan Region, Kingdom Of Saudi Arabia 33
Ismail A. Dorout, Faisal M. Tobaigy, Mohammed M. Al Moaleem, Manawar Ahmad, Mosa A. Shubayr and Hussain M. Kinani
Full Length Research Paper

Effect of different bleaching methods on stained composites

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This study aims to examine the whitening effect of three different bleaching methods on three different stained composite resins. Forty discs (5 mm diameter × 2 mm thick) from each tested material (ESTHET.X HD micro-matrix Restorative, Dentsply, Paradigm Nano-Hybrid Universal-Restorative, 3M/ESPE, and Artiste Nano-Composite, Pentron-Clinical) were made. The 40 discs of each tested material were immersed in coffee, 3 h a day for 21 days in order to be stained and then divided into four subgroups (n=10): non-bleached subgroup (color changes examined immediately after staining); bleached using Crest 3D-White Whitestrips Advanced Vivid (30 min once a day for 14 days); bleached using Colgate Visible White (30 min once a day for 14 days) and bleached using Pola Paint (30 min twice a day for 14 days). Between bleaching periods, specimens were immersed in artificial saliva. Specimens were tested for quantitative color changes using Quanta Environmental Scanning Electron Microscope. Data was statistically analyzed using three-way analysis of variance (ANOVA) and Tukey's post-hoc test (P<0.05). Pola Paint did not bleach stained samples effectively as it showed the highest mean color change value (117.47 pixel). Meanwhile, Colgate gel and Crest Strips showed better bleaching and no significant difference was found between them (112.59 and 113.04 pixel, respectively). No significant difference was found between the three tested composites. The result showed that the three tested composites performed similar under the test conditions. The use of Colgate bleaching gel and the Crest 3D-White Strips could effectively eliminate the discoloration that resulted from staining of the tested materials.

Key words: Bleaching, nano-composite, staining.

INTRODUCTION

Nowadays, a major concern for patients is the aesthetic appearance of their anterior teeth. Therefore, resin composites have gained wide popularity as esthetic restorative materials. However, their color may change over time as a result of surface and marginal staining, in addition to intrinsic material deterioration (Schulze et al., 2003; Janda et al., 2004). It was reported that, natural coloring agents as coffee and tea or mouth rinse agents have staining effect on resin composites to varying degrees (Yousef and Abo El Naga, 2012; Ertas et al.,...
Previously, microfilled or hybrid formulations were used for anterior composite restorations depending on the need for their use, whether more polishability or more mechanical properties. Recently, nanotechnology is used to introduce resin composites that combined both high esthetic and high mechanical properties (Yousef and Abo El Naga, 2012). These nano-composites claimed to be similar to ceramics in color stability and gloss retention (Celik et al., 2008).

However, following polymerization reaction, water molecules in the oral cavity get incorporated into the resin composite resulting in mobilization of ions within the resin matrix and leaching out of the unreacted monomers and ions from the fillers and the activators (Braden and Pearson, 1981; Fan et al., 1985; Ferracane, 1994). Subsequently, the stain resistance of resin composite will be reduced significantly (Soderholm et al., 1984; Yap et al., 2000). Therefore, by time, resin composites become easily discolored by extrinsic stains.

Earlier, any discolored teeth were treated with different aggressive approaches, including direct and indirect veneers, and crowns. Recently, more conservative approach has been used which includes bleaching. Both home and in-office bleaching techniques are used in teeth whitening (Kugel and Kastali, 2000; Dahl and Pallesen, 2003). In the bleaching mechanism for teeth, the active ingredient (peroxide solutions) can diffuse easily through enamel and dentin and this oxidize the stains in teeth (Greenwall, 2001). However, the color change of resin composites after bleaching results from superficial cleansing of the specimens, not by intrinsic color change (Villalta et al., 2006). Although, in-office bleaching with hydrogen peroxide had the benefit of producing instant results; it was reported that there were a profound color change with carbamide peroxide (Rao et al., 2009).

The literature is rich with research evaluating the effects of in-office bleaching on natural teeth and restoratives (Rao et al., 2009), but the effect of home bleaching on tooth-colored restorations is not fully clarified. Therefore, this study was conducted to determine effect of different home bleaching methods on stained nano-filled resin composites using Quanta environmental scanning electron microscope.

MATERIALS AND METHODS

Preparation of the specimens

A specially fabricated split cylindrical Teflon mold of 5 mm internal diameter and 2 mm thickness was used for making disc specimens of three tested restorative materials.

Application of the restorative material

Three different restorative materials (ESTHET.X HD, Micro-Matrix Restorative, Dentsply, Paradigm Nano-Hybrid Universal-Restorative, 3M/ESPE, and Artiste Nano-Composite, Pentron- Clinical) were tested in this study (Table 1). Forty discs of each tested material were made. Each disc was fabricated by carefully inserting an increment of tested restorative material using a nitride plated resin-composite instrument (Aescopal, Germany) into a circumferential Teflon mold with 5 mm of internal diameter and 2 mm of height positioned onto a 0.051 mm thick transparent polyester film strip (Mylar, DuPont, Wilmington, Del.) over a glass slide. The first increment was light cured for 20 s using Optilux 501 (Kerr Corp, Orange, CA). The second increment was inserted then another 0.051 mm thick transparent polyester film strip was applied on top of the Teflon mold filled with the tested material. An additional glass slide was placed over the previously positioned polyester film strip, and a 1 kg weight applied for 1 min to extrude the excess material and to obtain a uniformly smooth specimen surface. Afterwards, the weight was removed and the second increment of tested restorative material light was cured for 20 s through the polyester film strip. The output light intensity was continuously monitored with a radiometer (SDS Demetron, Orange, CA) to ensure a constant value of 600 mW/cm². The top surface of the disc against which the load was applied was marked by a notch from the side to be examined for color changes. For the purpose of surface standardization, the side to be examined for color changes of all specimens were wet ground with 600-grit silicon carbide abrasive papers for 10 s on a 300-rpm grinding machine (Buehler Metaser, Buehler, Germany) (El Seoud et al., 2009).

Grouping of specimens

After fabrication of the discs, 40 were immersed in freshly prepared coffee for 3 h a day for 21 days at room temperature in order to be stained. Coffee was prepared by mixing 12 g of natural coffee powder (Nescafe) and 10 g of white sugar with 200 ml of boiling water. The 40 stained discs were then divided into four subgroups (n=10) according to the bleaching method (Table 2);

1. Non-bleached subgroup (color changes examined immediately after staining);
2. Bleached using Crest 3D-White Whitestrips Advanced Vivid (30 min once a day for 14 days).
3. Bleached using Colgate Visible White (30 min once a day for 14 days) and
4. Bleached using Pola Paint (30 min twice a day for 14 days).

The discs of each assigned subgroup were immersed in a fresh amount of the bleaching agent for 30 min. Between bleaching periods, specimens were immersed in freshly prepared artificial saliva. The composition of the artificial saliva was as follows: 2.0 mM Ca²⁺, 1.2 mM phosphate, 130 mM KCl and 60 mM Tris (pH 7.0).

Color assessment

The process of measuring the color properties of the three tested materials used in this study was done by using Quanta Environmental Scanning Electron Microscope (QEMSEM) (Quanta 200, FEI Company, Philips) and a specific computer software (Yousef and Abo El Naga, 2012). The scanning photomicrograph taken by QEMSEM (Figure 1a) was converted to have quantitative computerized image analysis using digital scanner with a special computer program. The program divided the surface of all specimens’ images on computer monitor into points. Each point has a pixel value at the two coordinates (x, y) as shown in the excel sheet. From the data of the two coordinates, the gray value for each point can be calculated (Figure 1b) to get the statistics sheet.
Table 1. Manufacturers and compositions of materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Principal components</th>
<th>Manufacturer</th>
</tr>
</thead>
</table>
| ESTHET.X HD            | **Resin matrix:** Bis-GMA adduct, a Bis-EMA adduct and TEGDMA camphorquinone, photoinitiator, stabilizer, pigments.  
                          | **Filler:** Barium fluoroborosilicate glass with a mean particle size below 1 µm and nano-filler silica (particle size 0.04 µm). | Dentsply Caulk, Milford, DE, USA |
| Paradigm (Nano-Hybrid Universal-Restorative) | **Resin system:** BIS-GMA, UDMA, BIS-EMA, PEGDMA and TEGDMA  
                                   | **Filler system:** 1. Surface-modified zirconia/silica with a median particle size of approximately 3 microns or less; 2. Non-agglomerated/non-aggregated 20 nm surface-modified silica particles; 3. The filler loading is 82% by weight (68% by volume). | 3M/ESPE, St. Paul, USA |
| Artiste (Nano-Composite) | **Resin matrix:** PCBisGMA, BisGMA, UDMA and HDDMA; photoinitiator, accelerator, stabilizer, silane and pigments.  
                        | **Filler:** Barium boro-silicate glass, nano-particulated silica, zirconium silicate and a small amount of Al2O3. Filler particle range 0.02 to 0.7 average µm, 75% by weight | Pentron Clinical, USA |

Table 2. Bleaching materials.

<table>
<thead>
<tr>
<th>Material</th>
<th>Manufacturer</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest 3D Whitestrips</td>
<td>Crest, Proctor and Gamble, USA</td>
<td>10% Hydrogen peroxide</td>
</tr>
<tr>
<td>Colgate Visible White Chairside</td>
<td>Colgate Palmolive Company, USA</td>
<td>9% w/w Hydrogen peroxide</td>
</tr>
<tr>
<td>Pola Paint</td>
<td>SDI, Australia</td>
<td>8% Carbamide peroxide</td>
</tr>
</tbody>
</table>

Table 3. Comparison between color values of the three resin composites.

<table>
<thead>
<tr>
<th>Esthet.X HD</th>
<th>Paradigm</th>
<th>Artiste</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>119.9</td>
<td>10.3</td>
<td>120.9</td>
<td>11.4</td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05.

Table 4. Comparison between color values before and after bleaching.

<table>
<thead>
<tr>
<th>Stained</th>
<th>Crest 3D White</th>
<th>Colgate visible white</th>
<th>Pola Paint</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>136.8a</td>
<td>1.7</td>
<td>113c</td>
<td>1.5</td>
<td>112.5c</td>
</tr>
</tbody>
</table>

*Significant at P ≤ 0.05, Different letters are statistically significantly.

containing the mean of the gray value for these points which ranges between 0 and 255. The gray value was measured as a linear measurement. Three readings (count, maximum, and minimum values of these points) were obtained. To ensure proper and accurate data, the mean of three readings was calculated as mean gray value of the tested materials.

Statistical analysis

Data were calculated and statistically analyzed using IBM® SPSS® Statistics Version 20 (Statistical Package for Scientific Studies) (SPSS, Inc., Chicago, IL, USA). Three-way analysis of variance (ANOVA) was used in testing significance for the effect of resin
composite, bleaching, bleaching technique and their interactions on color. Tukey’s post-hoc test was used for pair-wise comparison between the mean values when ANOVA test is significant. The significance level was set at $P \leq 0.05$.

RESULTS

The results of the repeated measures of ANOVA showed that, the regression model is fit to describe the relationship between the studied variables. The results showed that the material had no statistically significant effect on mean color change. Meanwhile, bleaching and the interaction between the two variables had a statistically significant effect on mean color change ($P \leq 0.05$).

Effect of composite resin

Mean color change values obtained from each resin composite are shown in Table 3. Statistical analysis revealed that, there was no statistically significant difference between the three materials.

Effect of bleaching

Table 4 compares the mean color values of bleached and non-bleached subgroups, irrespective of resin composite. It shows that, there was a statistically significant decrease in mean color values after bleaching. The highest
mean color value was found in Pola Paint. Mean-while, there was no statistically significant difference between Colgate Visible White and Crest 3D Whitestrips bleaching; both showed the lowest mean color values (Figure 2).

DISCUSSION

The present study evaluated the effect of different three bleaching methods on stained composites. According to the results of the current study, after a staining period with coffee for 3 weeks, all composite specimens of different brands exhibited similar color change and staining staining and there was no significant difference among them. This is probably due to their similar composition as all of the three tested restorative composite materials were nanohybrid. Also, this can be attributed to water sorption since water is considered as a carrier for coloring agents in the water sorption process. Stain adsorption is a consequence of water sorption (Dietschi et al., 1994). This is in agreement with Catelan et al. (2011), who found that, all artificial aging methods resulted in a change in the color of the tested composite resins. Also, Villalta et al. (2006) found that, nanocomposite changed color as a result of staining in coffee.

Nowadays, different home systems of whitening gels are readily available in the market. Some of these are gels which are meant to be used with trays, or placed directly on teeth for 30 to 60 min. Hydrogen or carbamide peroxide is the main ingredient of these products with varying concentrations. Ten percent carbamide peroxide breaks down to 3.6% hydrogen peroxide. Both courses are the oxidizing agents responsible for removing dental stains and whitening teeth. Other ingredients are added to the mixture to stabilize the product, or reduce teeth sensitivity like potassium nitrate or fluoride. Several studies showed that, indeed using bleaching gels and strips will lighten composite materials whether carbamide or hydrogen peroxide. This however, is largely dependent on the type of stain, composition of the material, and duration of bleaching gel application (Villalta et al., 2006; Ertas et al., 2006; Monaghan et al., 1992; Anagnostou et al., 2010; Kolbeck et al., 2006; Briso et al., 2010; Yalcin and Gurgan, 2005; Yu et al., 2011).

In this study, the effect of three different home-based whitening systems on color change of three different nanohybrid composite materials were compared. While Pola Paint had 8% carbamide peroxide (which corresponds to 2.8 hydrogen peroxide), Crest White had 6% hydrogen peroxide, and finally Colgate Visible White bleaching gel had 9% hydrogen peroxide. Because of the higher percentage of hydrogen peroxide in the latter two systems, they significantly whitened the stained composite specimens compared to the Pola Paint system. However, Pola Paint had significantly whitened the composite specimens compared to the negative control.

These results are consistent with Canay and Cehreli (2003) who reported perceptible color change for composite resins bleached with 10% hydrogen peroxide. However, the result of the current study is different than what was found by Anagnostou et al. (2010) where they reported no color differences between nanohybrid composite specimens after bleaching with 10% carbamide peroxide gel and 6.5 to 14% hydrogen peroxide strips. This discrepancy, however, can be explained by the application time of 3 h for the carbamide peroxide in their study, compared with 30 min application time twice daily for 14 days in our study as per the manufacturer recommendation. Also, Li et al. (2009) reported that 15% of carbamide peroxide gel did not cause changes in the color of the composites (Li et al., 2009).

Conclusion

The three tested composites were performed similarly under the test conditions. The use of Colgate bleaching gel and the Crest 3D-White Strips could effectively eliminate the discoloration resulted from staining of the tested materials.

Conflicts of interest

The authors declare that they have no conflicts of interest.

REFERENCES


Short Communication

Effect of polymerization techniques and cleaning solution on flexural resistance of acrylic resin chemically activated

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The purpose of this study was to evaluate the impact of different disinfection solutions on flexural resistance of chemically-activated acrylic resin. Test pieces were made of clear acrylic resin using a rectangular mold and employing two techniques: wet polymerization under pressure (n = 20) and dry polymerization under pressure (n = 20). Test pieces were subdivided into four equal groups: distilled water (control), sodium bicarbonate, 1% sodium hypochlorite and effervescent tabs. The 30-day cycling technique consisted of immersing the test pieces in 100 ml of solution for 10 min three times a day and placing them in closed containers containing artificial saliva at 37°C. Subsequently, the flexural resistance of samples was tested. Data were analyzed using two-way analysis of variance (ANOVA) with forces serving as the dependent variables and the polymerization technique and cleaning agents as independent variables. Post hoc multiple comparisons were performed using Tukey’s test. There was no statistically significant difference in the flexural strength between the two polymerization techniques. The greatest flexural strength was observed for the effervescent tablets group followed by the control and 1% sodium hypochlorite groups which were statistically similar. Thus, the sodium bicarbonate solution caused the lowest flexural resistance of the test pieces.

Key words: Polymethyl methacrylate, material resistance, disinfection, orthodontic appliances.

INTRODUCTION

After completing palate expansion using a fixed appliance, a removable orthodontic appliance prevents the teeth from
from returning to their former position (Sadowsky et al., 1994). During its use, this removable appliance must be safe without the possibility of fractures and without serving as a niche for microorganisms (Suga et al., 2005).

Studies demonstrate that orthodontic appliances can alter the oral microbiota and increase the levels of *mutans streptococci* and *lactobacilli* in saliva and dental biofilm (Mattingly et al., 1983; Jordan and Leblanc, 2002; Anhoury et al., 2002). This is particularly important because of the high risk and the prevalence of caries in orthodontic patients (Bjerklín et al., 1983; Lombardo et al., 2013). According to Ogaard (2001), 50 to 70% of the patients undergoing fixed orthodontic appliance therapy have demineralization areas on the enamel near the brackets (active white spot lesions).

In orthodontics, no effective way has been found to clean appliances without damaging them. On the other hand, efficient protocols have been published for handling and cleaning dental prostheses made from heat-cured acrylic resin, thereby maintaining the properties of the resin and making their use safe. The structure of the resin of these prostheses is similar to chemically-activated acrylic resin (Hong et al., 2009).

The materials used to manufacture removable dental appliances must also satisfy specific requirements in relation to the objectives of orthodontic treatment in particular those regarding aesthetics, resistance and strength (Fernandes et al., 2009, 2010). Chemically-activated acrylic resin is the material of choice for the manufacture of these appliances due to its specific characteristics including low cost, good adaptation, biocompatibility, easy handling, satisfactory aesthetics and satisfactory resistance against fractures (Requa-Clark, 1983).

The resin polymerization process should follow the directions of technical manuals (Requa-Clark, 1983) which generally state a wet setting. However, some laboratory technicians use a dry environment which may cause changes in the structure of the finished product influencing the use of the removable appliances during treatment.

After polymerization, the structure of chemically-activated acrylic resin can suffer the effects of external agents, whether mechanical, such as abrasive toothpastes, or chemical, such as cleaning agents (Requa-Clark, 1983; Borges et al., 2000; Silva and Seixas, 2008). The cleaning of removable appliances using a toothbrush and toothpaste is contraindicated due to the damage caused to the surface of the resin by the abrasive particles which increases its roughness and promotes the retention of biofilm (Sesma et al., 1999). Moreover, according to Diedrich (1989), brushing is ineffective to remove microorganisms from difficult-to-clean areas of appliances.

The use of antimicrobial agents is recommended for orthodontic patients to help control the formation of bacterial biofilm (Lessa et al., 2007; Peixoto et al., 2011). Damage to acrylic structures can also be caused by the chemicals used to clean the appliances. These substances contain agents, such as sodium bicarbonate, and sodium hypochlorite that can damage or stain the surface of acrylic resin, as well as promote leaching of low-molecular-weight components, thereby increasing the roughness and a possible buildup of microorganisms on the surface (Budtz-Jorgensen, 1979; Asad et al., 1993; Neppelenbroek et al., 2005).

Thus, the production of removable appliances and cleaning and disinfection protocols should be standardized using procedures that do not weaken the structure of the resin or increase the buildup of pathogen microorganism biofilm on their surface. Thus, the aim of this work was to evaluate the effect of the use of different disinfection solutions on the flexural resistance of chemically-activated acrylic resin produced using two polymerization techniques.

The null hypothesis to be tested is that there are no differences between the polymerization techniques or the cleaning and disinfection protocols of removable appliances made with chemically-activated acrylic resin as proposed in this study.

**MATERIALS AND METHODS**

Forty test pieces of chemically-activated acrylic resin were made with clear self-curing acrylic resin using 2.5 parts of the polymer to 1.0 part of monomer according to the manufacturer's recommendations (JET®, Classic, Dental Products, São Paulo, Brazil, batch number 040508).

A rectangular mold was used to create the 65 × 10 × 2.5 mm test pieces for three-point flexural strength testing as specified in paragraph 12 of the norms of the American Dental Association (ADA, 1975) specifications for denture base polymers. Thus, to produce these test pieces, slightly larger (67 × 12.60 × 3.00 mm) stainless steel metal molds were made so that the test piece could be leveled without the finished piece being too small. The final size was measured using a digital caliper (Mitutoyo®, Japan).

Test pieces were made using the following two techniques: wet polymerization (n = 20) involving immersion in pressurized water (40 psi) at 40°C for 20 min in a semiautomated electric cooker (Metal Vander®, Piracicaba, São Paulo, Brazil) and dry polymerization (n = 20) under pressure (40 psi) for 20 min without water in the same semiautomated electric cooker. The data size was defined following the study of Ghaffari et al. (2014).

The two groups of test pieces (wet and dry polymerization) were further divided into four subgroups (n = 5) depending on the disinfectant solution to be used in the cleaning cycle: control group (distilled water); sodium bicarbonate group (20 g of sodium bicarbonate diluted in 200 ml of distilled water); 1% sodium hypochlorite group (Milton Liquid, Biodynamic SA, Ibirapuera, Brazil) and effervescent tablets group (Corega Tabs®, GlaxoSmithKline, Rio de Janeiro, Brazil).

The 30-day cleaning cycle consisted of placing the test pieces in a container of artificial saliva at 37°C in a bacteriological incubator and immersing them in 100 ml of the disinfectant solutions for 10 min three times per day (8:00 a.m., 1:00 p.m. and 8:00 p.m.). The artificial saliva and disinfectant solutions were changed after each procedure.
Table 1. Results of flexural strength test in megapascals comparing the two polymerization techniques and cleaning agents.

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Polymerization</th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>67.31 (9.59)</td>
<td>67.99 (7.80)</td>
<td></td>
</tr>
<tr>
<td>Effervescent</td>
<td>76.59 (11.25)</td>
<td>69.18 (2.86)</td>
<td></td>
</tr>
<tr>
<td>Hypochlorite</td>
<td>71.09 (8.69)</td>
<td>68.55 (7.48)</td>
<td></td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>62.58 (5.34)</td>
<td>64.08 (3.94)</td>
<td></td>
</tr>
</tbody>
</table>

Mean (standard deviation).

At the end of this period, the three-point flexural strength test was performed in an EMIC DL3000 universal testing machine calibrated with a 100-kg load cell, a crosshead speed of 5 mm/min and at 37°C. For this, the test pieces were placed on two metal supports and an axial force was applied equidistant from these two points until the test piece broke. The force needed to break the test piece was recorded in megapascal (MPa).

Statistical analysis

Descriptive statistics including mean values and standard deviation were calculated for the flexural strength and compared between the two polymerization techniques and different cleaning agents using two-way analysis of variance (ANOVA), followed by Tukey’s post-hoc test. An alpha-error of 5% was considered acceptable.

RESULTS

Table 1 presents the means and standard deviation of the flexural strength tests of the two polymerization techniques and different cleaning agents. The results of this first analysis showed no statistically significant difference for flexural strength between the two polymerization techniques independent of the cleaning agent (Table 1).

On considering the possibility of an interaction between the polymerization techniques and cleaning agents, an independent analysis of these different conditions was carried out (Table 2). When the types of cleaning solution in isolation were analyzed, a significant difference (p-value < 0.001) was found between cleaning solutions; hence, Tukey’s test was applied.

On comparing the cleaning agents regardless of the method of polymerization, sodium bicarbonate solution presented the lowest flexural strength, followed by the control and sodium hypochlorite groups with the highest flexural strength being found using effervescent tablets (Table 3).

DISCUSSION

On preparing chemically-activated acrylic resin, the manner in which the components are mixed together can lead to a lack of structural uniformity (Eliades and Brantley, 2000), and greater absorption of water (Dogan et al., 1995) that affect the mechanical properties of the polymers. Thus, irregularities in the mixture may favor porosity which when present on the surface of the appliance make daily cleaning difficult with the retention of residues and the development of biofilm.

According to the ISO standard 1567, a minimum flexural strength of 60 MPa is necessary for self-curing acrylic resins (American Dental Association Specifications n° 12 for denture base polymers, 1975). The flexural strength values obtained for some test pieces cleaned using sodium bicarbonate solution were lower than this unlike the flexural strength for the other cleaning agents.

According to this study, there were no statistically significant differences between the polymerization techniques (dry or wet), which leads us to believe that this is not so important.

The use of effervescent tablets is recommended to clean intra- and extra-oral acrylic resin prostheses (Goiato et al., 2010) and removable orthodontic appliances (Eichenauer et al., 2013). When these tablets are dissolved in water they form an alkaline peroxide solution. According to previous studies, effervescent tablets basically function by releasing oxygen which detaches food fragments and light stains (Oliveira et al., 2006). Therefore, using these denture cleansers can cause hydrolysis and decomposition of polymerized chemically-activated acrylic resin (Hong et al., 2009). Consequently, one might think that the detachment of fragments would increase the porosity of the material but this does not interfere in the strength, as this group had the highest flexural resistance. The true effects of aging should be investigated in future studies.

The results of this study indicate that there is no significant difference between disinfectants and polymerization methods in the study period in respect to the flexural resistance of the test pieces. Goiato et al. (2010), on studying the action of disinfectants on heat-activated acrylic resin did not observe any influence of disinfections with respect to the flexural resistance either.

Although, no significant negative effects on flexural strength were found with the effervescent tablets and 1% sodium hypochlorite solutions used in this study; a significant negative effect was identified with sodium bicarbonate solution (Table 3). The reason for this was not found in the literature; however, it is believed that the high pH of about 8 (Cunha, 2001) may damage the acrylic resin structure.

The disinfection and storage procedures of the laboratory in this study were not exactly the same as in other study protocols; although since there are few studies...
studies on chemically-activated acrylic resin for orthodontic appliances, there are many differences between those that do exist. It is important to note that several factors can influence the flexural resistance of acrylic resin, including the components used, particles in the environment (Raizada and Rani, 2007), porosity associated to the technique (Canadas et al., 2010) and surface flaws of the appliance (Pavanna et al., 2003).

Conclusively, the polymerization technique (wet or dry pressure) does not affect the flexural resistance of chemically-activated acrylic resin. However, there were differences in the flexural strength between the different cleaning solutions with sodium bicarbonate solution producing values lower than what is considered the minimum for chemically-activated acrylic resin.

### Conflict of interests

The authors declare that they have no competing interests

### REFERENCES


Table 2. Results of flexural strength test comparing two factors: polymerization technique and cleaning agents

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymerization</td>
<td>1</td>
<td>37.675</td>
<td>37.675</td>
<td>0.651</td>
<td>0.426</td>
</tr>
<tr>
<td>Disinfectant</td>
<td>3</td>
<td>484,031</td>
<td>161,344</td>
<td>2.789</td>
<td>0.056</td>
</tr>
<tr>
<td>Polymerization × disinfectant</td>
<td>3</td>
<td>122,542</td>
<td>40,847</td>
<td>0.706</td>
<td>0.555</td>
</tr>
<tr>
<td>Error</td>
<td>32</td>
<td>1851,345</td>
<td>57,855</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>2495,593</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

df: Degree of freedom; SS: sum of squares; MS: mean square. *p-value < 0.05.

Table 3. Results of flexural strength test in megapascals for each disinfectant agent regardless of the type of polymerization.

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Mean flexural strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>67.65 (8.25)</td>
</tr>
<tr>
<td>Effervescent</td>
<td>72.88 (8.67)</td>
</tr>
<tr>
<td>Hypochlorite</td>
<td>69.82 (7.76)</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>63.33 (4.49)</td>
</tr>
</tbody>
</table>

Mean value (standard deviation). Different capital letters in the column denote statistically significant differences (p-value < 0.05).
Knowledge and oral health related behavior among visually impaired subjects in Jazan Region, Kingdom of Saudi Arabia

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Knowledge and awareness of oral health issues are essential for prevention of dental and other associated systemic diseases. This study explores among visually impaired subjects living in Jazan region, with the respect to frequency and quality of use and the effect of type of blindness on the distribution of oral health related knowledge and behavior. Supervisors taking care of visually impaired subjects of different degrees were informed about the aim of the study. A total of 92 questionnaires were distributed randomly to be completed by the consent participants from each age group, gender and categories of blind situation. First, a consent letter was carefully read to the participants by the interviewer and data collected, and then processed and analyzed by means of the Statistical Package for Social Sciences. In total, 71.5% total blinds and 63.6% partial blinds scored high in the knowledge of caries. The corresponding rates regarding the knowledge of gingivitis were 61.2 and 41.4%, respectively. The scores of knowledge of oral infection in relation to systemic disease were 31.1% total blinds and 29.3% partial blinds. Tooth brushing ≤2 times a day was confirmed by 44.2% total blinds and 42.4% partial blinds, respectively. Awareness of oral health issues is high among the study subjects, but specific misconceptions exist. There is equality in knowledge and practice of oral hygiene among the types of blind subjects.

Key words: Knowledge, oral hygiene, toothbrush, oral health behaviour, visually impaired subjects.

INTRODUCTION

It has been indicated that caries experience and poor oral conditions have declined dramatically among different aged groups at global level. Such changes are reported in parallel with improved socio-demographic conditions,
changes in lifestyle and effective use of preventive oral health program such as personal self-care practices in terms of tooth brushing, use of inter-dental remedies, dental attendance patterns and use of fluorides (Bratthall et al., 1996).

The key oral health promotion tool used in dentistry is an oral hygiene instruction. It is especially important for prevention of oral diseases in children and it provides basis for good oral health throughout life. Oral hygiene instruction includes an explanation of the purpose of oral hygiene and demonstrations of tooth brushing and interdental cleaning. This normally includes the use of visual aids such as disclosing tablets and tooth brushing models. However, there are occasions when demonstrations and visual aids are not appropriate to be used such as when the patient is blind or visually impaired (O’Donnell and Crosswaite, 1990).

Blindness is defined by WHO as having a ‘visual acuity of less than 3/60 m or corresponding visual field loss in the better eye with the best possible correction’, meaning that whilst a blind person could see 3 m, a non-visual impaired person could see 60 m. Visual impairment relates to a person’s eyesight which cannot be corrected to normal vision (WHO, 2013).

Visually impaired subjects however, present a unique population that challenges the dentists’ skill and knowledge (Chang and Shih, 2004). Demonstrations of oral hygiene instructions using visual aids are not appropriate for this population. Therefore, they may be at a higher risk of developing oral diseases including dental caries and periodontal disease because of greater difficulty in attaining good oral hygiene. In addition, it may be due to the lack of ability to visually assess whether dental plaque has been effectively removed or if their gums bleed during tooth brushing often; dental plaque is an important prerequisite for the development of dental caries and periodontal diseases.

Studies have shown that the oral hygiene of the blind population is significantly worse than in an equivalent sighted one (Nandini, 2003). For instance, it has been concluded that students with visual impairments were less knowledgeable about their oral health care as compared with non visually impaired ones. The same study also showed that eighty percent of students with visual impairments did not realize the need to have regular dental visits, and only eighteen percent of the students had routine dental care. Moreover, it has been shown that thirty-seven percent of the participants were affected by dental caries and seventy-one percent by gingivitis (Nandini, 2003). A study from China found that ninety-two percent of visually impaired patients did not have a regular dentist or attend regularly; eighty-five percent of those persons have periodontal pockets and thirty-one percent suffered from deep pockets (Chang and Shih, 2005).

Visually impaired adolescents faced difficulties during the process of tooth brushing including putting toothpaste on tooth brush and using brushing techniques. These difficulties can only be demonstrated by oral hygiene instruction. Moreover, the lack of knowledge and behavior related to oral health such as regular visits to the dentist can be other reasons for poor oral health among visually impaired subject. Thus, there is a great need to provide visually impaired people with oral health education based on the notion that knowledge and behavior related to oral health is important for better oral health. A Taiwan study, had established that the knowledge of dental health among visually impaired students were poor compared to their sighted peers (Ng et al., 2003). The same study also found that visually impaired students were less likely to practice good oral health habits.

The Consensus Statement on Oral Hygiene states that tooth brushing and other mechanical procedures including miswak sticks are considered the most reliable means of controlling plaque, provided that the cleaning is sufficiently through and performed daily (Loe, 2000). The appropriate knowledge and behavior related to oral health of visually impaired subjects will assist establishment of preventive oral health program in Jazan Region, Kingdom of Saudi Arabia; with respect to visually impaired subjects, little information is available online about oral hygiene practices among visually impaired subjects in Jazan Region.

The aim of this study was to explores among visually impaired subjects living in Jazan Region, with the respect to frequency and quality of use and the effect of the type of blindness on the distribution of oral health related knowledge and behavior.

MATERIALS AND METHODS

The total study population of the visually impaired subjects in Jazan Region was estimated to be less than 200 according to the eye specialist (Dr. Tobaigy and the supervisors who are taking care of blind subjects). By using convenience sampling for the attendees of the impaired subjects entering the blind school for that week, 92 subjects of both sexes were randomly selected to be involved in the study. Of these, 33 (39.7%) were with low vision and 59 (71.1%) were totally blind.

Samples and procedures

By using interviewing questionnaires, the supervisors (4 males and 1 female) who are taking care of each category of the blinks subjects were asked to collect data from the participants. These supervisors are teachers who are well trained on different general health issues. The consent participants joined the study after having listened to each question written in the questionnaire and accepted to participate. Refusals were replaced by random distribution of new questionnaires.

Survey instrument

The study involved distributions of a pre-coded questionnaire constructed in English by the authors and then translated to local
The Arabic language to be clearly understood for the interviewers and the study subjects (Darout et al., 2005). The questionnaire contained questions assessing socio-demographic characteristics and the type of blindness of the participants. In addition, to questions assessing a number of variables related to knowledge of causes of oral diseases and systemic disease associated with oral infections and means of their prevention, including tooth cleaning frequency and methods of cleaning. Prior to the distribution of the questionnaire, the principal investigator explained to the supervisors of the blind participants the aims of the study, gave examples on how to complete the questionnaire adequately and offered immediate assistance with the completion if required; then the supervisors contacted the participants and explained exactly what they have been told.

**Measurements**

Gender was assessed as male and female and the participants were also divided into total or partial blindness; total blind subjects are not able to see anything; even light and partially blind subjects have limited vision (Yalcinkaya and Atalay, 2006). The ages were grouped into ≤17 and ≥18 years old. The socioeconomic characteristics were divided into low and high education; low education subjects got their education at the primary school level and high education subjects got their education at the secondary school and university level. The income per month was low ≤2000 or high ≥2000 Saudi Riyals. Frequency of tooth cleaning using toothbrush was measured as: less or equal to ≤2 times a day to more than 2 times a day. Two dummy variables were constructed, yielding ≤2 times a day, >2 times a day. Brushing methods were assessed by asking “proper brushing, improper or just brushing” using a scale ranging from 1 to 3 (I don’t know). Moreover, the participants were requested to evaluate their knowledge on causes of oral diseases and the relationship of oral diseases with eye disease as well as the systemic diseases in terms of yes/no/don’t know. Caries can occur by: bad cleaning; not visiting a dentist; having weak teeth; having microbes in the tooth; consuming sugar foods. In addition, if gingivitis can occur by irregular cleaning, bacteria in the gum, or virus in the gum, and if oral infections can affect the eyes or eye infections can affect oral tissues; concerning the impact of oral infections on systemic disease, it was therefore necessary to evaluate the participants knowledge on: (1) can oral infection affect cardiovascular disease? and (2) can diabetes have bidirectional effect with oral infection?

A sum index of knowledge about caries was constructed (range 1 to 5) and reduced to a dummy variable high knowledge and low knowledge based on a median split. Using the same response scale, participants were requested to evaluate four statements about the causes of gingivitis: irregular tooth; brushing; having a virus in the gum; having bacteria in the gum. A sum score of knowledge about gingivitis was constructed by adding the four items. This sum score was dichotomized based on a median split into high knowledge and low knowledge.

The participants were also requested to evaluate sex statements about oral infection effect on cardiovascular disease; diabetes with oral infection. A sum score of knowledge on the impact of oral infection on systemic disease was constructed by adding the sex items. This sum score was dichotomized based on a median split into high knowledge and low knowledge.

**Statistical analysis**

The data were processed and analyzed by means of the Statistical Package for Social Sciences (SPSS version 20.0, Institute Inc., Cary, NC, USA). Frequency distributions of variables were computed separately for total and partially visually impaired.

Logistic regression analyses were conducted with knowledge scores and oral hygiene behavior as dependent variables. Contingency tables were made for socio-demographic variables. Chi-square test was used for comparisons between males and females. Differences with a p<0.05 were considered statistically significant.

**Ethical considerations**

The study proposal was submitted to College of Dentistry Research and Publication Office for ethical clearance and written informed consent was obtained from the participants prior to study commencement. In this concern, it has been stated to the participants that there is no direct benefit of their participation in the study, however knowledge gained from the study may lead to the establishment of oral health preventive program for visually impaired people (general population benefits) and about the confidentiality, that no information about the participants, or provided by them during the research will be disclosed to others without their written permission.

**RESULTS**

The total participants were 92 individuals, 81 males and 11 females (mean age 26.3 years); of these participants, 77 (83.7%) and 15 (16.3%) were in age group ≥18 and 17 years. Total blind participants were 59 and partial blind were 33, respectively. Results regarding the percentage distribution and number of the study participants socio-demographic characteristics and type of blindness are as shown in Table 1. The knowledge items were divided into items of causes of caries and gingivitis. Totally, 71.5% total blinds and 63.6% partial blinds scored high in the knowledge of caries. The corresponding rates regarding the knowledge of gingivitis were 61.2% total blind and 41.4% partial blind, respectively. The results regarding the percentage distribution and number of the study participants who confirmed specific causes of dental caries, gingivitis and type of blindness are as shown in Table 2. Regular tooth brushing (at least twice a day) was common in both blind type groups, 26 (44.1%) total blind and 14 (42.4) partial blind, respectively. Both types of blindness 36 (61%) total blind and 26 (78.8%) partial blind, respectively used proper brushing methods while only few numbers showed improper brushing methods. The numbers and percentages distribution of the study participants according to frequency, methods of brushing and brush type and type of blindness is as shown in Table 3. Substantial proportion of the total blind participants (31%) and partial blind (29.3%) were knowledgeable about the impact of the oral infections on eye and ears. The knowledge of both blind types on the impact of oral infections on systemic diseases such as heart and blood and diabetes was 30%. The numbers and percentages distribution of the study participants according to the knowledge of impact of oral infections on eye, ears and systemic diseases is as shown in Table 4.
Table 1. Percentage distribution (%) and numbers (n) of the study participant’s socio-demographic characteristics and types of blindness.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total blindness [Participants (n=59)]</th>
<th>Partial blindness [Participants (n=33)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>5.1</td>
<td>03</td>
</tr>
<tr>
<td>&gt;18</td>
<td>94.9</td>
<td>56</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>5.1</td>
<td>03</td>
</tr>
<tr>
<td>Males</td>
<td>94.9</td>
<td>56</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low education</td>
<td>64.4</td>
<td>38</td>
</tr>
<tr>
<td>High education</td>
<td>35.6</td>
<td>21</td>
</tr>
<tr>
<td>Income per month</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income</td>
<td>84.7</td>
<td>50</td>
</tr>
<tr>
<td>High income</td>
<td>15.3</td>
<td>09</td>
</tr>
</tbody>
</table>

Table 2. Percentage distribution (%) and numbers (n) of the study participants who confirmed specific causes of dental caries, gingivitis and type of blindness.

<table>
<thead>
<tr>
<th>Knowledge item</th>
<th>Total blindness [Participants (n=59)]</th>
<th>Partial blindness [Participants (n=33)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Causes of caries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad Cleaning</td>
<td>91.5</td>
<td>54</td>
</tr>
<tr>
<td>Avoid visiting dentist</td>
<td>74.6</td>
<td>44</td>
</tr>
<tr>
<td>Having a week teeth</td>
<td>42.4</td>
<td>25</td>
</tr>
<tr>
<td>Microorganisms</td>
<td>64.4</td>
<td>38</td>
</tr>
<tr>
<td>Sugared food</td>
<td>84.7</td>
<td>50</td>
</tr>
<tr>
<td>Causes of gingivitis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irregular tooth brushing</td>
<td>89.8</td>
<td>53</td>
</tr>
<tr>
<td>Avoid visiting dentist</td>
<td>74.6</td>
<td>44</td>
</tr>
<tr>
<td>Bacteria in the mouth</td>
<td>59.8</td>
<td>35</td>
</tr>
<tr>
<td>Virus in the gum</td>
<td>34.1</td>
<td>20</td>
</tr>
<tr>
<td>Knowledge of oral hygiene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good oral health</td>
<td>40.1</td>
<td>23</td>
</tr>
<tr>
<td>Average oral health</td>
<td>49.2</td>
<td>29</td>
</tr>
</tbody>
</table>

DISCUSSION

Epidemiological data regarding oral health knowledge and behavior of visually impaired subjects in Jazan Region have not previously been published online. The present survey was undertaken to gather such information to aid establishment of preventive oral health education program for visually impaired subjects in Jazan Region. Thus, the participants of this study were interviewed by questionnaires because they were blind or visually impaired subjects and currently are not involved in preventive oral health program of visually impaired subjects. Therefore, this study considered them as a sample with equal knowledge in the field of preventive oral health.

The results presented in this study are considered to be
Table 3. Numbers (n) and percentages distribution (%) of the study participants according to frequency, duration, method of brushing and brush type and type of blindness.

<table>
<thead>
<tr>
<th>Toothbrush</th>
<th>Total blindness [Participants (n=59)]</th>
<th>Partial blindness [Participants (n=33)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Brushing frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤2 times a day</td>
<td>44.1</td>
<td>26</td>
</tr>
<tr>
<td>&gt;2 times a day</td>
<td>42.4</td>
<td>25</td>
</tr>
<tr>
<td>Brushing methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proper brushing</td>
<td>61</td>
<td>36</td>
</tr>
<tr>
<td>Improper brushing</td>
<td>27.1</td>
<td>16</td>
</tr>
<tr>
<td>Just brushing</td>
<td>13.6</td>
<td>8</td>
</tr>
<tr>
<td>Toothbrush type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth brush</td>
<td>20.3</td>
<td>12</td>
</tr>
<tr>
<td>Medium hard brush</td>
<td>64.4</td>
<td>38</td>
</tr>
<tr>
<td>Hard brush</td>
<td>16.9</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4. Numbers (n) and percentages distribution (%) of the study participants according to infectious and systemic diseases in relation with oral and eye diseases and type of blindness.

<table>
<thead>
<tr>
<th>Knowledge item</th>
<th>Total blindness [Participants (n=59)]</th>
<th>Partial blindness [Participants (n=33)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Infectious disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouth infection</td>
<td>28.8</td>
<td>17</td>
</tr>
<tr>
<td>Eye infection</td>
<td>27.1</td>
<td>16</td>
</tr>
<tr>
<td>Ear infection</td>
<td>37.3</td>
<td>22</td>
</tr>
<tr>
<td>Systemic disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood diseases</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Heart diseases</td>
<td>23.7</td>
<td>14</td>
</tr>
<tr>
<td>Diabetes mallets</td>
<td>44.1</td>
<td>26</td>
</tr>
</tbody>
</table>

a representative for visually impaired population in the region. Our study shows that both type of blindness or visually impaired participants correctly completed the questionnaires which demonstrate keen interest of oral health and related systemic diseases matters. Less type of blindness differences were identified in this study concerning the single knowledge items. However, both type of blindness were often more knowledgeable about their own oral health status. Due to insignificant number of female participants in this study no comparison was done between males and females; however, the observations of other studies indicate that when both sexes are at identical educational or social levels they may be equally knowledgeable with respect to oral health issues (Rajab et al., 2002; Farsi et al., 2004; Almas et al., 2003).

Although misconceptions about oral health still exist in the present study, a high proportion of both types of blindness had correct knowledge, confirming for instance that inappropriate cleaning and consumption of sugar foods cause tooth decay and that gingivitis might be attributed to irregular tooth brushing.

The level of knowledge identified among visually impaired participants in this study was encouraging and may have implications for preventive oral health program. Thus, from a theoretical point of view, oral health habits are a function of perceived vulnerability to an oral disorder and the belief that a particular preventive measure will be sufficient to overcome this vulnerability. People who have assimilated oral health knowledge and feel a sense of personal control over their oral health are more likely to adopt self-care practices (Al-Ansari et al., 2003).

Thus, special considerations must be made to teach the visually impaired people about their oral health matters. Demonstrations using aids like full mouth
models and toothbrushes greatly aid the visually impaired people, they can use the sense of touch to tell them what vision would tell others, however the one to one teaching that they also receive is crucial to allow them develop their personal care skills. Developing the manual dexterity of those visually impaired people can allow them to be in control of their brushing and of being independent of secondary help (Darout et al., 2005). A study in Istanbul, Turkey concluded that with an appropriate program, the oral health knowledge of visually impaired students could be improved (Yalcinkaya and Atalay, 2006).

Recently, it was concluded that visually impaired Saudi adults living in Riyadh have poor plaque control, widespread gingivitis and limited access to the health care providers and that they need an oral health promotion program to maintain their periodontal health and improve their quality of life (Aljoharah, 2013). Moreover, a study conducted to detect the preventive and treatment modalities among visually impaired students living in a residential school of Aligarh in India concluded that visually impaired students need a special way to educate and motivate to keep the oral hygiene better in order to prevent dental caries (Mohammad et al., 2009).

The finding of the present study demonstrated that a substantial proportion of the participants reported using correct tooth brushing frequency more than twice a day which is according to international recommendation. Tooth brushing with toothpaste is arguably the most common form of tooth cleaning practice by individuals in the industrialized countries, whereas chewing stick is often used as the sole cleansing agent by individuals in developing countries (O'Donnell and Crosswaite, 1990).

Substantial proportion of both blindness types in this study was knowledgeable about the impact of the oral infections on eye and ears. Low knowledge of both blind types on the impact of oral infections on systemic diseases such as heart and blood diseases and diabetes was confirmed in this study. It was recently concluded that oral infections can have systemic impact through spread of infection from the oral cavity (Otomo-Corgel and Merin, 2002).

The present study shows that awareness of oral health issues among visually impaired subjects in the region is high, but specific misconceptions exist and that there is equality in knowledge and practice of oral hygiene among the types of blind subjects. However, self-reported information may need to be confirmed by clinical assessments or checked up from dental files.

RECOMMENDATIONS

Based on our study findings, establishment of oral health program in the region that addresses oral health promotion and disease prevention for visually impaired people were recommended. The Department of Preventive Dental Sciences, Division of Community Dentistry, College of Dentistry, Jazan University and other personnel working in health care systems in addition to dental hygienists should be involved in such program and that the notion of oral health as integral part of community health should be central to construction of such strategy.

Conflict of interest

The authors declare that they have no conflict of interest.

ACKNOWLEDGEMENTS

The authors thank the supervisors of the visually impaired subjects at the Jazan Region, who participated in this study. They also thank the College of Dentistry, Jazan University for facilitating, translation and preparation of the questionnaires.

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