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Contemporary CAD/CAM view in dentistry

With the improvement of dental computer-aided design/computer-aided manufacturing (CAD/CAM) systems and restorative materials, CAD/CAM restorations are available in all over the world [1]. These restorations are indicated to reestablish esthetics and function saving time with quality and predictable results. Thus, the knowledge of these systems is important for professionals of all areas in dentistry.

Currently, new CAD/CAM systems and restorative materials are accessible. Examples of some systems are: CEREC, LAVA, EVEREST, PROCERA [3]. It can use materials such as zirconia-reinforced, lithium disilicate-reinforced ceramic, feldspathic ceramic, composite resin or hybrid (ceramic-resin). These new systems/materials present excellent marginal quality and can be indicated for inlays, onlays, anterior and posterior crowns, bridges, and laminate veneers. Thus, procedures can be performed in all areas of dentistry with CAD/CAM systems as a conservative and predictable treatment to establish the harmony of the smile.

Many are the advantages of these versatile CAD/CAM systems. Their intraoral scanner can capture the details of either restorations or teeth. Consequently, the process is much less time consuming and more precise [4]. The new softwares make system handling easy and accept the application of new materials available. And, today, the cost of the system (scanner, software and milling machine) is much more accessible in all countries.

The quality control of CAD/CAM system is well documented in the literature for over 20 years [2]. As result, nowadays, the application of CAD/CAM technology in dentistry can provide a state-of-the-art service for dental technicians, patients and dentists.

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Original Research Article

Evaluation of dentinal permeability reduction provided by different desensitizing treatments

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Abstract

Introduction: Dentinal hypersensitivity consists in an increasing problem at dental offices and new approaches may be developed. **Objectives:** The authors studied different desensitizing treatments and their efficacy in reducing dentinal permeability and dentinal tubules opening. **Material and methods:** One hundred bovine incisors roots had their buccal surface flattened and treated by 3 applications of each desensitizing agent, following the respective groups (n = 10). After treated, 7 specimens of each group were prepared for a 0.5% basic fuchsin permeability test and the other 3 specimens were prepared to SEM qualitative analysis. The permeability test specimens were sectioned with a diamond saw in order to evaluate the stained and unstained areas. Kruskall Wallis statistical analysis was performed ($p < 0.05$). **Results:** Colgate Pró-Alívio paste and toothpaste, diode and Nd:YAG Lasers, GHF, Sensi Active, Oxagel and 2% Desensibilize promoted a significant permeability reduction when compared with the respective control groups ($p < 0.05$). Comparing the mean permeability differences between the different groups after the treatments, Oxagel and Nd:YAG were better than 0.2% Desensibilize group. **Conclusion:** None of the treatments may be considered 100% effective in treating dentinal hypersensitivity since a partial reduction of the permeability was observed.

Introduction

In recent decades, a significant reduction in the incidence of teeth decay was observed [27, 33]. Thus, the teeth have remained longer in the mouth, which makes them more susceptible to other types of non-carious lesions such as gingival recession and tooth wear which may, in some cases, cause dentin hypersensitivity [1, 2, 35, 36]. The prevalence of hypersensitivity varies widely (from 8% to 57%) depending on the population, methodology and resources used for diagnostic [3, 36, 42].

Dentin hypersensitivity has a multifactorial etiology and can be described clinically as an acute pain that occurs in response to thermal (hot or cold), chemical (acid fruits, spicy foods, sugar and salt), mechanical (brushing) and evaporative stimuli (air jets) applied to the exposed dentin due to the presence of opened dentinal tubules. The exposure of dentin to the oral environment may occur due to processes as gingival recession and root erosion, abrasion or attrition, as well as surgical and non-surgical periodontal treatments [3, 5, 8, 22, 32, 42].

The most widely accepted theory to explain dentinal hypersensitivity is the "Hydrodynamic Theory" from Brännström [7] that provides a plausible explanation for the hypersensitivity manifestation in which the motion of dentinal tubules internal fluids are able to stimulate nervous cells present in the pulp tissue, leading to a painful sensation [8, 30].

The treatment of dentinal hypersensitivity has as goal pain remission, often by topic application of desensitizing agents, anti-inflammatory agents, agents that block the neuronal response, root coverage procedures through periodontal plastic surgery and, most currently, high and low input laser irradiation [5, 11, 43].

Although there are different therapies for the treatment of dentin hypersensitivity, the main challenge is to find a substance or treatment that effectively eliminates the pain and does not relapse, which unfortunately is still not available [28].

So, it is fundamental to have comparative studies of different treatments and products, considering their dentinal tubules physical obliteration efficiency and the associated dentin permeability reduction.

Material and methods

Experimental design

The experimental design presented one variation factor (treatment), divided in ten levels. The quantitative response variable was percentage of infiltrated area, measured by imaging software. The sample size was 100 bovine incisors, divided into ten groups (n = 10).

Specimen preparation

One hundred bovine incisors had their roots separated from the respective crowns. The root lingual surfaces were flattened with 320 grit SiC sandpaper (Extec. Corp., Enfield, USA) and after achieving a flat surface, the specimens were fixed in acrylic discs using viscous wax, with the buccal surface upwards. This surface was also flattened and polished using 320, 600 and 1200 grit SiC sandpaper, at low speed (Figure 1). Specimens were stored in 0.1% thymol solution after extraction for a maximum time period of 3 months. All specimens were prepared at the same time and stored at 4ºC deionized water until used (treatment applications).

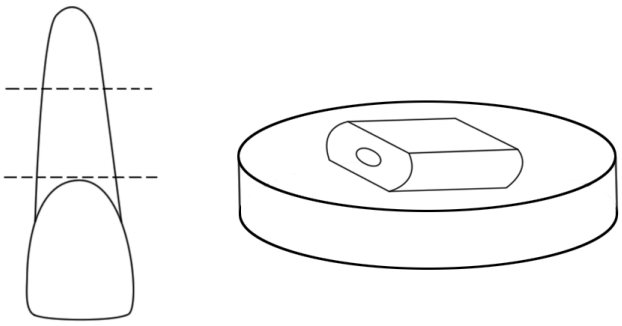

Figure 1 – Schematic aspect of buccal surface after specimen flattening

The specimens were randomly divided into 10 groups (n = 10), with 3 applications of different desensitizing treatments. Seven specimens of each group were used for dye infiltration test and the others were used for visual analysis in scanning electron microscopy (SEM).

Each flattened surface was marked in the center with a ¼ steel drill at low speed in order to delimit the test and control areas. EDTA pH 7.5 was applied (1 minute) over the flattened surface, with a KG microbrush (Kg Sorensen, Cotia, SP, Brazil), in order to remove debris allowing a wide-open dentinal tubules aperture. Half of the surface was protected with a light-cured gingival barrier (Top-Dam, FGM, Joinvile, SC, Brazil), based on the previously center mark. On the other half (non-protected) the treatment was performed according to the guidelines of the respective manufacturer (Table I and Figure 2).

Figure 2 – Desensitizing agent application over the test surface (non-protected)

Considering the laser groups, a 30 mm^2 area (5.0 X 6.0 mm) was delimited using the gingival barrier, half of this area (15 mm^2 – 2.5 X 6.0 mm) was protect with gingival barrier (control area) and the unprotected test area was irradiated as follows:

- Nd:YAG laser: 1064nm wave-length, 300 μm fiber diameter, 0.5W power output, 10 Hz frequency, long pulse and entire area scanning (30s) in contact mode;
- Diode laser: 970nm wave-length, 300 μm fiber diameter, 0.5W power output, 10 Hz frequency, long pulse and entire area scanning (30s) in contact mode.

After the treatments, the gingival barrier was removed of the specimens' surface.

Table I – Different desensitizing products and treatments and their respective manufacturer and active ingredients

Group	Product	Manufacturer	Active ingredients	Application
1	Paste Colgate Pró-Alívio	(COLGATE, São Bernardo do Campo, SP, Brazil	8% Arginine and calcium carbonate	Prophy brush for 1 minute
2	Toothpaste Colgate Pró-Alívio	COLGATE, São Bernardo do Campo, SP, Brazil	8% Arginine, calcium carbonate and 1.10% sodium monofluorophosphate (1450ppm F)	Prophy brush for 1 minute
3	0.2% Desensibilize	FGM, Joinville, SC, Brazil	5% Potassium nitrate, 0.2% sodium fluoride	Microbrush for 10 minutes
4	2% Desensibilize	FGM, Joinville, SC, Brazil	5% Potassium nitrate, 0.2% sodium fluoride	Microbrush for 10 minutes
5	Oxa-gel	Art-Dent, Araraquara, SP, Brazil	3% Potassium oxalate	Microbrush for 2 minutes
6	Sensiactive	Ativus Farmaceutica Ltda, Valinhos, SP, Brazil	3% Potassium oxalate	Active microbrush for 4 minutes
7	GHF	Biodinâmica, Ibiporã, PR, Brazil	5.1% Glutaraldehyde, 36.1% HEMA, sodium fluoride	Microbrush for 30 seconds
8	Gluma Desensitizer	Heraeus-kulzer, Hanau, Hesse, Germany	5% Glutaraldehyde, 36%HEMA	Microbrush for 60 seconds
9	1064nm Nd:YAG Laser - Smart File	Deka M.E.L.A. Calenzano, Italy	----	Scanning in contact mode
10	970nm Diode Laser - SIRO Laser	Sirona Dental Systems GmbH - Bensheim-Germany	----	Scanning in contact mode

Permeability tests

In order to realize the permeability test, 0.1mL of 0.5 % basic fuchsin was placed in contact with the buccal surface for 4 hours, using a 5mm diameter plastic tube centered over the guide hole, hold steady with use of the gingival barrier (Figures 3A and 3B).

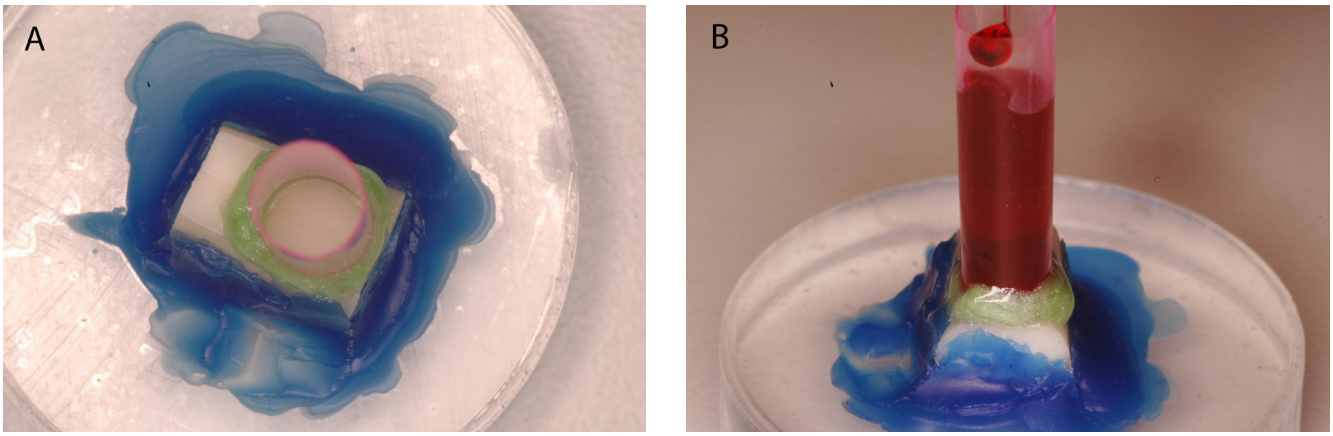

Figure 3 – (A) plastic tube fixed with gingival barrier centered over the guide hole; (B) dye application on buccal surface

After the dye infiltration time, the plastic tube and gingival barrier were removed and the surface was washed with air-water spray for 2 minutes.

The stained specimens were taken to the cut machine in order to perform a mesiodistal section, also based on the guide hole. In sectioned specimens was possible to visualize the test and control surfaces (Figure 4).

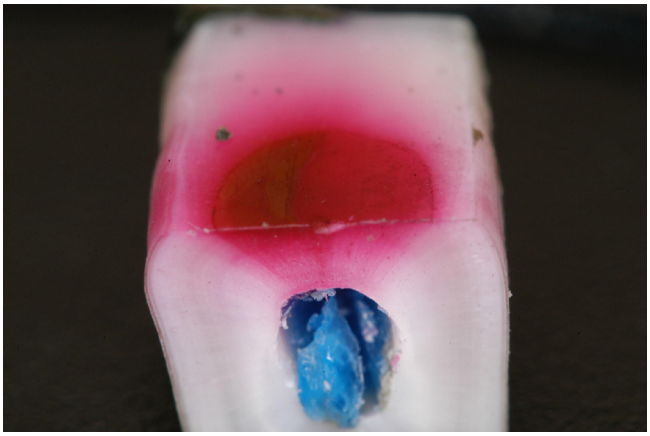

Figure 4 – Sectioned specimen aspect in order to make the dye infiltration analysis (left side control and right side test)

The image of each half was captured with a professional digital camera (Nikon D100, Japan). The digital images were transferred to UTHSCSA Image Tools version 3.0 software, where the total area (from flattened surface to root canal as vertical length) and the dye leakage area (test and control sides) were quantified, allowing to calculate the percentage of dye penetration in each specimen.

Scanning Electron Microscopy

Three randomly selected specimens of each group were processed for qualitative analysis. The specimens were fixed on a metallic stub with their treated surfaces facing up. After dried in an desiccator and metallized, the samples were analyzed in a scanning electron microscope JSM-T220a (Jeol, Tokyo, Japan) with 15 kV and 1000X magnifying. Digital photomicrographs, from both test and control sides, were analyzed qualitatively illustrating the behavior of each treatment.

Statistical analysis

The results of each group were obtained from the percentage of infiltrated (stained) area versus the total area. Since the means did not reach the normality test, a non-parametric Kruskal-Wallis test was applied ($p < 0.05$).

Results

Permeability

The infiltration observed (% ± SD) in all groups after 3 applications of the desensitizing treatment is shown in table II (test and control areas values) and table III (test and control mean differences).

Table II – Dye infiltration mean (% ± SD) at control and test areas after different treatments

Product	Test area	Control area
Colgate Pró-Alívio Toothpaste	59.18 ± 8.621[a]	63.93 ± 6.363[b]
Colgate Pró-Alívio Paste	51.30 ± 8.355[a]	59,52 ± 5.647[b]
0.2% Desensibilize	68.69 ± 13.12[a]	71.14 ± 14.46[a]
2% Desensibilize	54.74 ± 18.35[a]	61.80 ± 15.93[b]
Oxagel	35.26± 16.79[a]	51.11 ± 17.35[b]
Sensi Active	49.35 ± 10.98[a]	60.67 ± 10.33[b]
GHF	51.61 ± 11.76[a]	62.90 ± 11.36[b]
Gluma Desensitizer	56.05 ± 5.871[a]	60.65 ± 6.345[a]
0.5W Nd:YAG laser	42.90 ± 8.998[a]	57.63 ± 6.881[b]
0.5W Diode laser	58.17 ± 6.820[a]	64.71 ± 7.896[b]

Different letters indicate difference in the same group/line ($p < 0.05$)

Table III – Test and control mean differences (% ± SD) considering different treatments

Product	3 Applications
Toothpaste Colgate Pró-Alívio	4.752 ± 3.511[ab]
0.2% Desensibilize	2.443 ± 5.741[a]
2% Desensibilize	7.056 ± 3.525[ab]
Oxagel	15.84 ± 10.98[b]
Sensi Active	11.32 ± 6.705[ab]
GHF	11.29 ± 8.440[ab]
Gluma Desensitizer	4.604 ± 5.672[ab]
0.5W Nd:YAG laser	14.73 ± 5.066[b]
0.5W Diode laser	6.534 ± 2.542[ab]
Paste Colgate Pró-Alívio	8.215 ± 5.073[ab]

Different letters indicate statistical difference ($p < 0.05$)

Colgate Pró-Alívio paste (in office) and toothpaste, diode and Nd:YAG Lasers, GHF, Sensi Active, Oxagel and 2% Desensibilize promoted a significant permeability reduction than the respective control groups ($p < 0.05$). Comparing the mean permeability differences between the different groups after the treatments, Oxagel and Nd:YAG were better than 0.2% Desensibilize group.

Scanning Electronic Microscopy

In general, a superficial deposit and consequently reduction in diameter and obliteration of the dentinal tubules could be observed, at varying degrees, but with the presence of some open dentinal tubules. Considering the desensitizing agents and the lasers, different levels of superficial deposit were observed; when considering the Nd:YAG laser group,

an irregular surface with mosaic-like structures was observed, compared with the wide open tubules observed in the control groups (Figures 5A, 5B, 5C and 5D).

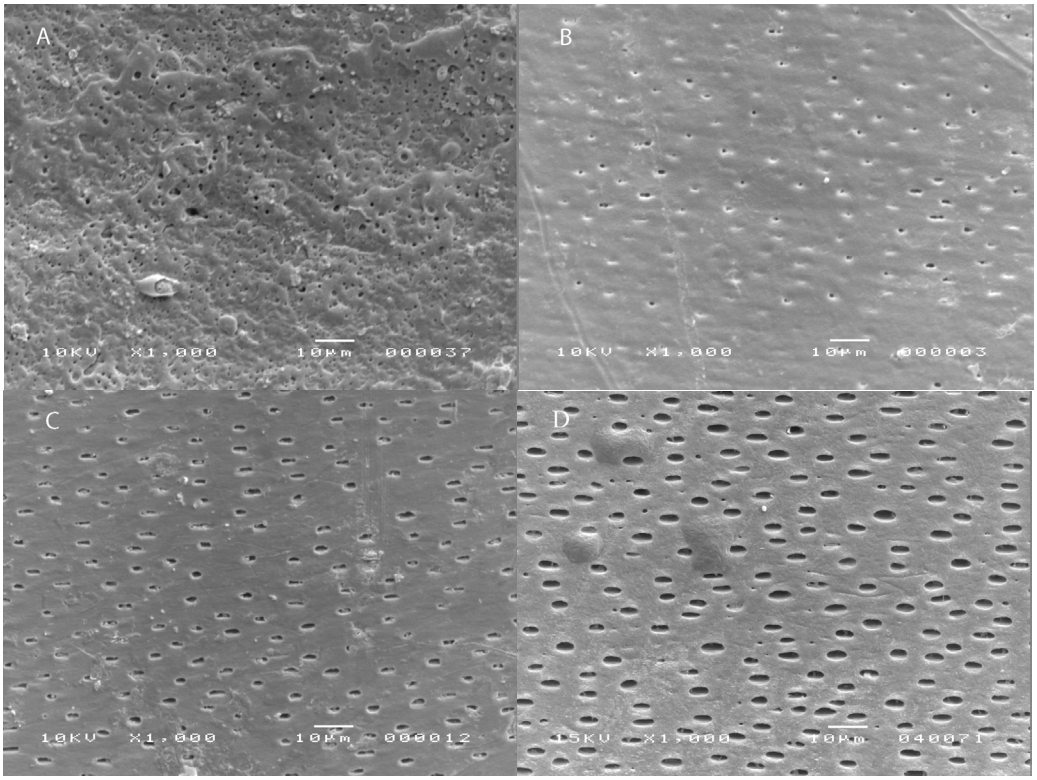

Figure 5 – (A) Dentinal surface after 3 applications of Nd:YAG laser, (B) Sensi Active, (C) Pró-Alívio paste and (D) Control

Discussion

Dentin hypersensitivity has been the subject of many studies that have evaluated different strategies and products for its treatment [5, 11, 43] and the use of bovine dentin near to the cementum-enamel junction consists in a suitable substitute of the human dentin considering the permeability and SEM analysis [38]. Among the tested products in this study, it is worth mentioning the different action mechanisms. The GHF and Desensibilize are NaF based products and act through the formation of a CaF_2 layer on the surface promoting a dentinal permeability reduction through the obliteration of exposed dentinal tubules [12, 13, 25]. It is important to say that GHF also has glutaraldehyde in its composition, which may act as an active component in desensitizing. In the present study, a significant reduction in dentin permeability could be observed after 3 applications of these products.

The Oxagel and Sensi Active are potassium oxalate based products that also act by depositing crystal-like structures within the lumen of the tubules [5]. These crystals are formed after active substance penetration within the tubules resulting in insoluble calcium oxalate crystals formation [6, 15, 17, 19, 31]. The precipitates occur within the dentinal tubules, forming crystals that extend 15 μm depth and with various dimensions that allow different degrees of tubules occlusion [10]. This fact can explain the results of the present study in which, even with a superficial deposit not as great as in some treatments, the permeability test showed an statistically significant reduction in dentin permeability.

The Gluma Desensitizer is an aqueous solution containing 5% glutaraldehyde and 35% HEMA. It has been suggested that its action mechanism is based on the dentinal tubules occlusion through reaction with plasmatic dentinal fluid, which would lead to the formation of a thin resin layer of about 1 μm thickness (due to the HEMA polymerization) that can obliterate the dentinal tubules [24, 40]. In the present study, Gluma showed no significant

reduction in dentin permeability and these results are consistent with a clinical study where no reduction in dentin hypersensitivity was observed before one week after agent application [24].

Pastes and toothpastes containing desensitizing agents has also been widely researched and produced. In the products tested in this study, these agents differ by the presence of 1.10% sodium monofluorophosphate, present in the toothpastes. The arginine and calcium carbonate work together in order to accelerate the dentinal tubules natural obliteration mechanisms by "dentin-like" mineral deposits containing calcium phosphate within dentinal tubules [34]. In the present study, a significant reduction of dentin permeability was observed after three applications of both products, but in photomicrographs a great number of opened dentinal tubules could still be observed.

Another treatment used to relief dentin hypersensitivity by physical obstruction of the tubules is high-intensity laser irradiation on hypersensitive dentine. According to some authors, the laser consists in an easy application method and also painless, with a fast action [9, 14, 18, 20]. According with Dilsiz et al. 2009 [10] there are two types of lasers: the high (e.g. Nd: YAG) and low level (e.g. diode laser) that can in some models, operate at high intensity.

The Nd: YAG laser has been used for the reduction of dentin hypersensitivity as it induces an occlusion or narrowing of the dentinal tubules, leading to a pain relief [14, 21, 23]. Dentin is fused after a brief laser exposure (melting), whereas it re-solidifies in the form of a glazed and non-porous surface [4]. In the present study, all irradiated samples showed the same surface changes with irregular mosaic-like structures with a significant reduction in dentin permeability. Similar results also were observed by other authors [16, 23, 37, 39].

In the present study, the diode laser also promoted a significant decrease in dentin permeability. In photomicrographs a reduction in the number and diameter of dentinal tubules could be observed. Umberto *et al*. 2012 [41], also observed a significant reduction in dentin hypersensitivity after 980nm diode laser irradiation.

It is also unclear whether permeability must be completely stopped before sensitivity can be treated, considering this, it is important to say that some substances may also have a desensitizing effect observed only "in vivo", such as Desensibilize that has also potassium nitrate in its formula, which acts as a neural depolarizer; Sensi Active and Oxagel, based on potassium oxalate, which can inhibit the transmission of nerve impulses [26]. Besides these, the low-level lasers can also interact with the pulp tissue inducing a biomodulatory effect that increases odontoblastic metabolic activity enhancing the production of tertiary dentin and can also interfere in the sodium pump reducing intra dental nervous response [29, 44].

Even with the limitations of this study it has been concluded that none of the treatments may be considered 100% effective in treating dentinal hypersensitivity since a partial reduction of the permeability was observed.

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Original Research Article

Sealing ability of different versions of GuttaFlow2 in comparison to GuttaFlow and AH Plus

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Keywords: AH Plus; dye penetration; GuttaFlow; GuttaFlow2.

Abstract

Introduction and objective: GuttaFlow2 is a further development of the silicone sealer GuttaFlow, exhibiting a stiffer consistency. This is intended to overcome possible problems regarding retention of the apical part of the root canal filling when preparing for a fiber post. GuttaFlow2 is delivered within a capsule, like GuttaFlow, or within an automix syringe. This study compared apical dye leakage of GuttaFlow2 in comparison to GuttaFlow and AH Plus. The null hypothesis tested was that different sealers exhibited similar microleakage. **Material and methods:** Seventy extracted human lower premolars with fully mature apices were root canal prepared to 45/.04 and divided into seven groups: group 1: AH Plus sealer, group 2: "normal" setting GuttaFlow, group 3: "fast" setting GuttaFlow, group 4: GuttaFlow2 within a capsule, group 5: GuttaFlow2 within an automix syringe, group 6: positive control, group 7: negative control (n = 10 each). Root canals were filled with sealer (except group 7) and a master gutta-percha cone size 40/.04 using the non-compaction technique. A dye penetration test was carried out by centrifugation for 3 min at 30 G within 5 % methylene blue dye. Linear dye penetration was recorded. Statistical evaluation was carried out with IBM SPSS 19.0 (α = 0.05). **Results:** The positive control was significantly different from all other groups (ANOVA, $p < 0.001$; Student-Newman-Keuls post-hoc test $p < 0.05$). When the control groups were disregarded, no significant differences were apparent. Groups 1 to 5 showed low leakage values when compared with results of earlier studies using a similar methodology. **Conclusion:** All sealers tested exhibited low dye leakage values.

Introduction

The objective of root canal filling is to prevent the passage of microorganisms and their by-products along the root canal [13]. Today's state of the art is the combination of a semi-solid material (e.g. gutta-percha) with a root canal sealer [13]. The latter has a significant impact on microleakage of root canal fillings [25]. The group of silicone sealers exhibited promising results regarding microleakage in different studies besides the well-established group of epoxy resins (e.g. AH Plus, DeTrey Dentsply, Konstanz, Germany) [3, 4, 7, 12, 23, 30, 33]. This may be due to their slight expansion upon Setting [14].

Silicone sealers remain relatively soft after Setting [20], which may cause difficulties when subsequently additional preparation, as for a root canal post, is necessary. This problem may be addressed using a silicone primer and / or special retentive gutta-percha points (Silicone Primer, Roeko Retention Points, both Coltène/Whaledent, Langenau, Germany). Another way to handle this problem is the use of a silicone sealer with an optimized consistency due to variations in inorganic fillers: GuttaFlow2 (Coltène/Whaledent). GuttaFlow2 is delivered in two different ways: a capsule that is to be triturated for 30 s (see figure 1), and an automix syringe (see figure 2) which is well known from other materials like dual-cure composite cements or from the sealer AH Plus Jet (DeTrey Dentsply).The aim of this study is to test microleakage of this newly developed cuttable silicone sealer GuttaFlow2 in comparison to the established sealer materials GuttaFlow, GuttaFlow fast and AH Plus.

The null hypothesis tested was that there is no difference regarding microleakage for different groups.

Figure 1 – The GuttaFlow2 capsule is mixed for 30 s within a triturator

Figure 2 – GuttaFlow2 as delivered by an automix syringe

Material and methods

Seventy straight single-rooted lower premolars with one root canal each and with fully mature apices were selected. Teeth were stored in a 0.5% chloramine-T solution (Merck, Darmstadt, Germany) or water, or were stored in humid conditions (100% humidity) over the whole time of the study. Access cavities were prepared and the lengths of the root canals recorded by passing a size 10 K-file through the apex and subtracting 1 mm. Teeth were randomly divided into five experimental groups and two control groups of ten teeth each.

All root canals were instrumented to size 45/.04 by nickel-titanium instruments (Hyflex, Coltène/Whaledent, Langenau, Germany). Instrumentation was accompanied by copious irrigation with 3 % NaOCl and 40 % citric acid. A final irrigation with 40 % citric acid followed by 3 % NaOCl and 70 % ethanol was performed (2 mL per root canal for approximately 60 s each) and the root canals were dried with paper points.

For each root canal, a gutta-percha cone size 40/.04 (MTwo Gutta-percha point, VDW, Munich, Germany) was adjusted to fit with tug back at working length. For filling the root canals, a non-compaction technique was applied: the respective sealer was placed with a paper point size 25/.02: group 1: AH Plus sealer, group 2: "normal" setting GuttaFlow, group 3: "fast" setting GuttaFlow, group 4: GuttaFlow2 within a capsule, group 5: GuttaFlow2 within an automix syringe; then the master gutta-percha point was placed; additional gutta-percha points size 25/.02 were placed if appropriate, without the use of a spreader; finally, excess

gutta-percha was cut off, followed by immediate vertical condensation of the gutta-percha with double-sided hand instruments (HDC 1 and HDC 2; both Deppeler, Rolle, Switzerland). The teeth of the positive control group were only filled with a single gutta-percha cone size 40/.04 without sealer. The teeth of the negative control group were filled similarly to group 5. The floor and the walls of the pulp chamber were cleaned with ethanol-moistened foam pellets until the pulp chamber appeared to be clean as judged by the naked eye. Then a temporary filling with a glass ionomer cement was applied (Fuji IX; GC, Tokyo, Japan) to facilitate the subsequent complete covering of the tooth with nail varnish.

Following the completion of root canal filling and temporary filling, teeth were stored in a wet chamber (37°C / 100% humidity) for one week to allow complete setting of the respective sealer. The roots of the teeth were completely covered with two layers of nail varnish. After drying of the varnish, apices of teeth were cut off (1-2 mm) to expose the root canal fillings of the teeth. Negative control teeth were left completely covered. Then the teeth were placed into test tubes together with 5% methylene blue dye solution (Merck), pipetted to a height of 30 mm. A dye penetration test according apical microleakage was performed using centrifugation for 3 min at 30 G (Varifuge-K, Heraeus Christ, Osterode, Germany; 400 rpm) [25].

Following the dye penetration test, excess of dye was washed off. The teeth were dried and the apical surface gently ground on a fine (250 grit) sand paper to remove superficially adhering dye. Each specimen was then embedded in a resin material and serial sectioned in distances of 1 mm using a Buehler low-speed-saw (Buehler GmbH, Lake Bluff, IL, USA). Transversal cuts were made perpendicular to the long axis under water cooling. Dye penetration was scored using a stereo microscope at x25 magnification. Linear dye penetration was recorded using a simple yes / no decision for presence of dye for each sectioning plane. As the sectioning blade had a thickness of 0.5 mm, and the upper and lower surfaces of each slice could be evaluated, the ingress of dye could be measured near to the next 0.5 mm. The readings were counted until the first sectioning plane without dye. For example, a reading of 3.5 mm of dye penetration results of dye present up to the plane 3 mm from the apex and the first plane without coloration at 3.5 mm from the apex. As the dye that had been adhering on the apical cut-off plane of the root was removed, a reading of 0 mm of dye ingress could be recorded in several specimens.

Data were statistically analyzed with IBM SPSS 19.0 (SPSS, Chicago, IL, USA), using Kolmogorov-Smirnov tests, ANOVA with Student-Newman-Keuls (SNK) post-hoc-tests, Kruskal-Wallis (KW) tests and pairwise Mann-Whitney (MW) tests. The level of significance was set at $\alpha = 0.05$.

Results

Some of the groups showed no normal distribution (groups 5 and 7: Kolmogorov-Smirnov test, $p < 0.05$), so additionally to ANOVA with SNK, non-parametric tests were applied as the main statistical tests. According to ANOVA ($p = 0.001$) and Kruskal-Wallis-test ($p < 0.001$) significant differences were found regarding the entity of groups, so the test method itself can be regarded as valid. SNK post hoc test indicated that the positive control differed from all other groups ($p < 0.05$). When positive and negative controls were disregarded, no significant differences could be found (ANOVA: $p = 0.150$; KW test $p = 0.111$). However, in some of the pairwise comparisons between groups, significant differences were revealed: group five showed significant lower values than groups 1, 2 and 3 (MW Test $p < 0.05$) and no significant difference to the negative control (MW Test $p = 0.147$). Because of the results of the KW test (no significant difference), these results have to be interpreted with care. Results are also shown in figure 3.

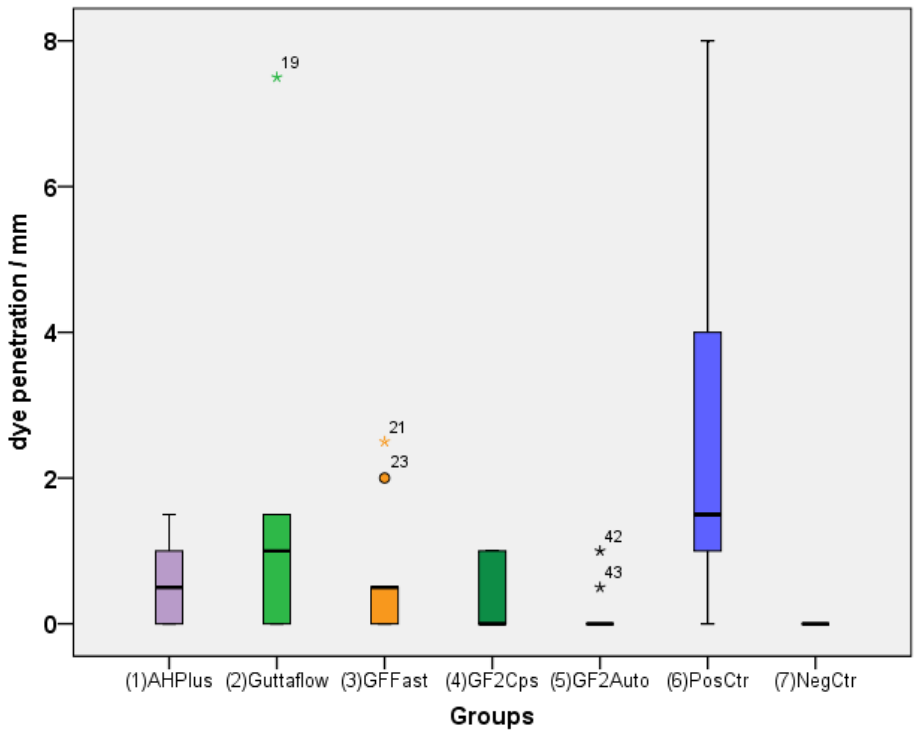

Figure 3 - This boxplot shows the results of different groups regarding linear dye penetration in mm. Boxplots indicate the median (black line) and interquartile ranges (boxes); the whiskers specify the 10 and 90% percentiles (n = 10 per material in each group). The positive control group was the only group that was significantly different from all other groups (ANOVA / SNK, $p < 0.05$). Within the experimental groups (1 - 5), Mann-Whitney tests revealed significant differences between groups "GF2Auto" to groups "AHPlus", "Guttaflow" and "GFFast" ($p < 0.05$). However, looking at the entity of experimental groups, no significant differences were found (Kruskal-Wallis test $p > 0.05$)

Discussion

Arguments towards or against dye penetration within the debate over leakage studies have already discussed in an earlier paper [10]. The main reason why we chose apical dye penetration for the present study is that the problem with a large scale of variation within results could not be avoided in any of the published studies, regardless of the applied methodology [1-12, 15-19, 21, 23, 25-33]. Thus, we chose the method that is the most easy to apply and control and is very cost effective [10, 26]. Furthermore, the chosen variant of dye penetration test using centrifugation was able to detect significant differences between groups within different earlier studies [9-11, 15, 25, 26]. A further point towards apical dye penetration is that it focuses on the apical end of the root canal, rather than looking at the whole root canal filling, similar to which is done in the most of the bacterial leakage [2, 6-8, 18, 19, 21, 23, 29], fluid movement [3-5, 27, 30-32], or glucose filtration studies [12, 16, 17]. The apical end of the root canal is the region that is most difficult to be cleaned and therefore is crucial regarding a possible treatment failure due to residual bacteria [22, 24].

Regarding the entity of experimental groups of the present study no significant differences were found. Thus, the null hypothesis had to be confirmed. However, at least a tendency towards better values for GuttaFlow2 automix compared with GuttaFlow, GuttaFlow Fast and AH plus could be recognized. This can be substantiated by the significant differences found in the comparisons of groups when using pairwise MW tests. This slight improvement maybe derived from an improved handling of GuttaFlow2 automix found during the experiments. Both versions of GuttaFlow2 were not significantly different from each other. However, a trend towards better values for GuttaFlow2 automix was recorded. Favorable results for GuttaFlow2 compared with AH Plus could also be found in a recently published study using a glucose leakage model [12].

When looking at the raw data (that partly can be recognized in figure 3), none of the specimens within the GuttaFlow 2 groups exhibited any coloration beyond 1 mm, whereas one specimen of AH Plus reached 1.5 mm, two of the specimens of GuttaFlow Fast ranged 2 mm or more, and one specimen within the "normal" GuttaFlow group exhibited a coloration ranging up to 7.5 mm. These findings – outliers regarding leakage – were also common in earlier studies using a similar methodology [25, 26]. However, the mean values achieved within the present study are very low for every material tested when compared with the results of earlier studies [25, 26]. On the other hand, the values recorded within the present study cannot be directly compared with these former studies with a similar methodology, as some slight changes within the evaluation method have been made: lower premolars were used instead of lower incisors; root canals were enlarged to size 45 taper 0.04 instead of size 60 taper 0.02. Furthermore, a finer scale for examination was used: in these former studies, a reading of 0 mm or 0.5 mm would not have been possible, because the first plane for examination was 1 mm from the apex. As our results indicate, this finer scale of evaluation is apparently necessary to examine contemporary very well sealing materials without the need for changing the methodology of the dye penetration test itself.

One effect happened within the positive controls: in some specimens of the positive control group dye penetration unexpectedly stopped within the first millimeters of the root canal. This may be attributed to the gutta-percha point used (MTwo gutta-percha). These points seemed to be rather soft and may be prone to swelling due to water uptake [32]. This may have been the effect that led to sealing of the apical part of the root canal in spite of using no sealer. However, this effect has to be examined in future experiments.

Conclusion

Within the limits of this study, both forms of GuttaFlow2 showed very good and predictable sealing ability when compared with the former versions of GuttaFlow as well as with the established sealer AH Plus.

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Original Research Article

Evaluation of adhesive systems in primary dentin by nanoleakage: effects of aging

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Abstract

Introduction: Nanoleakage evaluation by silver uptake in permanent teeth provides good spatial resolution of submicron defects at the hybrid layer, which have not been tested in primary teeth. **Objective:** This study evaluated the nanoleakage at the dentin-adhesive interface in primary teeth by two methods, for three adhesive systems, immediately (IM) and six months (6M) after adhesive procedures. **Material and methods:** Crowns of primary molars were occlusal flat grounded and divided into three groups according to the adhesive system tested (n = 6-7). Scotchbond Multi-purpose/SMP, Single Bond/SB and Clearfil SE Bond/CSB adhesive systems were applied with a composite resin (Filtek Z-250). Crowns were sectioned so that 0.8 mm² sticks were obtained and subdivided depending on the time of evaluation: IM or 6M. They were immersed into silver nitrate solution and evaluated by SEM-EDS. Data (%) were analyzed by ANOVA ($p < 0.05$) and the scores by Kruskal-Wallis and U Mann-Whitney tests ($p < 0.05$). **Results:** There was no difference between groups regarding to the evaluation time (aging) percentage. In terms of scores, there was a significant difference for the adhesive variable: SMP and SB showed similar results with less leakage, while CSB demonstrated higher leakage. **Conclusion:** Nanoleakage was not influenced by aging, but noticeable difference was observed between total-etch and self-etching adhesives. Total-etch showed better performance.

Introduction

Adhesion to dentin is primarily based on the hybridization mechanism, which is a micromechanical bond between adhesive polymers and collagen fibrils from the demineralized dentin [15]. Thus, modern adhesive systems may remove total or partially the smear layer as well as the subjacent dentin's mineral, which are replaced by resin monomers [3, 27].

Some adhesive systems showed a reduction in the time and number of application steps in order to reduce defects of handling [27], which is attractive for pediatric dentistry [22, 23], due to the child's management. However, it is known that this simplification does not necessarily improve bonding effectiveness over time [2-4, 32]. Adhesion between dentin and resin deteriorates over time, limiting adhesive restorations longevity [28]. Studies demonstrated that resin-dentin bond strength decreases over time and that the hydrolysis of collagen fibrils is responsible for such reduction, even in the absence of interfacial gaps. The degradation of the bond could be the result of water movement within the hybrid and adhesive layers. This hydrolysis may extract unconverted monomers from the hybrid layer rendering a weak interface [1, 16, 19-21, 26]. Also, not encapsulated collagen fibrils can be hydrolyzed by metalloproteinase enzymes [21, 25, 29].

Interfacial gaps inside of the hybrid and adhesive layers [21] are explained by nanoleakage, described for the first time by Sano et al. (1995) [19, 20]. The evaluation of nanoleakage by silver uptake provides good spatial resolution of submicron defects in resin infiltration or inadequate polymerization [25, 27], which have been evaluated in many studies involving permanent teeth [5, 6, 10, 13, 14, 16, 18, 22, 24-26, 30-32]. However, few studies so far, have attempted to show this phenomenon in primary teeth [7, 8, 11, 17].

Therefore, the objective of this study was to evaluate the nanoleakage in primary dentin for three different adhesive systems by means of silver nitrate uptake, immediately and six months after bonding aged specimens.

Material and methods

Teeth selection, storage and preparation

This study was approved by Institutional Review Board (under protocol no. #205/07). Forty extracted caries-free human primary molars were stored into 0.1% thymol solution, 0.9% saline solution, pH = 7 at room temperature. A flat superficial dentin surface of each tooth was exposed after wet grinding the occlusal enamel with a #200 grit silicon carbide paper (SiC). The surface was further wet polished with a #400 and #600 grit SiC paper in four different directions, during 10 seconds each, to standardize the smear layer.

Bonding procedures

All the bonding procedures were carried out by the same operator, at room temperature. After cleaning with distilled water, specimens were divided into three groups (n= 6-7 teeth) for each adhesive systems: *Scotchbond Multi-Purpose (3M ESPE, St. Paul, MN, USA), Single Bond (3M ESPE, St. Paul, MN, USA*, and *Clearfil SE Bond (Kuraray Medical, Tokyo, Japan)* (Table I). The adhesives were applied according to the manufacturer's instructions and light cured with a LED light unit with a power output of 400 mW/cm^2 (Radii, SDI, Bayswater, Australia). Resin composite build ups (Filtek Z250 - *3M ESPE, St. Paul, MN, USA*) were then constructed on the bonded occlusal surfaces in three increments of 1.5 mm, which were light cured for 20 seconds each with the same light intensity.

Sections of 0.9 mm thickness each were made in a longitudinal direction (perpendicular to the adhesive interface) with a 0.3 mm diamond disc (Buehler, Lake Bluff, IL,USA) in an Isomet 1000 machine (Isomet 1000, Buehler, Lake Bluff, IL, USA), under water refrigeration at 250 rpm. Initially those sections were cut in a mesial-distal direction in order to obtain specimen's slices. A sticky wax was applied in order to keep the slices together. After that, another buccal-lingual sectioning was performed to provide sticks with 0.8 mm^2 area. The bonded sticks from each tooth were then randomly subdivided into two groups: one assigned to be tested immediately and the other six months after storage in distilled water containing 0.4% sodium azide, at 37°C.

Table I – Adhesive systems. Composition, application mode, batch number

Adhesive System	Composition	pH (primer)	Steps	Batch number
Scotchbond Multi-Purpose	Primer: Aqueous solution of HEMA, polyalkenoic acid copolymer. Bond: Bis-GMA, 2-HEMA, photo initiator component.	3.3 *	a; b; d; e; f; i	Primer: 7BJ Bond: 7PX
Single Bond	Water, ethanol, HEMA, Bis-GMA, dimethacrylates, photo initiator systems, methacrylate functional copolymer (polyacrylic, polyitaconic and polyalkenoic acid.	4.7 *	a; c; d; g; h; i	7LY
Clearfil SE Bond	Primer: MDP, HEMA, hydrophilic dimethacrylate, di-camphorquinone, N,N-p-toluidine diethanol, water. Bond: MDP, HEMA, Bis-GMA, hydrophobic dimethacrylate, di-camphorquinone, N,N-p-toluidine diethanol, colloidal silanated silica.	1.9 **	j; f; h; i	Primer: 00760[a] Bond: 01094[a]

Abbreviations - HEMA: 2-hydroxyethyl methacrylate, Bis-GMA: bisphenyl-glycidyl methacrylate, 10- MDP: 10-methacryloyloxydecyl-dihydrogen-phosphate.
* Manufacture information
**Van Meerbeek et al. (2003)
Application Mode - a) acid etch – phosphoric acid 35% (15s); b) rinsing (15s); c) rinsing (10s); d) drying with absorbent papers – with no dentin over dry; e) primer application and drying (5s); f) adhesive application; g) 2 coats of adhesive; h) drying the adhesive (2-5s); i) light cure (10s); j) primer (20s) and air dry.

Nanoleakage evaluation

Bonded sticks were coated with two layers of nail varnish applied up to within 1 mm of the bonded interface. They were then rehydrated in distilled water for 10 minutes and immersed in ammoniacal silver nitrate tracer solution for 24h (Cennabras Indústria e Comércio Ltda., Guarulhos, São Paulo, Brazil). The solution was prepared according to the protocol previously described by Tay et al. (2002) [26]. The specimens were then rinsed thoroughly in distilled water and immersed in photo developing solution (Caithec Materiais Odontológicos, Rio do Sul, Santa Catarina, Brazil) for 8h, under a fluorescent light to reduce silver ions. All sticks were then placed inside an acrylic ring, which was attached to a double-sided adhesive tape, and embedded in epoxy resin. The specimens were wet polished with #600 SiC paper to remove the nail varnish, and further polished with a #1200 grit SiC paper with a 1; 0.3; and 0.05 μm diamond paste (Buehler, Lake Bluff, IL, USA). They were then ultrasonic cleaned, air dried and gold coated (SCD 005, Bal-tec, Balzers, Liechtenstein) in order to analyse the resin-dentin interfaces by SEM (Philips XL-30, Philips Eletric Corporation, Eindhoven, Netherlands). Two analysis were performed to verify the silver uptake: a) A percentage of silver uptake evaluated [18]; b) the silver nitrate uptake expressed by scores [32].

For the first method (a), the analysis was performed in the backscattered electron mode (BSE) and by the use of energy dispersive X-ray spectrometry (EDS) (EDAX, Ametec Inc., USA). Analysis of each stick was performed at three regions (center, right and left) of the bonded stick (adhesive layer, hybrid layer and resin tags) (1000X) (Figure 1). The silver nitrate uptake was expressed as a percentage, according to the mean values observed by EDS for each tooth.

In the second method (b), photomicrographs of the whole stick were taken in BSE mode (90X) and one single operator analysed each one of the photomicrographs in a 14" laptop (Aspire 4520, Acer Inc., China). The evaluation was performed in total area by the use of scores, following an adaptation of the method suggested by Yuan et al. (2007) [32]:

0 - no leakage;
1 - Mild leakage - less than 25% of the evaluated area;
2 - Clear leakage - between 25 and 50% of the evaluated area;
3 - Large leakage - more than 50% of the evaluated area.

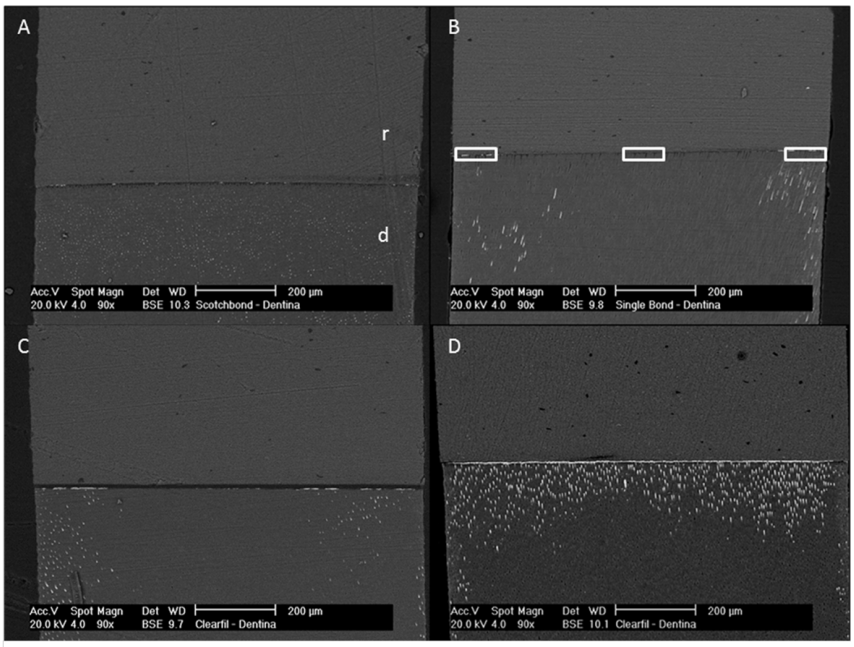

Figure 1 – Photomicrographs of the dentin-resin interface (90X). Different degrees of silver nitrate penetration (white) can be observed: discrete **(A)**; clear and localized **(B)**; clear and disperse **(C)**; intense deposition of silver uptake **(D)**. Images show lower silver uptake penetration for Scotchbond Multi-purpose and Single Bond **(A and B)**, and higher penetration for Clearfil SE Bond **(C and D)**. Photomicrograph **B** shows areas evaluated by EDS. (r- resin; d-dentin; A and C: 6M groups; B and D: baseline)

Data treatment

The percentages calculated from the mean values of silver uptake for each tooth were analyzed by ANOVA. Analysis of each stick's score was performed by Kruskal-Wallis and U Mann-Whitnney Test ($p < 0.05$).

Results

Silver nitrate penetration expressed by percentage

The mean values of silver penetration for each tooth, as well as the results of the statistical analysis are expressed in table II.

Table II – Mean values (%) silver nitrate leakage

Adhesive	Time			
	Baseline		6 months	
	n	Mean (SD)	n	Mean (SD)
Scotchbond MP	7	27.15 (8.26)	6	30.54 (11.74)
Single Bond	7	32.16 (11.54)	7	33.18 (9.94)
Clearfil SE Bond	6	30.31 (18.73)	7	31.39 (13.3)

n= number of teeth; SD = Standard deviation

Silver nitrate penetration expressed by scores

The score distribution according to the silver nitrate penetration for each adhesive system is presented in table III. Kruskal-Wallis test revealed that there was no significant difference for the variable aging ($p = 0.79$), but there was a statistical difference among the adhesives ($p = 0.00$). The U of Mann-Whitney test ($p < 0.05$) showed that Scotchbond Multi-purpose and Single Bond adhesives had similar performance and allowed less silver nitrate uptake than Clearfil SE Bond adhesive.

Table III – Score distribution from the silver nitrate leakage to each adhesive system. Immediate (baseline) and six months evaluation

Time	Adhesive	0	1	2	3	Total
Baseline	Scotchbond MP	0	11	5	2	18
	Single Bond	0	9	7	1	17
	Clearfil SE Bond	0	7	5	6	18
6 months	Scotchbond MP	0	13	5	2	20
	Single Bond	0	9	9	1	19
	Clearfil SE Bond	1	4	4	8	17
					Total	109

Kruskal-Wallis test (Adhesive, p = 0.00 / time, p = 0.79)
U Mann-Whitnney test: (Scotchbond MP = Single Bond) < (Clearfil SE Bond)

Photomicrographs

Figures 1-4 show representative photomicrography observed in SEM.

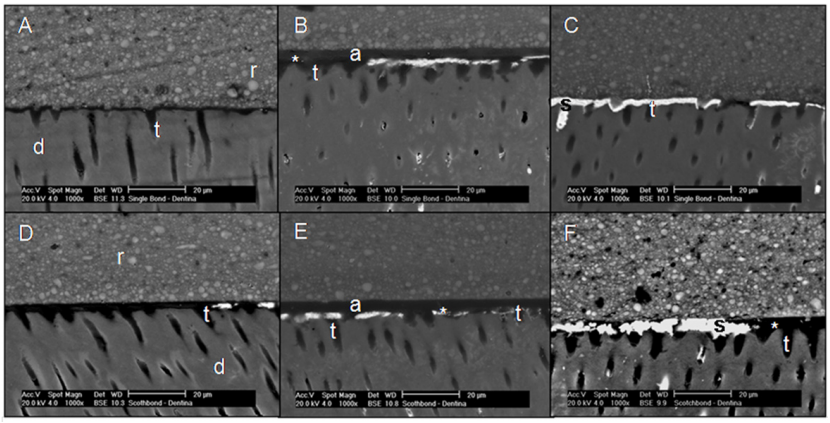

Figure 2 – Photomicrographs of dentin-resin interface (1000X) of total-etch adhesives baseline. For Single Bond **(A-C)** and Scotchbond Multi-purpose **(D-F)** can be observed: absence **(A)** and discrete silver nitrate penetration (spot) **(D)**; infiltration at the base of hybrid layer (reticular) **(B and E)**; large penetration at the hybrid layer and at the adhesive layer (reticular) **(C, F)**. (r-resin, d-dentin, a-adhesive, s-silver uptake, *-hybrid layer, t- resin tags)

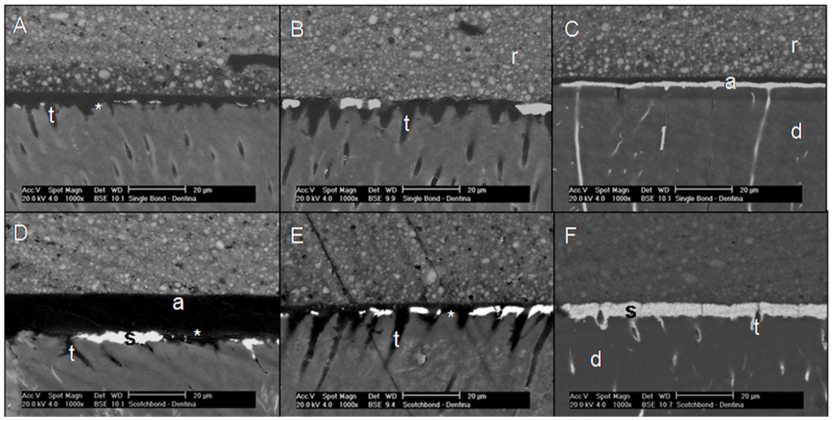

Figure 3 – Photomicrographs dentin-resin interface of total-etch adhesives (1000X) after six months. Single Bond **(A-C)** and Scotchbond Multi-purpose **(D-F)** show discrete **(A)** and clear **(D)** silver nitrate penetration at the base of the hybrid layer (spot); clear penetration of silver nitrate at the adhesive layer and hybrid layer (spot) **(B)**; intense infiltration at the hybrid layer and at the adhesive layer **(F)** (reticular); and intense penetration of silver nitrate at the hybrid layer **(C and E)** (reticular). (r-resin, d-dentin, a-adhesive, s-silver uptake, *-hybrid layer, t- resin tags)

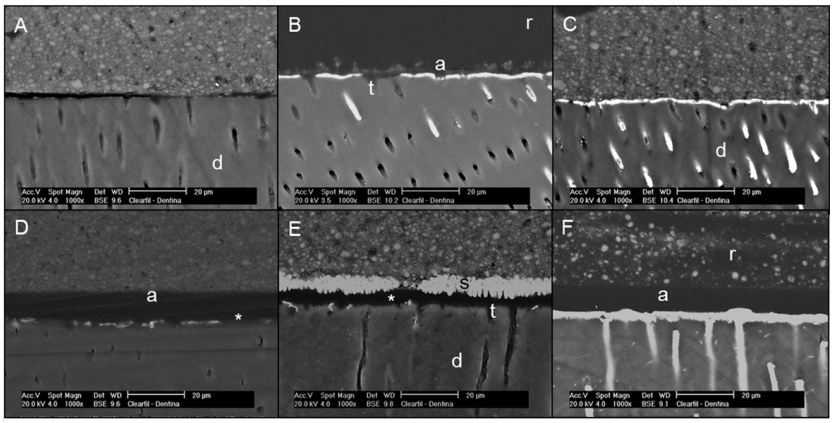

Figure 4 – Photomicrographs of dentin-resin interface (1000X) after self-etch adhesive application at baseline and after six months. Images of Clearfil SE Bond show: absence **(A)** and discrete silver nitrate penetration (spot) **(D)**; infiltration at adhesive layer (water tree) **(B)**; higher penetration at hybrid layer and adhesive layer (reticular) **(C)**; intense deposition at the superior layer of the adhesive (reticular) **(E)** and at the base of hybrid layer (reticular) **(F)**. (r-resin, d-dentin, a-adhesive, s-silver uptake, *-hybrid layer, t- resin tags)

Discussion

Nanoleakage was first described in 1995 by Sano et al. (1995) [19, 20] when a little diffusion of small ions was observed inside of the hybrid layer even with the absence of interfacial gaps. The most commonly technique to analyze these defects uses silver nitrate immersion technique in conjunction with Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) analyses [4, 6-8, 11, 16, 17, 26, 31, 32].

The results of this study (in percentage) showed that there was no significant difference among the groups studied. Regarding score's evaluation, there was no significant difference for aging, but there was a difference among adhesives.

Scotchbond Multi-purpose and Single Bond showed similarity between them with less silver nitrate penetration than Clearfil SE Bond. One can note that the adhesive that demonstrated higher leakage (Clearfil SE Bond) is self-etching adhesive, contrasting with the ones that require total etching (Scotchbond Multi-purpose and Single Bond) which have lower leakage (Figure 1). These findings can be related to higher water content in the self-etching adhesives, once they need it to activate the acidic

monomers and produce an efficacious hard tissue demineralization. This necessary water decreases the hydrolytic stability of the adhesive system due to water sorption [7, 26].

Some studies have related the influence of aging in nanoleakage [16, 18, 31], by means of hydrolysis degradation, as well as polymer's plastification, which was not observed in this study. One of the reasons could be the absence of the storage liquid's renewal, since there is an acceleration of adhesion aging when the solution is changed periodically [9].

The short time of evaluation as well as the other factor's interaction over adhesion's aging should be considered, as observed by Ernhardt et al. (2008) [4], who reported a stable adhesion in sound dentin after 6 months, suggesting that other factors may contribute for the physico-chemical degradation of the interface, as pH changes, occlusal load and enzyme's variations [4].

The nanoleakage patterns observed in this study were similar to those reported in the literature (reticular, spot and "water tree type") as well as the location of the silver nitrate at the adhesive interface (hybrid layer and adhesive layer) (Figure 2-4). All patterns and location of the nanoleakage were found in all adhesives, except for the "water tree type" pattern, observed only for self-etching adhesive, probably due to the higher water content of those systems (Figure 4) [6-7, 26]. The analyses of resin-dentin interface produced by total-etch adhesives revealed a hybrid layer with high amount and long length of the resin tags, meanwhile the self-etching adhesive showed a hybrid layer with a lower quantity of tags (Figure 2-4) confirming previous studies [12, 23]. Further studies should be conducted in order to evaluate bonding mechanism in primary dentin.

According to results, the two methods of evaluation showed that nanoleakage at the adhesive interface in primary dentin was not influenced by aging of the three adhesive systems tested. However, the analysis of the scores showed that there was more silver uptake for specimens of the self-etch group than those of the total-etch group.

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Original Research Article

Use of restorative materials for direct and indirect restorations in posterior teeth by Brazilian dentists

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Abstract

Introduction: Often, dentists perform procedures aiming at more esthetical than long-term clinical performance of restorations. **Objective:** To evaluate the prevalence of use of different direct and indirect restorative materials in posterior teeth. **Material and methods:** In 2004, a questionnaire was applied to 486 dentists living at five geographical regions of Brazil. The dentists answered a questionnaire containing four questions, in which they reported the most widely used restorative material for direct (amalgam, composite resin, and glass ionomer) and indirect restorations (gold, silver, and copper/aluminum alloys, indirect resin composites, and ceramics) and specified the reason for using the material type selected. **Results:** In 2004, amalgam was the direct restorative material most used by dentists at almost all regions, except from South region, where resin composite was the most used. Esthetics was the main reason stated for the use of resin composites. As for

indirect restorations, metallic restorations were the most used in Northeast (77.8%). No differences were found regarding the material type use between metallic and aesthetic materials at North, Southeast and Center-West regions. At South region, esthetic restorations were the most used. **Conclusion:** Despite the limitations of this present study, direct and indirect metallic restorations were the most common materials in 2004.

Introduction

The constant advancement of science and technology compels all professional to update mainly because globalization of modern society. Marketing power of dental material industries has influenced on decision process of restorative treatment, especially regarding the restoration type (direct or indirect; metallic or esthetic), so that the dentist is often obliged to perform procedures aiming at more esthetical than long-term clinical restoration behavior of restorations.

Considering the appealing of different materials, the dental professionals have to search for solid knowledge to select the material most adequate for each situation. The main advantage of direct restorative materials, i.e. dental amalgam and resin composite, is shorter chair time.

Dental amalgam is a material very used for restorations in posterior teeth [33], presenting adequate resistance to masticatory forces [13, 32]. However, despite its adequate clinical behavior, dental amalgam would be replaced by materials with better clinical behavior [1, 3].

Accordingly, resin composites have been largely studied due esthetical features, which make them popular as restorative material [7]. Moreover, resin composites have great potential to obtain satisfactory mechanical properties together with the controversies on dental amalgam and the search for less invasive procedures [31]. On the other hand, resin composite in posterior tooth restorations tend to be a more complex procedure, generally with small durability [35]. Within this context, the longevity of resin composite restorations may be influenced by many factors such as adhesive system, type and composition of resin composite, light-curing unit, restorative technique, etc. [16, 18, 37].

Since the introduction in 1972 by Wilson and Kent [38], glass ionomer materials have undergone many changes that improved clinical behavior and increased versatility in clinical practice, exhibiting properties as bonding to tooth structures, biocompatibility, fluoride release, among others, leading such materials to be increasingly researched [11, 14]. Notwithstanding, glass ionomer cements still do not have mechanical properties enabling effective use as direct restorative material in posterior teeth [10, 20].

Both resin composite and indirect restorative materials improved mechanical properties because of the improvement of adhesive systems and luting materials, respectively. The development of resin composites leads to development of resin cements, increasing the possibilities of constructing esthetic adhesive indirect restorations as resin composite/ceramic inlays, onlays and overlays.

The indications for either resin composite or ceramic indirect restorations are basically the same [23], showing better morphology in extensively destroyed teeth and greater resistance to wear [9], better marginal adaptation and longer longevity than that of direct restorations [29], and having a technique depending on the luting material in the context of an adequate adaptation of restoration [22, 26].

Considering the metallic alloys used in indirect restoration, high gold percentage alloys (70-75%) have resistance to corrosion, easy handling because of relatively low flow limit and possibility of proper alloy burnishing. With the increasing of gold cost, low gold percentage alloys were developed by increasing other metal contents as silver, and often are adequate substitutes for high gold percentage alloys regarding the aspects of marginal adaptation and biocompatibility; the small cost of low gold percentage alloys make them relatively popular in Dentistry [4].

The so-called alternative alloys also appeared in the context of reducing costs and are composed by non-precious metals as copper/aluminum alloys. Alternative alloys exhibit some unsatisfactory properties: difficult technique for casting and polishing; resistance to corrosion; color change; hardness; among others; thus, these alloys should be carefully used despite of its low cost [17, 30].

Considering all options of direct and indirect restorative materials available in daily clinical practice, many times, the selection of the material most adequate for each clinical case is difficult, mainly from the point of view of both the professional and patient. Accordingly, the aim of this research was two-fold: 1) to analyze through cross sectional study, which dental materials for direct (amalgam, resin composite and glass ionomer) and indirect restorations (gold, silver, and copper/aluminum alloys; laboratorial resins and ceramics) would be

more used by Brazilian dentists, in 2004; 2) to assess the main reasons for the use.

Material and methods

Questionnaires were sent to 486 Brazilian dentists from March to July of 2004, living in the same city of the undergraduates of both the School of Dentistry of Santa Fé do Sul Integrated School (SP) and the Master Course in Operative Dentistry of São Leopoldo Mandic Center of Post-graduation (SP). The number of participants were determined based on the total number of dentists within each region (data obtained though the Brazilian Council of Dentistry website in March, 20, 2004). The number of participants included in the study according to the regions is seen below (table I).

Table I – Dentists' distribution according to the region of practice

Region	North	Northeast	Center-West	Southeast	South
Number	36	45	138	215	52

Data collection was obtained through a questionnaire composed by four multiple-choice questions on "Direct and indirect restorations: materials mostly commonly used by dentists", which was answered by the professional interviewed.

The response variables were:

1) Direct restorative materials:
a) Metallic: amalgam
b) Esthetic: glass ionomer cement and resin composite
2) Indirect restorative materials:
a) Metallic: gold, silver and copper/aluminum alloys
b) Esthetic: laboratorial resins and ceramics
3) Reason for using the materials:
a) Low cost
b) Better clinical behavior
c) Esthetical demanding by the patient
d) Easy handling

Collected data were analyzed through grouping the results by similarity and distribution on Excel sheets (Microsoft, Redmond, Washington, USA). The study of the association among the variables disposed as tables was performed through Pearson's chi-squared test and Fisher test, if necessary. Global significance level was set at 5%.

Results and discussion

Through a questionnaire applied to dentists from different Brazilian regions, we attempted to obtain and overview about restorative dentistry of the beginning of the century in Brazil. The following variables were considered: material type used for direct restorations in posterior teeth (Q1 direct): metallic (amalgam – AAA) or esthetic (glass ionomer cement – GIC – or resin composite – RC) and for indirect restoration in posterior teeth (Q2 indirect): metallic (gold – G –, silver – D – and cooper/aluminum alloys – Cu/Al) or esthetic (laboratorial resins – RES – and ceramics – CER). Also, variables regarding the reason for using these materials were analyzed (cheaper – CH –, clinical behavior – CB –, easy technique – ET – or patient's esthetical demand – PED). Thus, the materials used in either direct or indirect restorations were studied by statistically comparing the type (metallic and esthetic); within each type; and the reason for use (cost, clinical behavior, easy technique and patient's esthetical demand). The results regarding the material used in different restorative procedures at the different Brazilian countries are seen in tables II (direct restorations) and III (indirect restorations).

Table II – Direct restorative materials used in clinical procedures according to Brazilian regions

	Q1 direct				
	Metallic		**Esthetic**		
	AAA	**Total**	**GIC**	**RC**	**Total**
N	23	23 (63.9%)	-	13	13 (36.1%)
NE	29	29 (64.4%)	1	15	16 (35.6%)
S	19	19 (36.5%)	-	33	33 (63.5%)
SE	128	128 (59.5%)	6	81	87 (40.5%)
CW	76	76 (55.1%)	2	60	62 (44.9%)
Total %		**275 (56.6%)**			**221 (43.4%)**

Table III – Indirect restorative materials used in clinical procedures according to Brazilian regions

	Q2 indirect						
	Metallic				**Esthetic**		
	G	**S**	**Cu/Al**	**Total**	**RES**	**CER**	**Total**
N	1	4	16	21 (58.3%)	8	7	15 (41.7%)
NE	2	10	23	35 (77.8%)	4	6	10 (22.2%)
S	5	8	5	18 (34.6%)	20	14	34 (65.4%)
SE	16	44	69	129 (60%)	37	49	86 (40%)
CO	7	24	58	89 (64.5%)	25	24	49 (35.5%)
Total %				**292 (60.1%)**			**194 (39.9%)**

Direct restorations in posterior teeth

The analysis of percentage frequencies of metallic and esthetic materials did not show statistically significant differences comparing data among regions – North (63.9%/36.1%), Northeast (64.4%/3.,6%), Southeast (59.5%/40.5%) and Center-West (55.1%/44.9%) –; and general sample (56.6%/43.4%). However, statistically significant differences were seen for data regarding South region (36.5%/63.5%) ($p < 0.05$).

After the analysis of the results of this present study, considering direct restorative material at Brazilian Market, the most used material in 2004 was dental amalgam (56%), when compared with resin composites and glass ionomer cements (43.4%), with statistically significant differences. This tendency was observed at all regions, except from South region, in which esthetic materials were the most employed.

Many authors have cited dental amalgam as the direct restorative material with longer durability; smaller wear, fracture, marginal leakage rates; easier handling, among others than that of esthetic materials [8, 24, 25, 32]. Accordingly, dental amalgam is very employed in posterior teeth despite of the tendency towards indicating esthetically more accepted materials, which is in agreement with the results of this present study. It is important to emphasize that, currently, esthetic materials tend to be increasingly used when compared with metallic materials, similar to which was verified by the South region of Brazil.

By considering the reasons for using amalgam, the main rationale behind its use was the clinical behavior (48.4%), followed by low cost (32.7%) and easy handling (18.9%). Only at Northeast region, the rationale behind the amalgam use was low cost (55.2%). These findings are in agreement with those of Berry (1998) [5] in which amalgam cost is one of the items assuring the survival in restorative procedures. Similarly, Pucci *et al.* (1998) affirmed that amalgam should be the material of choice to construction of low cost direct restorations in posterior teeth, because the cost-benefit ratio of Class II amalgam restoration is greater than that of resin composite restoration [33]. The good clinical behavior of amalgam occurs because of the great capacity of supporting masticatory loads [13], longevity [33], easy handling and by the fact of exhibiting progressive self-sealing with low marginal leakage rates.

The study of esthetical materials used for direct restoration in posterior teeth, statistically significant differences were observed between glass ionomer cements (18%) and resin composites (82%); at North and South regions, glass ionomer cements were not cited. According the results of this present study, glass ionomer cements were little used in Brazil because of the esthetic outcome (100% of reports). However, a tendency towards making glass ionomer cement popular exists, because both the properties and possibilities of clinical indications have been improved, with interesting features, as adhesive properties and fluoride releasing [12, 19].

One great concern related with the employment of glass ionomer cements as restorative materials is the resistance to mechanical and erosive/abrasive forces, emphasizing that greatest differences exist in the mechanical properties among different glass ionomer cements commercially available [15]. Despite of this improvement, the inherent characteristics of these materials contraindicate their use for the restoration in posterior teeth, such as smaller tensile and compressive strengths than those of resin composites, and inferior esthetic outcome.

Despite the results of this present study, the resin composites have been very used for Brazilian

dentists and may become increasingly popular due to material. In most cases (95,7%), esthetics was the rationale behind resin composite use; only 3.8% of the dentists responded the clinical behavior of the material; and 0.5% cited easy handling. It is important noting that resin composite use probably increased in the last years, since the conduction of this present study, but resin composite still exhibit technical difficulties regarding its handling.

Both health/hygiene conditions and patients' motivation should be evaluated at the selection moment of the most adequate restorative material, since resin composite restorations tend to be more sensible at long term than dental amalgam restorations. Notwithstanding, by respecting the correct technique, the resin composites can show a durability similar to that of dental amalgams [21].

Indirect restorations in posterior teeth

The analysis of the percentage frequencies of metallic and esthetic materials did not presented statistically significant differences by comparing data among North (58.3%/41.7%), Southeast (60%/40%) and Center-West (645%/35.5%), and for general sample (60.1%/39.9%). Significant statistically differences were found at Northeast (77.8%/22.2%) and South regions (34.6%/65.4%).

After the analysis of the results of this present study, considering indirect restorative materials at Brazilian Market, in 2004, it was noted a predominance of metallic over esthetic materials. At Northeast region, this predominance was statistically significant (77.8%); at North, Southeast, and Center-West regions, no statistically differences were seen. At South region, a predominance of esthetic indirect restorative materials were seen.

Similarly to which was observed and considered the direct restorations, a tendency towards employing esthetic materials at the South region of Brazil was noted, demonstrating the dentist/patient's preferences by esthetic materials probably due to social-cultural issues.

The esthetic materials evaluated in this present study were laboratorial resins (48.5%) and ceramics (51.5%). Considering metallic materials, we evaluated Cu/Al (58.6%), Ag (30.8%) and Au alloys (10.6%), and the frequency of non-precious alloys was higher than that of gold alloys, except from South region, in which all alloys were used at similar frequencies.

The rationales behind the employment for metallic indirect materials were: clinical behavior (45.9%) and cost (44.2%), which were more significantly cited than easy handling (19.9%). The single rationale for using gold alloys were the clinical behavior, excepting from Southeast region, at which a small part of professions justifying their use by easy handling.

The high price of gold has forced the development of new low gold content. Some of them exhibited relatively low flowing; good ductility in the soften state, with easy burnishing; and good clinical behavior. A great concern on indirect restorations is marginal adaptation because of the most complex technique than that of direct restoration. Moreover, the adaptation of ceramic restorations is more difficult than that of indirect restoration made through resin composite stratification onto a dental cast previously obtained [2].

The use of silver alloy was more frequently employed (30.8%), justified by the clinical behavior of the material, excepting from the Southeast region, together with cost and easy handling. The material most used for metallic indirect restorations was Cu/Al alloy, justified by clinical behavior and cost.

On disadvantage of indirect restorations was both cost, greater number of appointments, and need of prosthetic technician [29]. Considering the esthetic indirect restorative materials, laboratorial resins were much employed (48.5%). According to Retief [34], polymerization contraction of these materials is minimum and compensated by the luting cement and hardness is similar to that of natural tooth [28].

At Southeast and Center-West regions, ceramics were the most used esthetic material. Ceramics have cost higher than that of laboratorial resins with higher hardness that that of dental structures which may result in wearing of opposing teeth [6, 27]. Notwithstanding, ceramics have excellent esthetic properties, biocompatibility, chemical stability, resistance to wear and oral cavity survival [36].

Generally, esthetic indirect restorative materials is justified by patients' esthetic demands followed by clinical behavior, cost and easy handling, which did not show statistically differences among each other. Thus, the results of this present study demonstrated that dental teaching should focus on all restorative materials, including metallic alloys and direct use of dental amalgam.

Conclusion

1) Direct restorations
a) Frequency of metallic material use (56.6%) was greater than that of esthetic material use (43.4%);
b) Concerning to metallic material types – 48.4% = clinical behavior; 32.7% = lower cost; 18.9% = easier handling;
c) Concerning to esthetic material– 72% (RC) and 18% (GIC);
d) Reason for esthetic use– 95.7% (patient's esthetic demand); 3.8% (clinical behavior) and 0.5% (easier handling).

2) Indirect restorations
a) Frequency of metallic material use (60.1%) was greater than that of esthetic material (39.9%);
b) Concerning to metallic material types – 58.6% (Cu + Al alloys), 30.8% (silver alloys) and 10.6% (gold alloy);
c) Concerning to use of metallic material – 45.9% (clinical behavior), 44.2% (lower cost) and 9.9% (easier handling);
d) Concerning to esthetic material types – 48.5% (laboratorial resins) and 51.5% (ceramics);
e) Reason for esthetic use: 77.8% (patient's esthetic demand), 19.1% (clinical behavior), 2.1% (lower cost) and 1% (easier handling).

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Original Research Article

Evaluation of three root canal filling techniques through digital radiograph

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Abstract

Introduction: Endodontic obturation consists of root canal filling by antiseptic or inert materials that promote a three-dimensional sealing and stimulate the repair process without interfering with it. Different obturation techniques and materials have been proposed to meet this requirement. **Objective:** To compare the root canal filling promoted by lateral condensation technique, Tagger's hybrid technique and McSpadden technique by assessing the filling quality through digital radiograph. **Material and methods:** A total of 45 extracted single-rooted human teeth were used and randomly divided into three experimental groups. After instrumentation, the teeth were filled by lateral condensation (n=15), Hybrid Tagger (n=15), and McSpadden techniques (n=15). Then, digital radiographs were taken with projected increased 10 times, at mesial-distal and buccolingual directions. **Results:** Visually, few empty spaces were detected at the three root thirds of teeth filled by different techniques. However, statistical analysis (Kruskal-Wallis) found no differences among the different groups, neither among the different thirds nor between both incidences evaluated. **Conclusion:** It was concluded that the three obturation techniques exhibited similar behavior in relation to the sealing of the root canal through digital radiograph.

Introduction

According to the American Association of Endodontics (AAE), an adequate filling is defined and characterized by the tridimensional filling of all root canal, as closest as possible to the cementum-dentine junction [9].

The filling goal is to seal root canal system (main and accessory canals) within an adequate limit and hermetically, by employing materials and techniques favoring apical and periapical healing process. Many filling techniques and endodontic cements have been proposed to meet these requirements [13].

Over time, different materials have been employed to fill root canals aiming to find the ideal one, that is, to provide both good biological and physicochemical properties [13].

Gutta-percha associated with endodontic cement has been the material of choice of most professionals, employed in different techniques, which can be divided into three groups: lateral and vertical gutta-percha compaction, thermomechanical gutta-percha condensation, and injection of thermoplasticized gutta-percha [13].

Currently, root canal filling has been considered as one of the main steps of endodontic therapy. With regard to the techniques (due to either the material used or the conditions of the treatment), all have a common goal: to match quality with practicability [14].

The quality of this obturation is normally evaluated through conventional radiograph examination, in which the distribution of the filling material is observed all over the canal extension. Notwithstanding, the process of radiographic diagnosis is subjective; thus, complementary resources, such as digitation of the radiographic image and use of digital tools can display architectural changes sometimes not seen during the visual interpretation of the conventional image [4].

The knowledge of the quality and sealing capacity of different filling techniques is of extreme importance and it is necessary an evaluation of Tagger's hybrid and McSpadden's thermomechanical techniques and lateral condensation technique, aiming to the daily clinical application to aid in endodontic treatment success.

Material and methods

This study was submitted and approved by the Institutional Review Board under protocol no. 103.958.

Fifty-four extracted teeth (9 for pilot study and 45 for study analysis) were selected. Inclusion criteria for data collection were: single-rooted human teeth, with one root canal, complete rhizogenesis, without previous endodontic treatment and/or calcifications, and without curvatures. These criteria were verified by conventional radiographic examination, at buccolingual and mesial-distal directions, using com 3x4 cm Ultra-speed Kodak film (Kodak®, Nova York, USA) during sample selection.

Firstly, the teeth were cleaned by toothbrushing and running water and kept into 0.2% thymol solution. At the moment of the use, the teeth were washed in running water and immersed in water for 24 hours to eliminate all thymol traces. Next, tooth crowns were sectioned at cervical level with the aid of no. 3228 bur (KGS, Barueri, SP, Brazil) at high speed, with water spray cooling, followed by size 1 to 3 Gattes Glidden burs (Dentsply Maillefer, Ballaigues, Switzerland), to enlarge the cervical access, and root canal access was complemented with the aid of 20:4 Laxxes bur (Dentsply Maillefer, Ballaigues, Switzerland).

Root canals were copiously irrigated with 2.5% sodium hypochlorite (NaOCl) with the aid of disposable plastic syringe (UltradentProducts Inc., South Jordan, Utah, USA) and NaviTip needle (UltradentProducts Inc., South Jordan, Utah, USA). Prior to odontometry, root canals were negotiated with the aid of size #10 K file (Dentsply Maillefer, Ballaigues, Switzerland) to determine apical patency.

Odontometry was achieved by determining the root length through leveling a size #15 K file with the apical foramen (Dentsply Maillefer, Ballaigues, Switzerland). From this measurement, 1 mm was subtracted resulting in real working length (RWL). Next, apical foramen was standardized by instrumenting root canal at that limit with the aid of size #15 K file (Dentsply Maillefer, Ballaigues, Switzerland).

Root canals were submitted to biomechanical preparation with Hero 642 system in the following instrument order: 20/.02; 25/.02; 25:04; 30/.02; 35/.02; 30:06; 40/.02; 45/02, (memory instrument); driven by rotary motor (X-Smart Dentsply – USA) at 350 rpm speed and 2.8 N torque. All instruments were used at RWL, with irrigation/aspiration at every instrument change.

After instrumentation, a size #15 K file was again introduced up to apical foramen level to

confirm the clearing and cleaning. 2.5% sodium hypochlorite was used as instrumentation adjuvant. After root canal shaping, root canals were irrigated with 17% EDTA pH 7.5 (Extratus Farmácia, Passo Fundo, RS, Brazil) followed by the last NaOCl irrigation. Prior to obturation, root canals were dried through aspiration and absorbent paper points (Dentsply Maillefer, Ballaigues, Switzerland) of size matching the memory instrument and according to RWL. Then, main gutta-percha cone (Dentsply Maillefer, Ballaigues, Switzerland) was selected according to the memory instrument and by verifying its lock at RWL. All cones were disinfected with 2.5% NaOCl and dried with the aid of sterilized gauze to verify their adaptation.

Next, the teeth were filled according to the techniques of this present study: G1 – Tagger's hybrid technique; G2 – McSpadden's technique; and G3 lateral condensation.

Group 1 – Tagger's hybrid technique: After selecting the main cone (Dentsply Maillefer, Ballaigues, Switzerland), it was placed into position with the endodontic cement (Endofill, Dentsply Maillefer, Ballaigues, Switzerland), according to the manufacturer's instruction. Then, two accessory points were placed (Dentsply Maillefer, Ballaigues, Switzerland) according to the volume of gutta-percha required to fill the root canal completely, together with the apical third compaction with the aid of an obturator (Dentsply Maillefer, Ballaigues, Switzerland). The gutta-percha McSpadden compactor (Dentsply Maillefer, Ballaigues, Switzerland) was selected one or two sizes above that of the main cone. The penetration depth of the compactor inside root canal was 2 mm short of RWL, at 8,000 to 12.000 rpm speed. After the compactor removal, gutta-percha was vertically compacted with the aid of Paiva's condenser (SS White Duflex, Pensilvânia, USA) to obtain a better adaptation to dentinal walls followed by the cleaning of cement remnants with cotton pellet and alcohol (Extratus Pharmacy, Passo Fundo, RS, Brazil).

Group 2 – McSpadden's technique: After selecting the main cone (Dentsply Maillefer, Ballaigues, Switzerland), this was placed into position with endodontic cement (Endofill, Dentsply Maillefer, Ballaigues, Switzerland), according the manufacturer's instruction. The compactor was selected as that of Group 1, placed without pressure with instrument inserted 2 mm short of RWL inside root canals, at 8.000 to 12,000 rpm speed, placed beside the gutta-percha cone. The heat resulting from friction plasticized gutta-percha which concurrently was compacted inside the canal. Vertical condensation was performed according to the group 1 with Paiva's condenser (SS White Duflex, Pensilvânia, USA), and cement remnants was cleaned with the aid of cotton pellet and alcohol (Extratus Farmácia, Passo Fundo, RS, Brazil).

Group 3 – lateral condensation: After selecting the main cone (Dentsply Maillefer, Ballaigues, Switzerland), this was placed into position with endodontic cement (Endofill, Dentsply Maillefer, Ballaigues, Switzerland), according the manufacturer's instructions. Next, an accessory point (Dentsply Maillefer, Ballaigues, Switzerland) was placed and lateral condensation at apical third was accomplished with the aid of an obturator (DentsplyMaillefer, Ballaigues, Switzerland), according to the gutta-percha volume required to fill root canal completely verified when the obturator did not enter more than 5 mm. Gutta-percha was vertically condensed with the aid of Paiva's condenser (SS White Duflex, Pensilvânia, USA) to obtain its better adaptation to the dentinal walls and the cement remnants were cleaned with the aid of cotton pellet and alcohol (Extratus Farmácia, Passo Fundo, RS, Brazil).

Digital radiograph was executed with Spectro II device (Dabi Atlante, Ribeirão Preto, SP, Brazil), at 70 KW, with exposure time of 0.12 second and focus-film film distance of 5 cm. After the exposure, the sensitized plates were read by the scanner of the digital system and the images were exhibited by the software inside Suarez system (São Paulo, SP, Brazil). Following, digital images were exported to digital media, saved as BMP format, and properly identified as figures 1 and 2.

The previously calibrated examiner visually detected the presence of empty spaces at the three root thirds of the filled canals.

Data were recorded in specific sheets, containing a space to record the items "presence" or "absence" of empty spaces at the different radiographic incidences at the respective root canal thirds.

The following scores were established:

- 0: no space at the analyzed third;
- 1: 1 space at the analyzed third;
- 2: 2 spaces at the analyzed third;
- 3: 3 spaces at the analyzed third, and so on.

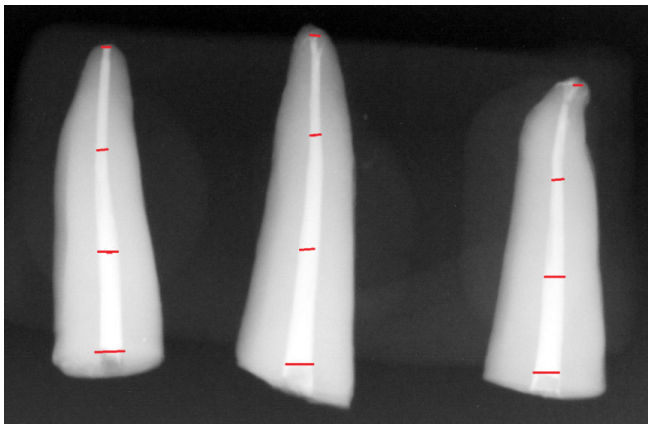

Figure 1 – Digital radiograph divided by thirds at buccolingual direction

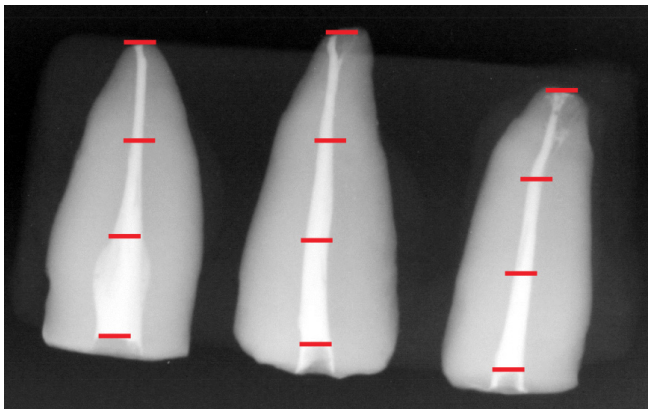

Figure 2 – Digital radiograph divided by thirds at mesial-distal direction

Statistical analysis was performed by Kruskal-Wallis test through SPSS version 15.0 software.

Results

Firstly, the amount of empty spaces in relation to the filling technique was verified. Three thirds were evaluated in each one of the 15 specimens from each group, totalizing 45 assessments per surface, thus, obtaining the mean of spaces found at each root third evaluate.

Table I – Mean and standard deviation values of the thirds evaluated by digital radiograph at MD and BL directions

Evaluated thirds	n	Mean	Standard deviation
M/D Apical	45	0.78	0.420
M/D medium	45	0.49	0.506
M/D Cervical	45	0.38	0.490
B/L Apical	45	0.49	0.506
B/L medium	45	0.24	0.435
B/L medium	45	0.18	0.387

Visually, few empty spaces were detected at the three root thirds filled by different techniques. However, the statistically analysis through Kruskal-Wallis test did not find differences among the studied groups ($p > 0.05$), neither among the different thirds nor between the radiographic incidences evaluated (table II).

Table II – Comparison among thirds and between radiographic incidences through Kruskal-Wallis test

	M/D apical	M/D Medium	M/D Cervical	B/L Apical	B/L Medium	B/L Cervical
Chi-square	3.269	2.261	0.739	5.391	3.059	3.865
Standard deviation	2	2	2	2	2	2
Significance	0.195	0.323	0.691	0.067	0.217	0.145

Although lateral condensation exhibited more empty spaces at medium third, this difference is not statistically relevant.

Table III – Number of empty spaces according to the technique, thirds and directions studied

Techniques	n	Cervical third		Medium third		Apical third	
		MD	VL	MD	VL	MD	VL
Tagger's hybrid (G1)	15	5	5	5	3	11	5
McSpadden (G2)	15	7	1	8	2	10	6
Lateral condensation (G3)	15	5	2	9	6	14	11

It is important highlighting that the radiographic images of this study were assessed by a single examiner, but at two times with one-week interval between them.

Discussion

Root canal obturation is the filling of root canal by physical and biological compatible materials, aiming to promote the most hermetically sealing as possible [14].

The final goal of Endodontics is the complete obturation of root canals. The studies revealed that one of the endodontic failures is the incomplete closure of root canal space. It has been determined inappropriate filling of root canal system accounts for a significant percentage of failures [8].

Taking into consideration that the main factor in root canal obturation is filling material adaptation to canal walls, to search the most hermetic sealing as possible and prevent bacterial proliferation, many studies have attempted to determine the most effective obturation technique [5].

Many gutta-percha obturation techniques have been used to close root canal system. Gutta-percha lateral condensation and several thermoplasticized gutta-percha techniques have been the most commonly used. Different studies search to evaluate the behavior of the filling material inside the canal.

Fracassi *et al.* [7] evaluated the filling techniques employing Thermafil, lateral condensation, and Tagger's hybrid technique, through three radiographic assessments: conventional, digitized with mesial-distal and buccolingual projections. The results showed that in most of the evaluations, Tagger's hybrid technique presented the smaller number of empty spaces, followed by Thermafil and lateral condensation, respectively. It was observed a greater number of endodontic filling failures detected in digital images. By evaluating the detection of the empty spaces, in relation to the radiographic projection, there was no statistically significant difference between buccolingual and mesial-distal projections, which was similar to the results of this present study.

Some authors agree that filling techniques employing heat for thermoplasticization of filling material resulted in better adaptation to dentinal walls and promoted better sealing of all root canal sealing, which did not influence on the results of this present study [1, 2, 6].

A study conducted by Martins *et al.* [11] evaluated the endodontic quality of the root canal system by three different techniques: conventional lateral condensation, Tagger's hybrid and Thermafil, through computed microtomography. All techniques showed empty spaces, and Thermafil accounted for the greater volume recorded. Conventional lateral condensation technique presented the best results among the techniques.

Ferraz *et al.* [4] assessed the quality of root canal filling through measuring the grey level means of the filled canals on the digitized radiographic images. The authors found that there were no statistically significant differences between lateral condensation technique and modified Tagger's hybrid, which corroborates the findings of this present study.

Marciano *et al.* [10] conducted a study aiming to determine the percentage of empty spaces by four different techniques: lateral condensation, Tagger's hybrid, MicroSeal and GuttaFlow. The

images were obtained by digital radiograph. The statistical analysis was verified by Kruskal-Wallis test ($\alpha = 0.05$). Concerning to the presence of empty spaces, there were no statistically significant differences among the techniques ($p > 0.05$), which was similar to this present study.

A study conducted by Monteiro *et al.* [12] suggested that the obturation through Tagger's hybrid technique (thermoplasticized) was more effective than passive condensation technique and none employed techniques prevented apical leakage.

Several studies already compared the performance of obturation techniques at different aspects, but with different results. Some demonstrated satisfactory results of lateral condensation technique and some did not exhibited differences among the techniques. Thus, little evidence supports one technique over another, considering the advantages and disadvantages of each one [7].

Conclusion

Based on the methodology employed and the results obtained, it can be concluded that:

• through the images obtained by digital radiograph, the three filling techniques exhibited a similar behavior in relation to root canal sealing;

• visually, few empty spaces were detected at the three root thirds by the different techniques;

• the evaluated technique did not demonstrate statistically significant differences in the digital analysis at mesial-distal and buccolingual directions at the different thirds evaluated.

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Original Research Article

Analysis of active chlorine releasing and pH of sodium hypochlorite solutions used in Endodontics

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Endodontics; sodium hypochlorite; pH; irrigation solutions.

Abstract

Introduction: The use of a suitable irrigation solution and a correct root system shape effectively contributes to the success of endodontic treatment. Among the irrigating solutions used in Endodontics, sodium hypochlorite has been the most used because of many qualities. However, this substance must have chemical stability of its properties, by maintaining the potential of hydrogen (pH) and chlorine concentrations appropriately. **Objective:** The aim of this study was to evaluate active chlorine releasing and pH of some sodium hypochlorite solutions used in endodontic clinical practice. **Material and methods:** The solutions tested in this study were 0.5% Dakin, 1% Milton, 2% Chlorinated Soda, and household bleaches (Brilux® and Qboa®), which were opened at the same period and first used, with the same storage modus but with different manufacturing dates. The pH was measured with a digital device, and the active chlorine content was obtained through iodometric titration. **Results:** All solutions presented chlorine content not smaller than that informed in the flasks, ranging from 1% to 2.4%; pH was higher in all solutions, between 9 and 13. **Conclusion:** Based on the method

applied and the results obtained, it was possible to conclude that sodium hypochlorite solutions used specifically in Dentistry (Dakin and Milton solutions and Chlorinated Soda), showed on the labels the hypochlorite content. On the other hand, household bleaches (Brilux® and Qboa®) showed the chlorine content. It was not possible to compare pH authenticity, due to lack of description on the label.

Introduction

Endodontic treatment success is directly related to the comprehensive respect to its different phases: biomechanical preparation, disinfection and root canal filling [12].

Sodium hypochlorite solution has been employed as adjuvant chemical substance in chemo-mechanical preparation of root canals worldwide [10].

The excellent properties of this irrigant accounts for its good acceptance, such as: dissolution of organic tissues, antimicrobial, alkaline pH, bleaching, deodorant, and low surface tension [13].

Siqueira Jr. *et al.* [20] also affirmed that sodium hypochlorite is the solution most used for chemo-mechanical preparation mainly because its activity of organic matter dissolution.

Estrela *et al.* [9] and Ludwing *et al.* [11] cited some of the most important chemical properties of sodium hypochlorite: antimicrobial action, capacity of dissolving organic tissue and saponification. Such properties account for the greatest acceptance as irrigant. Many solutions are available with this same goal, such as EDTA and Endo-PTC. Some studies have demonstrated that such solutions are associated with sodium hypochlorite to obtain better results of antimicrobial action by improving the chemical properties of sodium hypochlorite [1, 5, 6, 8, 14, 15, 17-19].

Pécora and Estrela [16] justifies that the interaction between the physicochemical factors (antimicrobial action of an adjuvant irrigant solution) and the mechanical factors involved in the root canal shaping intensifies the sanitizing process, making their use indispensable.

Sodium hypochlorite at low concentrations can be ineffective against some microorganisms. For example, the best results against *Enterococcus faecalis* were obtained at 5.25% concentration in comparison with lower concentrations [2].

If some sodium hypochlorite properties are altered, such as the active chlorine content and hydrogen potential (pH), the abnormal parameters may contribute for endodontic treatment failures considering that proper solution storage avoids the chemical variations [3].

Root canal shaping is faster because of the use of new technologies, such as rotary instrumentation. Thus, the use of irrigants of stronger action (sodium hypochlorite at higher concentration) is justified because of the shorter chair time [15].

Among all endodontic irrigants, sodium hypochlorite is the most used because of its powerful antimicrobial action, capacity of dissolving organic matter, lubricant, and low cost [17].

The active chlorine content may vary according to the irrigant use necessity. No consensus on the ideal sodium hypochlorite concentration in Endodontics has been achieved because although high concentrations account for periapical tissue irritation, they are required against larger bacterial infiltrate (antimicrobial action); while low concentrations show better biocompatibility consequently with low periapical tissue irritation and effectiveness against lower bacterial infiltrate [5].

Aiming to analyze whether the sodium hypochlorite solutions used in clinical practice have desirable quality for Endodontics, studies have been conducted to assess pH alkalinity and stability throughout the usage period, which is an indispensable property to maintain the stability of sodium hypochlorite solutions.

Thus, it is necessary to evaluate the active chlorine content and pH of sodium hypochlorite solutions most used in endodontic clinics aiming to obtain the best performance of these irrigants within root canal system.

Material and methods

Preparation of solutions

Because potassium iodate is a primary standard, it was used to standardize sodium thiosulfate solution. For this purpose, a mass of 12461 g of potassium iodate was measured, diluted into distilled water, and this mixture was transferred into a volumetric flask of 250 mL, completed up to the measurement mark.

Sodium thiosulfate solution was prepared by weighing approximately 24.8 g of sodium thiosulfate to achieve one liter of the solution, whose desirable concentration was of 1.0 mol/L.

All procedures were made in triplicate, which is the minimum acceptable for showing an analytical result.

Procedure steps

Standardization of sodium thiosulfate solution ($Na_2S_2O_3$) 0.1 mol/L

Inside an Erlenmeyer flask, an aliquot of 25 mL of potassium iodate (KIO_3) 0.02 mol/L was added to 10 mL of 10% potassium iodide (KI) m/v. Following, this mixture was acidified with 3 mL of sulfuric acid (H_2SO_4), moment at which the solution showed a brown color. The mixture was titrated with sodium thiosulfate solution up to reach a pale yellow color. Next, 3 mL of 3% m/v starch solution, with an intense blue color, was added; titration was continued up to obtain a colorless solution. The volumes were recorded and the concentration of the sodium thiosulfate was determined. This method was based on the procedures described by Vogel [22].

$$IO_3^- + 5I^- + 6H^+ \rightleftharpoons 3I_2 + 2H_2O \quad \text{(eq. 1)}$$

The acid stoichiometry is the same of the acid.

$$6\ M_{iodate} \times V_{iodate} = M_{thiosulfate} \times V_{thiosulfate}$$

in which:

M_{iodate}: potassium iodate molarity, which corresponding to 0.02329 mol/L;

V_{iodate}: potassium iodate volume added to the mixture, which corresponding to 25 mL;

$M_{thiosulfate}$: thiosulfate concentration that is being determined, in mol/L;

$V_{thiosulfate}$: sodium thiosulfate volume used in titration.

Table I – Standardization of the sodium thiosulfate solution ($Na_2S_2O_3$) 0.1 mol/L

$V_{thiosulfate}$ (mL)	$M_{thiosulfate}$ (mol/L)
30.22	0.1156
30.22	0.1156
30.25	0.1155
Average: $M_{thiosulfate}$ (mol/L) = 0.1156 mol/L	

The addition of excessive potassium iodide was necessary to avoid iodine (I_2) volatilization formed during titration process. The addition of sulfuric acid was executed to increase the potential of reduction of iodine-iodide system, and the iodine amount released during the titration process was equivalent to the solution acidity.

The reaction of chlorine with sodium hydroxide base is necessary to obtain sodium hypochlorite, according to equation no. 2.

$$2\ NaOH + Cl_2 \rightleftharpoons NaOCl + NaCl + H_2O \quad \text{(eq. 2)}$$

According to the stoichiometry, it was possible to deduce that:

$$\frac{Cl_2}{NaClO} = \frac{71}{74,5} \quad \text{(eq. 3)}$$

$$\frac{Cl_2}{NaClO} = 0,953 \quad \text{(eq. 4)}$$

Meaning that:

% sodium hypochlorite x 0.953 = % active chlorine (eq. 5)

The determination of the sodium hypochlorite content in the commercial solutions was based on the procedures described by Vogel [22], with modifications.

Procedure

Inside a 250 mL Erlenmeyer flask, it was added 5 mL of the sample, 25 mL of distilled

water, 2 mL of 10% m/v potassium iodide and 3 mL of glacial acetic acid. This mixture was titrated with standardized sodium thiosulfate up to obtain a pale yellow color. Next, 3 mL of 3% m/v starch solution showing an intense blue color was added; continuing the titration up to reach a colorless mixture. The volumes were recorded and the sodium hypochlorite concentrations of the commercial solutions were determined.

Inside the Erlenmeyer flask containing the samples, the following reactions occurred:

$$OCl^- + 2\ I^- + 2H^+ \rightleftharpoons Cl^- + I_2 + 2H_2O \quad \text{(eq. 6)}$$

$$I_2 + S_2O_3^{2-} \rightleftharpoons 2I^- + S_4O_6^{2-} \quad \text{(eq. 7)}$$

Meaning that:

$$\frac{2\ m_{hypochlorite}}{MM_{hypochlorite}} = M_{thiosulfate} \times V_{thiosulfate} \quad \text{(eq. 8)}$$

in which:

$M_{hypochlorite}$: sodium hypochlorite mass in the aliquot (g);

$MM_{hypochlorite}$: sodium hypochlorite molar mass, which corresponding to 74.5 g;

$Mh_{tiosulfate}$: sodium thiosulfate molarity, which corresponding to 0.1156 mol/L;

$V_{thiosulfate}$: thiosulfate volume used to titrate each sample (L).

After finding the sodium hypochlorite mass corresponding to 5 mL in the sample aliquot, a rule of three was carried out to determine the sodium hypochlorite concentration (percentage). Following, this value was replaced in equation no. 5 and the active chlorine content was determined.

$M_{hypochlorite}$ 5
x 100
x ⇨ correspond to the hypochlorite content in the sample

Results

All analyses were made in triplicate. In samples #1, #2 and #3 the labels exhibited the hypochlorite content, while in samples #4 and #5 the labels did not show the chlorine content. Accordingly, the following tables present the sample data in which either the sodium hypochlorite or chlorine concentrations were determined. When the chlorine content was specified on the label, this information is shown in the tables.

Table II – Result of hypochlorite and chlorine contents of sample 1

Sample 1: Dakin solution / ASFER		
Information: Hypochlorite content = 0.5% (label) Chlorine content = 0.5% Manuf.: Jan/13 Expiration date: 12 months Batch: 125		
$V_{thiosulfate}$ (mL)	Hypochlorite content (%)	Chlorine content (%)
V_1 = 15.50	$\%_1$ = 1.3348	$\%_1$ = 1.2701
V_2 = 15.49	$\%_2$ = 1.3340	$\%_2$ = 1.2713
V_3 = 15.50	$\%_3$ = 1.3348	$\%_3$ = 1.2701
-	$\%_{mean}$ = 1.3345	$\%_{mean}$ =1.2705

Figure 1 – Sample 1 Dakin solution / ASFER

Table III – Result of hypochlorite and chlorine contents of sample 2

Sample 2: Milton solution/ ASFER		
Information: Hypochlorite content: 1.0% (label) Chlorine content = 0.953% Manuf.: Jan/13 Expiration date: 12 months Batch: 98		
$V_{thiosulfate}$ (mL)	Hypochlorite content (%)	Chlorine content (%)
V_1 = 12.72	$\%_1$ = 1.0954	$\%_1$ = 1.0439
V_2 = 12.78	$\%_2$ = 1.1006	$\%_2$ = 1.0489
V_3 = 12.76	$\%_3$ = 1.0990	$\%_3$ = 1.0473
-	$\%_{mean}$ = 1.0983	$\%_{mean}$ = 1.0467

Figure 2 – Sample 2 Milton solution / ASFER

Table IV – Result of hypochlorite and chlorine contents of sample 3

Sample 3: Chlorinated soda / ASFER		
Information: Hypochlorite content: 2.5% (label) Chlorine content = 2.4% Manuf.: Out/12 Expiration date: 12 months Batch: 4338		
$V_{thiosulfate}$ (mL)	Hypochlorite content (%)	Chlorine content (%)
V_1 = 30.15	$\%_1$ = 2.5966	$\%_1$ = 2.4746
V_2 = 30.17	$\%_2$ = 2.5984	$\%_2$ = 2.4763
V_3 = 30.16	$\%_3$ = 2.5974	$\%_3$ = 2.4753
-	$\%_{mean}$ = 2.5975	$\%_{mean}$ = 2.4754

Figure 3 – Sample 3 Chlorinated soda / ASFER

Table V – Result of hypochlorite and chlorine contents of sample 4

Sample 4: Household bleach Brilux®		
Information: Hypochlorite content: 2.1-2.6% Chlorine content = 2.0-2.5% (label) Manuf.: 11/3/13 Expiration date: 11/9/13 Batch: 092[a]		
$V_{thiosulfate}$ (mL)	Hypochlorite content (%)	Chlorine content (%)
V_1 = 29.00	$\%_1$ = 2.4976	$\%_1$ = 2.3802
V_2 = 29.90	$\%_2$ = 2.5750	$\%_2$ = 2.4539
V_3 = 30.00	$\%_3$ = 2.5836	$\%_3$ = 2.4622
-	$\%_{mean}$ = 2.5521	$\%_{mean}$ = 2.4321

Figure 4 – Sample 4 Household bleach Brilux®

Table VI – Result of hypochlorite and chlorine contents of sample 5

Sample 5: Household bleach Qboa®

Information:
Hypochlorite content: 2.1-2.6%
Chlorine content = 2.0-2.5% (label)

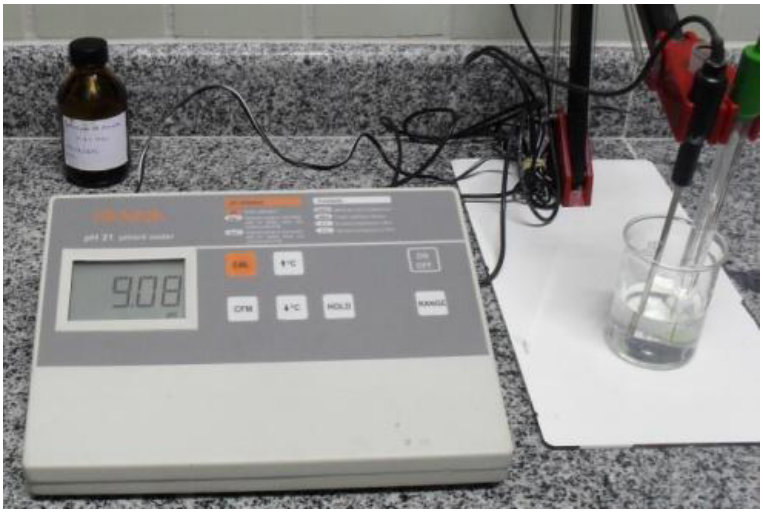
Manuf.: 15/2/13
Expiration date: 14/8/13
Batch: 106

$V_{thiosulfate}$ (mL)	Hypochlorite content (%)	Chlorine content (%)
V_1 = 30.00	$\%_1$ = 2.5836	$\%_1$ = 2.4622
V_2 = 29.60	$\%_2$ = 2.5492	$\%_2$ = 2.4294
V_3 = 30.00	$\%_3$ = 2.5836	$\%_3$ = 2.4622
-	$\%_{mean}$ = 2.5721	$\%_{mean}$ = 2.4513

Figure 5 – Sample 5 Household bleach QBoa®

Also, pH of the samples was measured, but because of lack of label information by the manufacturer, it was not possible to verify its authenticity. Table VII provides the data.

Table VII – Result of pH measurement of the samples



Sample	pH
Sample 1	9.08
Sample 2	12.13
Sample 3	12.45
Sample 4	13.10
Sample 5	13.09

Figure 6 – pH meter measuring sample 1

Discussion

Among the main requirements of endodontic treatment success, the complete elimination of all debris from root canal system during shaping is mandatory. The mechanical action performed by the instruments occurs only in the main canal lumen, not reaching the root canal system. Considering all this morphological complexity, the irrigant is chemically essential. According to Borin *et al.* [3], the irrigant action promoted the hydraulic circulation within root canal, acting on the organic matter and promoting tissue dissolution. Accordingly, the irrigant removes the dentine debris from the instrument cut, making possible the disinfection and cleaning of all root canal system.

Facing all endodontic irrigants available in Brazilian dental market, the dentist should choose a solution presenting satisfactory properties to obtain endodontic treatment success. It is important that the irrigant features continues unaltered during all storage time, so that caution is required to maintain the stability of each substance [6].

Sodium hypochlorite is found in Brazilian dental stores, compounding pharmacies, and even supermarkets. In some cases, the dentist only has access to the latter, and uses household bleach to replace easily a dental sodium hypochlorite. Thus, this study aimed to verify the chlorine content existing in solutions found in supermarkets.

The Brazilian warm weather and the characteristics of distribution and storage of dental products in the commercial places may result in problems during the use of sodium hypochlorite with active chlorine content smaller than that required. This occurs because of the instability of the solutions, which can be aggravated by warm, storage time, and even the use of inappropriate flasks.

Clarkson *et al.* [7] reinforced the need of storing sodium hypochlorite inside closed opaque flasks because the constant opening of these flasks may cause loss of chlorine concentration diluted within the solutions, leading to faster pH decrease.

The manufacturing negligence (use of improper water, inadequate storage) may also lead to the decrease of free chlorine content, resulting in the early decomposition of the product, and consequently, in the loss of antimicrobial power [21].

The iodometry was the method employed to analyze chemically and verify the active chlorine content, because it has been very used in literature. Iodometry may be very used because it is a totally manual and colorimetric technique, in which many dilutions are required to reach the titration itself. However, it is a sensible technique, and during the execution, a drop added or subtracted can result in difference in the final result.

Conclusion

Considering the methodology and the obtained results, it can be concluded that:
1. the sodium hypochlorite solutions specifically used in Dentistry (Dakin and Milton solutions and chlorinated soda) exhibited the hypochlorite content on the label, while the household bleaches (Brilux® and Qboa®) exhibited the chlorine content information on the label;
2. Milton solution and chlorinated soda showed the hypochlorite content similar to that specified on the label;
3. the household bleaches (Brilux® and Qboa®) showed the chlorine content similar to that specified on the label;
4. Dakin solution was the only irrigant showing a significant increase of hypochlorite content of 1.33%;
5. all solutions showed a high pH from 9.08 to 13.09; however, it was not possible to compare pH authenticity due to lack of information on the label.

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Original Research Article

Profile of temporomandibular disorder patients submitted to dental and physiotherapeutic treatment at a private clinic

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temporomandibular joint disorders; etiology; physiotherapy.

Abstract

Introduction: Temporomandibular disorder (TMD) is the term used in Dentistry to define the structural and disorder changes affect the physiology of the masticatory system composed of TMJ and related to musculoskeletal structures. **Objective:** To conduct a descriptive, transversal and documentary study aiming to determine the profile of 14 TMD patients undergoing simultaneous dental and physiotherapeutic treatment at a private practice of the city of Fortaleza-Ce. **Material and methods:** The following instruments for the collection of the data were employed: files registering the evaluation and evolution, findings of the radiographic examinations and forms. Data were statistically analyzed through SPSS software, version 10.0. **Results:** Most of the sample was composed by females aged 32 years (+/-10.60) in average, mainly complaining about chronic headache, masticatory myalgia , TMJ pain, cervicalgy, otalgia, among others. The complete sample presented, at least, one

pathology associated to and/or concomitant to TMD. The radiographic findings showed TMJ alterations and tooth losses. Analgesics were the most used drugs. **Conclusion:** TMD is a complex syndrome, with many etiologies and symptoms, aggravating and perpetuating factors, requiring multiple and even more specialized therapeutic management attempting treatment success.

Introduction

Temporomandibular joint (TMJ) comprises the stomatognathic system and has been classified as bilateral, interdependent, synovial, and thus enables simultaneous large mandibular around temporal bone, a fixed bone [8].

Temporomandibular disorder (TMD) is the term in Dentistry used to define structural alteration and disorders affecting masticatory system physiology, composed by TMJ and related muscle-skeletal structures [10].

TMD etiology is considered as multifactorial, that is, generally caused by the relationship among the neuromuscular, occlusal and physiopathological factors of TMJs. Infectious and inflammatory diseases, hormonal and vitamin deficiencies may affect TMJ physiology. Also, TMD may be related to the increasing of patient's emotional stress level that may induce the increasing of muscular tonus, frequently associated with the presence of parafunctional habits, such tooth clenching, resulting in fatigue and spasm producing pain and dysfunction [8, 9, 10].

Among TMD characteristics signs and symptoms, articular noises and crepitus, tinnitus, headaches, mandibular movement limitations or deviations, myalgias, ear pain, sensitivity to palpation, stomatognathic system pains, and in mostly severe cases luxations are seen [8, 12, 14].

Mainly pain can negatively influences on the patients' social activities thus affecting the emotional health. Accordingly, TMD etiology and symptomatology should be verified during anamnesis and require a multidisciplinary team, involving dentists, neurologists, orthopedists, otolaryngologists, physiotherapists, speech and hearing therapists, among others [1].

The aim of this study was to verify the profile of TMD patients simultaneously submitted to dental and physiotherapeutic treatment at a private practice in the city of Fortaleza (CE/Brazil).

The knowledge of TMD patients would guide Physiotherapists towards indicating therapeutic strategies considering not only the symptomatology but also the pathologic factors seen on radiographic examinations, which would greatly contribute to patient's satisfaction and conversation among the multidisciplinary team involved in the treatment of this pathology searching for more therapeutic effectiveness.

Material and methods

A descriptive, cross sectional, documentary, quantitative study was conducted. Study data were collected from TMD patients. The study sample was treated through a therapeutic approach including Dentistry and Physiotherapy simultaneously at a private practice in the city of Fortaleza (CE/Brazil). The private office team was composed of six dentists and one physiotherapist offering services of esthetic dentistry, orthodontics, TMD treatment with the association with physiotherapy.

Also, the type of drugs used by patients during TMD treatment was also researched. Moreover, we attempted to find on radiographic examinations the presence of previous and/or concomitant pathologies.

Inclusion criteria comprised both genders; presence of TMD; simultaneous dental and physiotherapeutic treatment, with at least five dental and five physiotherapeutic appointments; files of patients composed of the evolution progress and radiographic examinations. Exclusion criteria were composed by execution of just one treatment type, either dental or physiotherapeutic. Fourteen patients met the inclusion and exclusion criteria.

Data collection was obtained through analyzing the physiotherapeutic evaluation progress and radiographic examinations of the patients (panoramic radiographs and TMJ radiographs), followed by registering the data on specific charts. Statistical analysis was performed with SPSS software version 10.0.

This study followed the ethical aspects stated by the Resolution 196/96 of Brazilian Council of Health. Firstly, the main examiner signed a term to assure that all data would be only used for scientific purposes. All office's owners signed a consent form authorizing the data collection for the study.

Results and discussion

All 14 patients were diagnosed with TMD. Table I shows patients' characterizes.

Table I – Profile of TMD patients of the sample – Fortaleza (CE/Brazil)

Gender	**Absolute frequency (AF)**	**Relative frequency (RF)**
Female	12	85.7
Male	2	14.3
Profession	**AF**	**RF %**
Trader	2	14.2
Housewife	3	21.4
Student	4	28.5
Professor	3	21.4
Receptionist	1	7.1
Sales representative	1	7.1
Main complaint	**AF**	**RF %**
Headache	3	21.4
Cervicalgy	1	7.1
TMJ pain	2	14.3
TMJ click	2	14.3
Myalgia	1	7.1
Masticatory myalgia	3	21.4
Otalgia	1	7.1
Tinnitus	1	7.1

In this present study, most of patients searching treatment were females aged from 13 to 49 years (mean age of 32 years). Studies have pointed out that most TMD cases affect women at age range of 20-50 years, because women exhibits a greater TMJ ligament flexibility than men, resulting in more fragile articular disk, more vulnerable to damage [5, 6].

By analyzing patient's profession, no statistically significant differences were found by Chi-square test. Conversely, some studies have reported that some activities may increase emotional stress requiring greater physical and mental effort.

Patient's main complaint is an important parameter because allowed individualized care. Most of the main complaints in this present study were headache (21.4%) and masticatory myalgia (21.4%), followed by TMJ pain (14.3%) and TMJ clicking (14.3%). Other main complaints were cervicalgy, otalgia and tinnitus.

Studies on the detection of TMDs' signs and symptoms have found: pain and sensitiveness on masticatory muscles; TMJ pain and noises; and mandibular limitations of or disturbs [6, 7].

By comprehensively analyzing all symptomatology showed in this presented study (table II), masticatory myalgia and TMJ pain were presented in all patients; also, 92.9% of the sample had headaches.

Most of patients exhibited cervicalgy (78.6%) and some individuals showed limitation in the amplitude of cervical spine movements (57.1%), and articular and muscular pain in shoulder (14.3%). If these aforementioned areas presented muscular-skeletal imbalance, either spasms or disc displacement would be generated in the mandible, result in pain that can reach up to the cervical spine, shoulders and head. Postural dysfunction may alter other body's structures which may affect TMJ structure and functionality [6].

TMJ noises were described as crepitus and (14.3%) and clicking (64.3%). Patients exhibiting TMJ clicking had deviation of mandibular movements (64.3%). Of these, most had TMJ radiographic examinations showing symmetric mandibular condyles and articular tubercle. Chi-square test did not find statistically significant differences in the association main complaints with the radiographic findings.

Mandibular movement disturbs were limitation or hypomobility (57.1%) and hypermobility (28.8%). Articular dysfunctions may occur together with either hypermobility, that is, when the mandibular condyle surpass the articular tubercle during mandibular movements; or hypomobility, that is caused by limited mandibular opening or closure; or still with condyle asymmetry in which anterior disc displacement occurs resulting in clinical mandibular opening reduction towards the affected side [6, 11].

In 21.4% of the patients, sore throat was referred together with swallowing difficulty. These patients showed limitation of cervical spine movements with calcification and/or elongation of stylohyoid ligament in the radiographic examinations. According to the literature, these findings met the description of Eagle's syndrome, which is a symptomatic complex caused by stylohyoid ligament calcification resulting in frequent sore throat and earache. This can be easily seen on radiographs [13].

Signs and symptoms of ear injury were presented as hearing loss (14.3%); feeling of ear closure (28.6%); otalgia (42.9%); and tinnitus (42.9%). Many hearing symptoms may be present in TMD, including hearing impairment, tinnitus, otalgia and dizziness. Such symptoms may be related to the close anatomical and ontogenetic relationship between middle ear and masticatory structures [9].

Half of the patients showed tooth clinching (50%). The rationale behind this finding is that

some muscles have single characteristics from the context of muscular dysfunction. Both temporal and masseter muscles are closely related to headaches because of muscle contraction. This is a very common symptom in patients with muscle dysfunction, together with pain sites in the presence of parafunction due to tooth clinching. TMD is a disorder generally associated with stress, which induces the increasing of muscle tonus frequently associated with parafunctional habits, such as tooth clinching, resulting in fatigue and spasms, which result in pain and dysfunction [2, 12, 13].

In 14.3% of the patients, tooth sensitivity was altered. Of these, one patient (7.1%) also showed unilateral facial stabbing pain (piercing and burning), with duration of seconds. TMD patient may present severe, acute or pulsatile pain; pain with variable intensity in mandible or pre-auricular region; burning sensation on tongue and mouth; pain in face or cheek; muscle fatigue; neural piercing pain and frequent headaches. These different pain types may be related to both the receptors and tissues involved, suppressive and excitatory mechanisms of nervous system that can modulate pain perception [9].

In the analysis of the associated pathologies, TMD signs and symptoms can be verified.

Table II – Signs and symptoms present in the studied sample (14 patients) – Fortaleza (CE)

Signs and symptoms	Absolute frequency (AF)	Relative frequency (RF) %
Headache	13	92.9
Otalgia	6	42.9
TMJ pain	14	100
Masticatory myalgia	14	100
Cervicalgy	11	78.6
TMJ limitation	8	57.1
Cervical limitation	8	57.1
TMJ crepitus	2	14.3
TMJ clicking	9	64.3
Deviation	9	64.3
Sore throat	3	21.4
Shoulder pain	2	14.3
Hearing loss	2	14.3
Tinnitus	6	42.9
Ear closure	4	28.6
Tooth clinching	7	50
Facial pain	1	7.1
Oral sensitivity	2	14.3
TMJ hypermobility	4	28.6

TMD also have disturbs coming from a primary pathological condition of the structural and functional components of masticatory system. The harmony between structural and functional components is maintained at good health condition [4].

Direct and indirect traumas to TMJ, parafunctional habits, skeletal, oclusal, systemic/local alterations, and psychosocial questions can be associated, altering the functional balance of the stomatognathic system towards pathological dysfunction [10].

Most of patients had oclusal problems and tooth losses, mainly pre-molars and molars. TMD etiologies may comprise: oral and maxillofacial and cervical spine traumas; oclusal interferences (posterior and anterior tooth contacts) due to inappropriate restorations, which may interfere on normal function causing bruxism and tooth clinching, etc.; among others. Factors as malocclusion, loss of overbite due to weariness or tooth losses; hypoplasic mandible; and some systemic disturbs (allergy, osteoarthritis, hormonal disturbs, neuropathy, neoplasia, polyarthritis, among others) may affect TMJ [9, 11].

This present study detected that approximately 43% of the patient reported anxiety. This showed that emotional problems may lead to an excessive increasing of jaw's muscular activities, causing more problems on masseter, which can also be involved in malocclusions [15].

Studies on pain evolution have suggested that gradual development occurs with fluctuations over time, aggravated by mandibular movements and influenced by psychological factors associated to social-cultural level and the past pain experiences. Continue hypernociception may contribute to aggravate TMD because the patient becomes more depressive and sensible to psychological alterations [3, 15].

The pharmacological approach of TMDs comprises analgesics indicated alone or together with drugs to treat the signs and symptoms of the associated and/or concomitant pathologies. Generally, analgesics are prescribed but self-medication is not rare. Analgesics, anti-inflammatory drugs, muscle relaxant drugs, and other drugs to stabilize the pathological conditions have been largely employed. At initial TMD phase, patients respond well to analgesics and muscular relaxants. These latter act on muscles by relieving the fatigue and trismus and decreasing the tendency towards clinching because the muscles become less spastic. Some studies have suggested the use of amitriptyline (tricyclic antidepressant) because of action on general anxiety and sedative pharmacological properties [3, 4, 6].

Conclusion

It can be concluded that most of patients were female aged in average 32 years (+/- 10.60). The main complaints were: TMJ pain, masticatory myalgia, headache, cervicalgy, otalgia and alteration in mandibular movements. Most of radiographic examinations showed alterations in the condyle symmetry, shape and location at maximum opening. Also, most patients showed loss of pre-molars and molars. All patients reported during anamnesis at least one past or concomitant pathology which may possible influence on TMD.

Analgesics were largely employed because pain manifests differently and is the main TMD symptom. This present studies seem to reaffirm that TMD is a complex syndrome involving primary and secondary etiologies with perpetuating and aggravating factors, large symptomatology and compromising several structures. Accordingly, multidisciplinary treatment is required attempting treatment success.

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Original Research Article

Evaluation of postoperative pain in endodontically treated teeth

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Endodontics; post-operative pain; root canal therapy.

Abstract

Introduction: The success of endodontic treatment is directly related to the morphology domain and endodontic infection control. Some factors such as procedural errors (instrumentation, obturation apical deviations and perforations) can cause postoperative pain. **Objective:** This study aimed to evaluate postoperative pain in endodontically treated teeth at Dentistry Post-graduation Clinic of Meridional School (IMED/CEOM), Passo Fundo/Brazil from January 2010 to June 2013. **Material and methods:** The study was approved by the Institutional Review Board. After collection, data were analyzed regarding the occurrence of postoperative pain. This research is a quantitative cross-sectional study, whose sample comprised 302 medical records of patients undergoing endodontic treatment from a non-probability sampling. The review of follow-up appointment charts was carried out by the researcher. **Results:** During the research period and analysis of 302 medical records, 30.80% showed postoperative pain. However, 69.20 % did not feel any pain. **Conclusion:** It can be concluded that the pain was more frequent when associated with vital pulp, and these data are relevant to the dental clinic.

Introduction

The goal of endodontic treatment is to provide conditions so that periapical tissues normality can be reestablished. Such conditions occur through root canal cleaning and shaping that promotes disinfection maintenance. Thus, endodontic treatment is based on two fundamental principles: domain of tooth morphology and control of infection. Access to pulp chamber, main canals, dentinal tubules and ramifications accounts for controlling the infection through cleaning and disinfection of root canals [12].

Importantly, one should know the postoperative pain causes and whether postoperative pain may be involved with number of appointments, so that preventive measures would be adopted to reduce significantly the incidence of this highly disturbing, clinically undesirable phenomenon [10].

Moreover, other factors should be taken into consideration in choosing the treatment modality to be performed, such as: dentists' technical skills and clinical expertise; tooth conditions; morphologic and biological considerations; patient's postoperative period; and mainly proper cleaning and disinfection of root canal system [6].

Therefore, the aim of this study was to evaluate postoperative pain in teeth endodontically treated by students of the Course of Specialization in Endodontics at the Dentistry Post-graduation Clinics of the School of Dentistry of Meridional School (Imed/Ceom), Passo Fundo/Brazil, from January 2010 to June 2013.

Material and methods

Study design and sample size

This is a quantitative comparative study. This present study was submitted and approved by the Institutional Review Board (protocol no. 262.941, CAAE no. 08988612.4.0000.5319). Three hundred-two files of patients submitted to endodontic treatment by students of the Course of Specialization in Endodontics at the Dentistry Post-graduation Clinics of the School of Dentistry of Meridional School (Imed/Ceom), Passo Fundo/Brazil, from January 2010 to June 2013.

Procedures

All files of patients undergoing endodontic treatment who had a follow-up appointment from January 2010 to June 2013 were collected by a single examiner. The patients responded whether they had pain, and if positive, which had been the pain intensity. The study analyzed how many patients exhibited postoperative pain. Data collected were recorded in tables and analyzed regarding the number of patients reporting pain.

Results

The results are expressed in table I to VI.

Table I – Stratification of teeth endodontically treated and postoperative situation

Factors analyzed	Total n (%)
Symptomatic	93 (30.80)
Asymptomatic	209 (69.20)
Total	302 (100)

Of the 302 files collected during the study period, 93 (30.80%) presented information of symptomatic patients and 209 (69.20%) of asymptomatic patients.

Table II – Stratification of teeth endodontically treated and postoperative situation considering pulp condition – vital pulp

Pulp conditions	
Factors analyzed	**Vital pulp n (%)**
Symptomatic	47 (34.80)
Asymptomatic	88 (65.20)
Total	135 (100)

Considering the pulp condition, 135 endodontic treatments (ETs) were performed in vital pulp with 47 symptomatic patients (34.80%) and 88 (65.20%) asymptomatic patients.

Table III – Stratification of teeth endodontically treated and postoperative situation considering pulp condition – nonvital pulp

Pulp conditions	
Factors analyzed	**Vital pulp n (%)**
Symptomatic	46 (27.54)
Asymptomatic	121 (72.56)
Total	167 (100)

With regard to nonvital pulp, 167 ETs were carried out, of which 121 (72.56%) were asymptomatic and 46 (27.54%) symptomatic.

Table IV – Stratification of endodontically treated teeth exhibiting pain symptomatology and its intensity

Pain	Total n (%)
Tolerable	77 (82.80)
Intolerable	16 (17.20)
Total	93 (100)

Of the 93 cases exhibiting symptomatology (pain), 77 cases (82.80%) were tolerable and only 16 cases (17.20%) intolerable.

Table V – Stratification of endodontically treated teeth exhibiting pain symptomatology and its intensity related to vital pulp

Pain	Vital pulp n (%)
Tolerable	35 (74.47)
Intolerable	12 (25.53)
Total	47 (100)

Of the 47 cases of endodontic treatment carried out in vital pulp, 35 (74.47%) presented tolerable postoperative pain and 12 (25.53%) intolerable postoperative pain.

Table VI – Stratification of endodontically treated teeth exhibiting pain symptomatology and its intensity related to nonvital pulp

Pain	Nonvital pulp n (%)
Tolerable	42 (91.30)
Intolerable	4 (8.70)
Total	46 (100)

Of the 46 cases of endodontic treatment carried out in nonvital pulp, 42 (91.30%) showed tolerable postoperative pain and 4 (8.70%) intolerable postoperative pain.

Discussion

One of the problems when studying pain is the difficulty in evaluation because the threshold range, single and variable experience, pain modulation by many physical and psychological factors account for confusion both for patients and professional. Many techniques have been used to assess pain intensity in human beings and described in the literature, such as verbal, numerical, visual analog, colored analogue, and finger-reach rating scales; calibrated questionnaires; and cortical evoked potentials [5].

This present study aimed to assess postoperative pain in endodontically treated teeth. Three hundred-two files of patients followed-up after endodontic treatment were analyzed, and at that moment, the patients responded whether they had or had not suffered postoperative pain. If positive, a numerical rating scale ranging from 1 to 4 (tolerable) and from 5 to 9 (intolerable) was used.

Of the 302 files analyzed, 93 patients (30.80%) reported any type of postoperative pain and 209 (69.20%) reported they had not felt any pain.

Of the 93 patients felling pain, considering pulp condition, 47 of endodontic treatments (50.54%) were carried out in vital pulp and 46 (49.46%) in nonvital pulp.

With regard to pulp intensity, generally, 77 patients (82,80%) had suffered tolerable and 16 (17,20%) intolerable pain.

When relating pain intensity with pulp condition, of the 47 patients with endodontic treatment on vital pulp, 35 reported tolerable pain (74.47%) and 12 intolerable pain (25.53%). Of the 46 cases reporting pain after endodontic treatment on nonvital pulp, 42 (91.30%) had suffered tolerable and 4 (8.70%) intolerable pain. Of these 93 patients reporting any pain symptomatology, intolerable pain requiring medication occurred more often in vital pulp.

Gotler, Bar-Gil and Ashkenazi [3] also found that endodontic treatment on vital pulp exhibited significantly more incidence and intensity of postoperative pain than that on either nonvital pulp or retreated teeth, corroborating the findings of this present study.

Other study evaluating postoperative pain incidence in endodontic treatments on vital and nonvital pulp concluded that postoperative prevalence was not different regarding to pulp conditions. Most of patients reported lack of pain or mild pain [4].

Mild pain or sensitivity is a fast, tolerable pain that decreases over time. Consequently, the patients are not able to report exactly what they are feeling. Many factors may cause this pain, such as: the pressure exerted by dental clamps; and modus of anesthetic injection, which may injure the site and cause postoperative discomfort. Even the endodontic treatment itself may cause mild pain or sensitivity.

The results of this present study did not agree with those of the studies of Rigo, Petrini and Lodi [7], in which global postoperative pain was of 64.2% regardless of the pulp condition, probably because of the small sample size of only 141 files.

The study conducted by Walton [13] also reported findings similar to those of this present study, in

which 49 patients (34.8%) of the 141 files evaluated exhibited any pain type. The authors affirmed that because the interaction between periapical tissues and microorganisms, the flare-up occurred more easily in nonvital pulp cases.

Farzana *et al.* [2], aimed to evaluate postoperative pain incidence in multi-appointment endodontic treatments on either vital or nonvital pulp of 52 teeth requiring treatment. The authors observed that mild to moderate pain occurred in 4.34% and 4.39% of vital pulp teeth, respectively; and 17.3% and 3.44% of nonvital pulp, respectively. This aforementioned study concluded that no significant difference was found in postoperative pain between vital and nonvital pulps.

With regard to postoperative pain intensity, this present study's results are similar to those of Risso *et al.* [8], who analyzed postoperative pain in teenagers undergoing one- or two-appointment endodontic treatment. Post-operative pain was verified through visual analog scale ranging from 0-5. These authors observed that pain frequency was of 10.5% (6 of 57 cases) in one-appointment group and 23% (14 of 61 cases) in two-appointment group; and global pain frequency was of 30%, similar to the results of this present study.

Singh and Garg [9], evaluated pain intensity in 200 patients aged from 20 to 60 years, who were instructed to put a mark on a horizontal scale to represent the intensity of pain experience. The authors concluded that postoperative pain incidence and intensity were gradually reduced over the study time without statistically significant differences. Similarly, other significant differences in pain levels between vital and nonvital pulp were not found. In this present study, vital pulp showed more severe pain, regardless of the number of appointments.

According to Elmubarak *et al.* [1], endodontic treatment is a common procedure in Dentistry that can lead to postoperative pain, regardless of pulp condition and number of appointments.

The prevalence of postoperative pain, so-called flare-up, is a factor that should not cause concern at the moment of clinical decision. Certainly, endodontic treatment with smaller postoperative pain rates is preferentially the treatment of choice, since decision does not compromise endodontic treatment effectiveness and costs [11].

Conclusion

Within the limits of this clinical study, it was observed that:

- of the total 302 files revised within the study period, 209 (69.20%) did not show any symptomatology;
- of 302 patients, 93 (30.8%) experienced postoperative pain, from whom 77 (82.8%) reported tolerable pain and 16 (17.2%) reported intolerable pain;
- of the 47 cases treated with vital pulp, 35 (74.47%) experienced tolerable postoperative pain and 12 (25,53%) experienced intolerable pain; of 46 cases treated with nonvital pulp, 42 (91.30%) experienced tolerable postoperative pain and 4 (8.70%) experienced intolerable pain. Thus, intolerable pain, when present, was associated with vital pulp and further studies are necessary aiming to evaluate postoperative pain.

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Original Research Article

Study on prevalence of traumatic injuries in deciduous teeth of children aged from 6 to 60 months in the city of João Pessoa – Paraíba

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Keywords: child clinics; epidemiology; dental trauma; public health.

Abstract

Introduction: Traumatic injuries in anterior teeth are common in children and can cause serious consequences in subsequent permanent teeth, requiring professional intervention to minimize complications. **Objective:** To evaluate the traumatic injuries in anterior deciduous teeth of children enrolled in kindergartens and schools at the city of João Pessoa, Paraíba. **Material and methods:** The sample comprised 46 children, both genders, aged from 6 to 60 months. Data collection was based on X-rays, intraoral clinical analysis and the application of questionnaire with open and structured questions to obtain information on previous injuries, obtained by a calibrated examiner. Data was subjected to descriptive statistics by calculating absolute and relative frequencies, and to inferential statistics by Chi-square test ($p < 0.05$). **Results:** The results showed that 71.73% of children affected were male, 60.9% aged from two to three years, 63% of injuries occurred at home, 56.5 % had enamel fractures and 53.3% had injuries in the maxillary right central incisor. **Conclusion:** Trauma in deciduous teeth is common, especially in young children. Thus, preventive and corrective measures should be taken, both at private and public dental care.

Introduction

Trauma at childhood is the result of impact whose force surpass the resistance of bone, muscle and tooth tissues. Some factors have determined trauma severity degree and extension, such as: child's age; stage of deciduous tooth development; trauma intensity, type, impact duration, and site; and elapsed time.

Maxilla is the bone most affected by traumas and central and lateral incisors are the most affect teeth [11]. The most common injury types have been enamel/dentine fractures, followed by tooth avulsion [11, 12]. The fractures may cause loss of masticatory function, alterations in occlusion, tooth migration, damages to surrounding tissues, esthetics and speaking impairment. Moreover, traumas psychologically affect the child and may cause damages to permanent teeth, such as crown-root dilacerations, tooth discolorations due to enamel hypoplasias or hypocalcifications, among other disturbs that triggers other functional esthetic problems [11, 12].

Immediate treatment of tooth trauma requires deep technical-scientific knowledge; however, great variability of trauma type classifications and lack of treatment protocols of eventual sequelae lead to doubts on follow-up procedures of these cases [8]. Emergency dental treatment should include firstly the anamnesis to gather information on type, time and site of trauma aiming to find whether prescription of tetanus vaccine is necessary; next, the dentist should evaluate surrounding teeth and bone tissue through radiographic examination and soft tissue injuries to find the possible presence of foreign bodies [5].

Many educative measures directed to little-age children provide reduction in the amount of caries lesions in deciduous teeth. Notwithstanding, the effects of these measures do not reach the prevention of tooth lesions from traumas. The increase in the number of violence cases, car accidents, and high impact and contact sports activities contributes to raise tooth trauma as emerging public health problem [1].

Thus, the aim of this present study was to evaluate the type and site of trauma; patient's age, gender, and most affected deciduous teeth in children at complete deciduous dentition in the city of João Pessoa (PB/Brazil), to gather specific information on trauma at this geographic area and provide subsidies to help dentists treat dental trauma which has been reported to increase in the population of the aforementioned geographic area. The current stage of studies on dental trauma shows advance in cellular and molecular biology field to repair hard tissues undergoing trauma, but little focus on preventive measures [14]. The epidemiological profile designing of trauma injuries in these children may help establishing preventive and educational measures which would decrease the severe repercussions of trauma lesions and provide relevant data to trauma treatment.

Material and methods

This observational, cross-sectional study with qualitative and quantitative data was submitted and approved by the Institutional Review Board and authorized by the Municipal Secretary of Education, according to the guidelines of the Resolution no. 196/96 of the Brazilian Council of Health, which states the guidelines of studies on human beings.

Study sample firstly comprised 544 children aged from 6 to 60 months. Because of the presence of pathologies with different etiologies of tooth trauma, the final study sample was composed by 46 children, both genders, with tooth trauma cases confirmed.

Data was collected from February to June of 2011 through anamnesis directed to the children's parents/guardians, performed by a single examiner, specialized in Pediatric Dentistry, previously calibrated. Intra-examiner agreement was measured by Kappa test, at the beginning of the study in 10% of the sample, twice, at 10 day interval. Kappa coefficient was considered as excellent (Kappa = 1.0). The evaluation method applied for tooth trauma classification was based on the classification proposed by Andreasen and Andreasen [1], adopted by the World Health Organization (WHO) [15], the International Association Dental Traumatology (IADT) [10], and the American Association Pediatric Dentistry (AAPD) [9]. Traumas were classified as follows: lesions to tooth hard tissues, pulp and alveolar bone (incomplete enamel fracture, enamel dentine fracture, enamel dentine fracture with exposed pulp, crown-root fracture, root fracture, and alveolar fracture), lesions to periodontal tissues (concussion, subluxation, extrusion, lateral luxations, intrusion and avulsion). After the confirmation of tooth trauma history by parents/guardians, anamnesis and clinical examination, the children were referred to the Radiologic Clinic of the University Center of João Pessoa (UNIPE), to be submitted to radiographic examination. To obtain the radiographic image, modified intraoral occlusal technique was applied with size 2 type E

radiographic films (Kodak Company, Nova York, USA), with the aid of radiographic device (X-Timex 70X® Drs GNATUS) at 70kVp and 7mA. Exposure time was of 0.4 second, focal distance of 20 cm, following geometric standardized technic, in which the X-ray central beam focuses at vertical angle of 65 to 70° on the glabella in upper shots and -90° on oral floor in lower shots. Next, the films were processed by time/temperature method and the findings were registered by a radiologist.

Obtained data were submitted to descriptive and inferential statistics by Pearson's chi-square test and Fisher's exact test with level of significance of 5% ($p < 0.05$).

Results

Gender data of the children undergoing tooth trauma showed significant statistically differences ($p = 0.001$), according to Pearson's chi-square test. Of 544 children, only 46 exhibited tooth traumas (11.9%). Of these latter, 33 (71.7%) were male while 13 (28.3%) were female. Concerning to trauma types on hard or soft tissues, this did not present association with gender ($p = 0.667$) (table I).

According to the results displayed in table II, regarding tooth trauma, enamel fracture was the most found (56.5%), followed by intrusive luxation (10.9%), lateral luxation (8.7%) and concussion (2.2%). Considering to age ranges, at 2 to 3 years (60.9%) there were an increasing of traumatic injuries, which reduces as age increasing (table III). With regard to teeth, right maxillary central incisor was the most affected (53.3%) followed by left maxillary central incisor (36.7%), as demonstrated in table IV.

Tooth trauma occurred mostly at the children's home (63%), followed by school (2.2%), and collision to other children at school and home outdoors (2.2%). In all sample analyzed, only 4.3% of the parents/guardians requested dental treatment.

Table I – Absolute and relative distribution regarding to gender and oral tissue affected by trauma

	Trauma				
	Absence	**Presence**	**Lesions on hard tissues**	**Lesions on periodontal tissues**	**Level of significance***
Gender	n (%)	n (%)	n (%)	n (%)	
Male	230 (48%)	33 (71.7%)[1]	18 (39.1%)[2]	15 (32.6%)[2]	$p < 0.05$[1]
Female	249 (52%)	13 (28.3%)[1]	8 (17.4%)[2]	5 (10.6%)[2]	$p = 0.667$[2]
Total	479 (100%)	46 (100%)			

* Pearson's chi-square test
[1] Presence of trauma: male versus female ($p < 0.05$)
[2] Lesions on hard and periodontal tissues ($p = 0.667$)

Table II – Absolute and relative distribution of tooth trauma type prevalence

Tooth trauma	Prevalence (n)	Frequency (%)
Concussion	1	2.2
Enamel fracture	26	56.5
Intrusive luxation	5	10.9
Extrusive luxation	5	10.9
Lateral luxation	4	8.6
Avulsion	5	10.9
Total	46	100.00

Table III – Absolute and relative distribution of tooth trauma presence according to age range

	Tooth trauma	
Age range	**n**	**%**
0 to 12 months	3	6.5
13 to 24 months	10	21.7
25 to 36 months	28	60.9
37 to 48 months	5	10.9

Table IV – Absolute and relative distribution of tooth trauma prevalence according to deciduous teeth

Deciduous teeth	Prevalence (n)	Frequency (%)
51	32	53.3
52	0	0.0
53	0	0.0
61	22	36.7
62	1	1.7
71	0	0.0
72	0	0.0
73	0	0.0
81	0	0.0
82	0	0.0
83	0	0.0
No information	5	8.3
Total	60	100.00

Discussion

Tooth trauma injuries are part of daily practice due to many etiologic factors and have been considered as public health cases because of high incidence in children [5]. According to Rodriguez [17], approximately 30% of children have been exposed to tooth trauma.

In this present study, statistically significant differences were seen in the presence of tooth trauma in males (71.7%) in comparison with females (28.3%), corroborating other studies [2, 5, 17] that reported trauma prevalence in 56.7% of males and 43.3% of females [4]. Such fact suggests the influence of boys' behavioral at this age range, coming from bruising physical activities leading to tooth trauma. Girls are generally more protected by the parents reducing trauma chances.

Concerning to age range, 2-3 years of age was the most affected (60.9%) similar to the finding of other study indicating that 86.7% of injuries affected children at 25-36 month age range [4]. At this phase, the child commonly begins to walk and explore the environment, which increase trauma incidences. According to Duarte *et al.* [6] and Kramer and Feldens [12], the age range most prone to trauma occurrence is 1 to 3 years, because at these ages the child does not have enough improved motor coordination to avoid possible falls together with the involuntary acts of the age itself. Notwithstanding, some authors indicated higher ages, around 4 years-old, as the most susceptible to trauma because potentially high energy behavior [11]. Kramer *et al.* [11] believes that the higher age reported by some studies occur because of exploratory researches citing trauma cases with visible sequelae after the event.

The environment where most of the traumas took place was the children's home (63.0%), followed by the children's school (2.2%) and collision to other children (2.2%), data similar to those of other study reporting the child's home as the site of most occurrences (64.9%) [2]. Trauma injuries on deciduous dentition occur at familial environment because children stay mostly at home [3]. Notwithstanding, sites close to houses and school are greater sources of trauma affecting permanent dentition [3]. Trauma site of occurrence is important for treatment planning so that the possible contamination level of the injury could be evaluated. However, to better assess and follow-up the injury, dental referral is necessary. According to

this present study, only 4.3% of this study sample searched for dental treatment after trauma. This probably occurred because of lack of knowledge and information of parents/guardians on the necessity of immediate trauma care, lack of symptoms after trauma, and difficult to treatment access.

The most prevalent tooth trauma type was enamel fracture (56.5%), followed by avulsion, intrusive luxation, extrusive luxation (10.9%), lateral luxation (8.7%) and only one concussion case (2.2%). Such result was similar to that of other authors [4, 13, 16], such as Beltrão *et al.* [4], who described that 83.3% of traumas were enamel fracture and 2.8% extrusive luxation and avulsions. According to Kawabata *et al.* [13], 69.8% of injuries cause enamel fractures. Cabral *et al.* [5] affirmed that the high prevalence of luxations in deciduous teeth occur because of the small alveolar bone resilience and loosen bone trabeculae, which does not prevented the impact mechanical force and leads to tooth luxation.

By evaluating the affected deciduous tooth, maxillary central incisors were the most affected, with little predominance of the right (53.3%) over the left central incisor (36.7%), corroborating other studies [4, 5, 11]. Kawabata *et al.* [13] found that left maxillary central incisors were the most affect deciduous teeth (44.3%) followed by the right maxillary central (41.4%). According to Beltrão *et al.* [4], maxillary central incisors are 94.4% more affected by traumas. Anterior teeth are the most affected by traumas and fractures, because physiologically maxillary teeth are in front of mandibular teeth and become more susceptible to injury. Likely, according to Cabral *et al.* [5], factors as the maxillary skeletal fixations, loosen and thin bone trabeculae, presence of thumb sucking habit, and oral breathing raises put maxillary anterior teeth at greater risk of trauma.

Deciduous tooth traumas are frequently, mainly affecting boys at little age and maxillary central incisors. Final diagnosis, treatment planning and prognosis depending on many factors, such as the stage of permanent bud development, patient's age, trauma site and lesion nature. Therefore, the result of this present study showed the epidemiological profile of tooth trauma in this population, undoubtedly demonstrating the need of implementing educative and preventive measures aiming to decrease the damages to the stomatognathic system of children and psychobiosocial impairment. Educative actions towards tooth trauma prevention can decrease behavioral alterations and physical disturbs due to tooth trauma in little age children. Moreover, tooth trauma prevention would avoid longer follow-up periods, interventions in oral cavity, and possible sequelae to permanent teeth.

Conclusion

Trauma injuries in children frequently affect oral cavity leading to damages to stomatognathic system. Considering the population of João Pessoa (PB/Brazil), the most affected children were male, at 2 to 3 years-old, suffering mostly enamel fracture mainly involving the right maxillary central incisor, at home, with lack of referral to the dentist. Thus, the results of this present study demonstrated the need of preventive measures focusing on tooth trauma together with the instructions to parents/guardians on the relevance of the dentist's role in tooth trauma treatment.

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Literature Review Article

Influence of the chlorhexidine application on adhesive interface stability: literature review

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chlorhexidine; dentine; permanent dental restoration.

Abstract

Introduction: There is a consensus that dentine/resin bonding deteriorates over time, and such degradation is one of the main reasons for limiting adhesive restoration longevity. Enzymes known as matrix metalloproteinases (MMPs) are responsible by enzymatic degradation of collagen fibrils without protection, which are present in the resin-dentine interface. Therefore, these enzymes are involved in the process of adhesive interface degradation. Currently, studies point out chlorhexidine digluconate has antiproteolytic function by inhibiting the action of MMPS. Thus, it is thought this substance application prior to the use of bonding agents could slow the process of degradation of the tooth-restoration interface, resulting in longevity. **Objective:** To review the literature on the influence of chlorhexidine application on the stability of the adhesive interface. **Literature review:** Chlorhexidine digluconate proprieties and its application in Dentistry were discussed. Next, hybrid layer formation and degradation was discussed and the mechanism of action of chlorhexidine on preserving this layer was detailed. Finally, scientific studies from the last six years were analyzed on the performance of adhesive systems after chlorhexidine application. **Results:** Considering the results of reviewed studies, it can be concluded that chlorhexidine application did not interfere on the immediate bond strength to dentin and

hybrid layer degradation over time occurred later and/or with lower intensity. **Conclusion:** Chlorhexidine application interferes positively when incorporated into the adhesion protocols, by promoting hybrid layer stability over time.

Introduction

The improvement of dental adhesive materials has allowed important advancements in restorative technique, providing more conservative and esthetic treatments. Currently, scientific researches have targeted the assessment and improvement of bonding to dentine because bonding to this tooth substrate is critical. Dentine has a structural complexity because of its high organic content and intrinsic variations in mineralization and humidity. Moreover, caries removal forms the smear layer on dentinal surface. Smear layer contains debris making difficult the interaction of substances applied to dentine [53].

The adhesive systems can remove total or partially the smear layer and the mineral of underlying dentine, replacing them by resin monomers which are involved within a collagen fibrils-rich layer [17]. Thus, bonding to dentine is based on hybridization mechanisms in which the micromechanic bonding between adhesive polymers and collagen fibrils of demineralized dentine, forming the hibrid layer [40]. The literature agress that the bonding of resin to dentin deteriorates over time, and such degradation is one of the main reasons for limiting adhesive restoration longevity [41].

The mechanism of adhesive interface degradation is the result of the deterioration of both the resin components, hydrolysis, and enzymatic degradation of collagen fibrils without protection within resin/dentine bonding. With regard to these enzymes (metalloproteinases – MMPs), studies have demonstrated its effect on collagen fibril degradation and indicated the possibility of slowing this process through inhibiting its activity [3, 5, 15, 47, 49].

Clorhexidine digluconate, usually employed as antimicrobial agent, has demonstrated antiproteolytic function by inhibiting MMP action. Thus, studies have emploied this solution after acid etching and prior to bonding agents, as slowing adhesive interfaces [3, 5, 15, 47, 49].

In some studies, chlorhexidine use after acid etching and prior to bonding agent did not compromise adhesion [3, 5, 15, 47, 49]. Moreover, these studies indicated that the application of chlorhexidine solution may slow the adhesive interface degradation, and can be considered as a promising alternative in the search for long-term longevity of adhesive restorations.

This present literature review aimed to evaluate the influence of chlorhexidine on adhesive interface stability.

Literature review

The bibliographic search was performed through using the following databases: Scopus, Medline, Scielo, PubMed, ScienceDirect and Portal of journals sponsored by Capes. The search was not limited by the year of publication, except from the subitem "Performance of bonding agents with prior use of chlorhexidine", from 2007 to 2013.

The following keywords were used to search the journals: chlorhexidine and dental adhesives, chlorhexidine and dentine.

Properties and application of chlorhexidine digluconate

Chlorhexidine digluconate solution at low concentrations acts as bacteriostatic agent, and at high concentrations it acts as bacteriolitic agent. Additionally, chlorhexidine may also inhibit bacterial adherence to surfaces through calcium competition [39].

Chlorhexidine is commercially available at different concentrations, in the formo f gel or solution, and associated with other compounds, i.e., dentifrices, phosphoric acid for tooth etching [1].

Generally, chlorhexidine gluconate solution concentration ranges from 0.02 to 5% and can be employed in wound and burn treatment and as antiseptic [28]. Orally, chlorhexidine is found in mouthrinses at 0.12 % to 0.2 % [20]. Chlorhexidine gels are presented at 0.5 % to 1 % concentrations applied with toothbrushing or trays to reach all tooth surfaces, although both ways can be less effective [2]. Specifically, dentifrices contain 0.6 or 0.8 % chlorhexidine [46].

Chlorhexidine digluconate can be employed as cavity disinfectant, as solution, just after the removal of all caries tissue and prior to acid etching [13].

Other application currently proved by recent studies is chlorhexidine digluconate after acid etching. This step seems to promote and increase in restoration longevity by slowing the degradation process of adhesive interface [11].

When chlorhexidine digluconate is applied aiming to preserve the hibrid layer, used after acid etching, the concentrations should be equal or greater than 0.1% [54]. Most studies have employed concentrations of 2% [3-5,7-13, 24, 27].

Formation and degradation of hybrid layer

Hybrid layer is a zone of bonding between dentine and resin composite which is formed after dentine demineralization by phosphoric acid, exposing collagen fibrils. Accordingly, this surface receives the bonding agent which allows the organic substrate adhesion to restorative material. This adhesion is stablished by micromechanical phenomena between the adhesive polymers and collagen fibrils that were demineralized [40].

The mechanism of bonding to dentine is much more complex than that of enamel. Dentine has smaller content of inorganic substances and greater amount of water, making more difficult to achieve a long-lasting adhesion of resin to dentin [36].

Adhesion of resin to dentin becomes viable due to hydrophilic bonding agents capable of infiltrating and polymerizing within the collagen net exposed through dentine decalcification [4]. However, despite of significant improvements in bonding agents, adhesive interface is the area most susceptible to failure between tooth and restoration. If dentine/adhesive interface is exposed to oral cavity, marginal discoloration, loss of marginal adaptation and subsequent loss of restoration retention may occur [6].

Once hybrid layer is formed, adhesive interface stability will be based on the creation of a compact and homogenous layer. Notwithstanding, this adhesion degrades over time, due to MMPs hydrolysis and proteolytic action [4].

Mechanism of action of chlorhexidine in preserving hybrid layer

Dentine contains matrix metalloproteinases (MMPs), which are a group of zinc- and calcium-dependent enzymes regulating the physiologic and pathologic mechanism of collagen-based tissues [14]. In a study conducted by Pashley *et al.* [44], MMPs action was inhibited by the use of proteases, preserving the structural integrity of collagen fibrils, which would minimize hybrid layer degradation.

In vivo [27] and *in vitro* [10] studies have revealed that dentinal collagen degradation activities may be reduced through the use of chlorhexidine digluconate on dentine surface after phosphoric acid application and prior to adhesive application.

Metalloproteinases are a set of 23 zinc- and calcium-dependent endopeptidases having the capacity of degrading extracellular matrix components. Dentine has MMP-2 (gelatinase-A), MMP-8 (collagenase-2), MMP-9 (gelatinase-B), MMP-14 and MMP-20 (enamelysin) [38, 51].

Chlorhexidine digluconate solutions are capable of completely inhibiting MMP-2 and MMP-9 activity, even at concentrations as small as 0.03%. Thus, chlorhexidine digluconate is effective at very low concentrations of 0.02% and 0.002%, but it is not known yet which concentration is more effective and how much time is required for such application [26].

Recently, *in vitro* [4, 8, 10] and *in vivo* [11, 27] studies have demonstrated good results in inhibiting subclinical degradation after the application of chlorhexidine digluconate (2%) onto dentine etched by phosphoric acid prior to conventional single-component bonding agent.

Some authors affirmed that chlorhexidine digluconate solution application onto etched dentine did not negatively influence the immediate bond strength of adhesive systems to this substrate [4, 10, 11, 13, 25, 45].

Consequently, chlorhexidine digluconate solution application after dentine acid, etching and prior to adhesive application acts as an antimicrobial agent in addition to a more important function: the prevention or slowing of collagen fibril degradation, resulting in more stable long-term adhesive interfaces [11, 19].

Performance of adhesives after chlorhexidine use

Brackett *et al.* [4] conducted an *in vivo* study in which hybrid layer degradation in deep oclusal restorations was evaluated through transmission electron microscope (TEM). Control group was restored according to the manufacturer's instructions through one-bottle adhesive (Single Bond/3M Espe). Experimental group received the application of 2% chlorhexidine digluconate solution for 30 seconds after acid etching. After two and six months of saliva storage, microtensile tes was performed.

During the analysis of adhesive failures, the authors observed that all failures were adhesive. Both groups did not exhibit degradation after two months. A small degradation was found in control group after six months, but not in experimental group. No statistically significant differences were observed in microtensile strength between groups.

Carrilho *et al.* [11] tested the hypothesis that adhesive interface degradation could be prevented or slowed through application of 2% chlorhexidine digluconate, for 60 seconds, after acid etching. Single Bond (3M Espe) was applied at two moments (immediately and 14 months after saliva storage). Through microtensile test and TEM analysis, *in vivo* bond strength was stable in the specimens treated with - chlorhexidine digluconate, but significant decrease in control group. Test groups exhibited normal structured of collagen net. The authors concluded that the self-degradation of the collagen matrix may occur in the adhesive interface, but it can be avoided by applying an inhibitor agent.

Carrilho *et al.* [10] conducted an *in vitro* study on adhesive interface preservation with chlorhexidine digluconate through microtensile test. The authors hypothesized whether chlorhexidine digluconate would slow interface degradation through inhibiting the action of metalloproteinases. The two-step conventional adhesive (Single Bond/3M Espe) was used. The authors observed that 2% chlorhexidine digluconate used for 60 seconds significantly preserved the bond strength after six months of artificial saliva storage. Scanning electronic microscopy (SEM) analysis showed no failures in hybrid layer compared with control group after six months; cohesive failure was predominant. Therefore, the authors suggested chlorhexidine digluconate use to preserve the bond strength of adhesive interface.

Erhardt *et al.* [23] performed a study aiming to investigating whether the use of protease inhibitors such as EDTA and 5% chlorhexidine digluconate, for 120 seconds may influence on the microtensile bond strength of an adhesive system (Adper Scothbond/3M Espe) to dentine affected by caries. SEM analysis showed predominantly mixed failures. The authors concluded that the use of inhibitors did not compromise bond strength to dentine affected by caries and suggested that further studies are necessary to discover which is the ideal MMPs inhibitor that would result in hybrid layer preservation and longevity of restorations.

Campos *et al.* [9] conducted a study aiming to investigate the effects of chlorhexidine digluconate at 0,2% and 2% for 60 seconds on bond strength to dentin of two adhesive systems (Single Bond/3M Espe and Clearfil Tri-S Bond/Kuraray). Three-cycle thermocycling tests were carried out immediately and after six months, at every 8 hours. The results showed that 2% chlorhexidine digluconate was capable of decreasing the loss of microtensile bond strength over time for both adhesive agents. SEM analysis found most adhesive failures. Small concentrations of chlorhexidine digluconate (0.2%) did not have the same effect when associated with self-etching adhesive.

Komori *et al.* [30] evaluated the effect of 2% chlorhexidine digluconate, for 60 seconds on the bond strength of two adhesive agents (Scothbond Multipurpose and Single Bond 2, a 3M Espe) to sound and caries affect dentine, through microtensile test immediately and after six months of artificial saliva storage. The authors concluded that chlorhexidine digluconate did not affect immediate bond strength to sound and caries affected dentine. Chlorhexidine digluconate significantly decreased the bonding loss after six months in sound dentine group, but did not altered bond strength in caries affected dentine group. SEM analysis revealed that most failures were mixed, followed by interface failures.

Loguercio *et al.* [33] evaluated different concentrations of chlorhexidine digluconate (0.002%, 0.02%, 0.2%, 2%, and 4%) at two application times (15s and 60s) after acid etching. The following adhesive agents were used: Prime & Bond 2.1 (Dentsply) and Adper Single Bond (3M Espe). The authors concluded that 0.002% chlorhexidine digluconate, applied for 15 seconds on demineralized dentine is already capable to degrade resin/dentin adhesive interface for six months. SEM analysis showed that failure types were similar for all adhesives tested.

Stanislawczuk *et al.* [49] studied the effect of 2% chlorhexidine digluconate for 60 seconds, after acid etching on bond strength of resin to dentine, immediately and after six months; and evaluated the nanoinfiltration pattern when chlorhexidine digluconate was applied in aqueous solution alone or aqueous solution associated with phosphoric acid. The following adhesive agents were tested: Adper Single Bond (3M Espe) and Prime & Bond NT (Dentsply). SEM analysis revealed that most failures were mixed. The authors concluded that the use of chlorhexidine digluconate aquous solution associated with acid was effective for reducing tooth/restoration interface degradation, immediately and six months after water storage.

Zhou *et al.* [54] investigated whether chlorhexidine digluconate application could preserve the interface bond strength. The following concentrations were employed: 0.05%, 0.1%, 0.5% and 1.0%, applied for 60 seconds to dentine after acid etching. The adhesive agent used for microtensile test was Clearfil SE Bond (Kuraray). Samples were analyzed in SEM showing tendency towards cohesive failures. The authors concluded that chlorhexidine digluconate may preserve bond strength since it was used at concentration equal or greater than 0.1%.

Dalli *et al.* [15] evaluated the effect of 1% chlorhexidine digluconate gel on bond strength to dentine in resin composite restorations using two adhesive systems (Prime & Bond NT/Dentsply and Clearfil SE Bond/Kuraray). The authors employed immediate shear bond test and the specimens were evaluated through SEM, which exhibited the predominance of adhesive failures. The authors concluded that 1% chlorhexidine digluconate gel did not adversely affect shear bond strength of adhesive agents to dentine.

De Munck *et al.* [16] verified the enzymatic endogenous degradation associated to self-etching bonding agents. For this purpose, the authors added MMP inhibitors: chlorhexidine, a non-specific inhibitor; and SB-3CT, a specific inhibitor of MMP-2 and MMP-9. The authors concluded that endogenous MMP-2 and MMP-9 involvement in the process of bond strength degradation is minimum for self-etching adhesive agents.

Manfro *et al.* [36] evaluated the use of chlorhexidine digluconate at 0.5% and 2% concentrations, for 30 seconds, after acid etching on immediate bond strength of deciduous teeth. The adhesive agent was Apder Single Bond 2 (3M Espe), and microtensile test was immediately carried out. SEM analysis found adhesive or mixed failures. The authors reported that 0.5% and 2% chlorhexidine digluconate showed similar behaviors and did not adversely affected the immediate bond strength to dentine when compared with control group. The authors affirmed that adhesion to dentinal substrate is much more complex than that of enamel because dentine has smaller inorganic content and more water amount, which makes difficult a long-lasting adhesion.

Ricci *et al.* [47] evaluated the mechanical stability of resin/dentine interface in the presence of 2% chlorhexidine digluconate, applied for 60 seconds, after acid etching. The authors performed the immediate microtensile test with Prime & Bond NT (Dentsply), and the specimens were analyzed in TEM. Mostly, the failures were adhesive types. The authors concluded that the use of chlorhexidine digluconate did not jeopardize the immediate adhesion and was capable to reduce the interface degradation rate at the first months after restoration.

Shafiei *et al.* [48] evaluated the effect of 2% chlorhexidine digluconate use, for 40 seconds, on microleakage of restorations by using four different adhesive agents (Scothbond Multipurpose/3M Espe, Excite/Ivoclar Vivadent, Clearfil SE Bond/Kuraray and Ibond/Heraeus Kulzer). The authors concluded that chlorhexidine digluconate did not affect microleakage of the four adhesive tested.

Zhou *et al.* [55] investigated whether chlorhexidine digluconate at the following concentrations of 0.05%, 0.1%, 0.5% and 1%, for 60 seconds, after acid etching associated with Clearfil SE Bond (Kuraray), would affect the bond strength of adhesive interface. The authors concluded that chlorhexidine digluconate associated with the adhesive did not jeopardize the immediate bond strength at concentrations equal or greater than 1%.

Leitune *et al.* [31] evaluated the influence of 2% chlorhexidine digluconate for 30 seconds after acid etching of dentine. The author performed shear bond strength tests immediately and after six months in deciduous teeth. The adhesive agent tested was Scothbond Multipurpose (3M Espe). The authors observed that there were no statistically significant differences between the groups evaluated.

Osorio *et al.* [42] conducted tests that indicating the amount of degradation suffered by the collagen exposed after acid etching and 24 hour, one and three week storage, in the presence of absence of chlorhexidine digluconate. Chlorhexidine digluconate reduced the collagen degradation in 30%. The dentine treated with self-etching adhesive, the MMPs inhibiting effect by chlorhexidine digluconate lasted for until three weeks.

Islam *et al.* [29] conducted an *in vitro* study investigating the effect of the incorporation of the extract of grape seed, hesperidin, and chlorhexidine digluconate to Clearfil SE Bond (Kuraray) on the bond strength of adhesive interface. SEM analysis showed that mostly cohesive types occurred. The authors concluded that hesperidin incorporated to *primer* exerted positive influence on immediate microtensile test and mechanical properties, while chlorhexidine digluconate did not affect the bond strength.

Manfro *et al.* [35] evaluated the effect of different concentrations of chlorhexidine digluconate at 0.5% and 2% on immediate bond strength to deciduous

dentine, immediately and after 12 months of saliva storage. Single Bond (3M Espe) adhesive was used in microtensile tests. The results confirmed the concept that chlorhexidine digluconate, at different concentrations, can prevent the degradation of the adhesive interface in deciduous teeth. Also, no significant reduction was found in bond strength values when 0.5% and 2% chlorhexidine digluconate was used.

The influence of chlorhexidine on bond of self-etching and conventional adhesive systems to dentine was evaluated through microtensile and nanoinfiltration tests after thermocycling. The results demonstrated a preservation of interface in conventional adhesives; no significant effect was found in self-etching adhesives [21].

Dutra-Correa *et al.* [22] clinically evaluated the hypothesis that 2% chlorhexidine digluconate use would not affect the clinical behavior of two adhesive systems: XP Bond (Dentsply) and Xeno V (Dentsply). The results demonstrated that chlorhexidine application prior to the application of adhesive systems did not exert influence on the clinical performance of the adhesive systems at six and 18 month periods.

Lin *et al.* [32] evaluated *in vitro* the influence of peripheral enamel presence, the dentinal pre-treatment with chlorhexidine digluconate, and storage time on microtensile bond stregth of a two-step self-etching adhesive system and self-etching resin cement. The authors concluded that the absence of peripheral enamel and longer storage times decreased the bond strength of two-step self-etching adhesive systems self-etching resin cement. Moreover, dentinal pre-treatment with chlorhexidine improved bonding stability.

Stanislawczuk *et al.* [50] evaluated the effect of chlorhexidine added at concentrations ranging from 0.01 to 0.2% on two experimental adhesive systems. The authors analyzed the bond strength, conversion degree, water sorption, solubility, chlorhexidine release, microtensile, and immediate and 1-year nanoinfiltration. The results were positive for chlorhexidine addition which increased the longevity of adhesive interface, without compromising the mechanical properties evaluated.

Discussion

Despite the large number of studies on the mechanisms of resin/dentine degradation, the subject has not been completely elucidated. The last-longing adhesion to a vital and moist substrate, as dentine, is deficient. To achieve the bonding of adhesive resin to dentinal substrate, the mineral phase has to be totally or partially removed and replaced by adhesive solution. The bonding agent has to infiltrate into this collagen fibril-rich layer and polymerize *in situ*, forming the so-called hybrid layer [37, 40].

Currently, the use of chlorhexidine digluconate has been discussed after acid etching and prior to adhesive application because chlorhexidine digluconate inhibits MMPs, which account for the degradation of the collagen exposed on the base of the hybrid layer. Thus, its action slowed the degradation of the adhesive interface over time [33].

By evaluating studies that employed bond strength tests between dentine and restoration, immediately and with chlorhexidine digluconate use after acid etching and prior to adhesive agent application, no alteration was found in the values of control group (without chlorhexidine) [3, 5, 6, 9-11, 13, 15, 19, 27, 30, 33, 47, 49, 54]. Accordingly, this result is favorable to the use of chlorhexidine digluconate because its addition did not affect immediate bond strength, important for the initial maintainance of the restoration [17].

Other studies conducted after the specimen storage for some months aiming to simulate the restoration aging, the authors found reduction in bond strength over time. Notwithstanding, chlorhexidine digluconate group showed a significant smaller reduction than that of control group [8, 11, 32]. Similar researches pointed out to a reduction in bond strength without alteration in the group where chlorhexidine digluconate was applied [5, 10, 13, 27, 33, 54]. Based on these results, it is possible to confirm that chlorhexidine digluconate has a positive effect on slowing the adhesive interface.

Similarly, some *in vivo* studies have demonstrated that chlorhexidine digluconate reduced the degradation of resin/dentin interface and decreased nanoinfiltration without promoting adverse effects on the effectivity of adhesive materials [3, 5, 15, 22, 47, 49].

However, in other *in vitro* studies in which the storage of specimens over time was performed, a different result was observed because no significant difference between the use or not of chlorhexidine digluconate [19, 30].

The difference in results among studies possibly occur because of methodological differences and the use of different adhesive systems, which makes their comparison different.

With regard to the methodology employed, by analyzing the studies, it was verified that

microtensile test was the most used aiming to verify the bond strength between tooth/restoration [3-5, 8-11, 13, 15, 23, 24, 32]. This test has been largely employed in the literature due to accurate and safe results, because of the reduced bonding area (smaller than 2 mm^2), enabling the occurrence of minor structural failures at adhesive interface. Moreover, microtensile test provides obtaining many specimens from a single tooth, performing the evaluation of bond strength on small areas, and analyzing the adhesion in clinically relevant substrates, such as sclerotic dentine or caries affected dentine [34, 41, 43, 52].

With regard the adhesive systems used, among the studies evaluated, one-step self-etching and two-step conventional adhesive systems have been the most employed. Possibly, this occurred because these systems are already simplified and the use of chlorhexidine digluconate will increased one more step for the execution of the restoration.

Additionally, conventional adhesive systems seemed to have more favorable results in relation to chlorhexidine use [4, 9-11, 30, 33, 35, 47, 49], because studies conducted with self-etching adhesive systems have shown positive effect, [32, 42], little or none influence on adhesion durability [9, 16, 21, 54]. It has been reported the need of a chlorhexidine concentration 0.1% [54] and 0.2% [9] to achieve any effect on preserving tooth/restoration interface. This fact can be explained by the involvement of endogenous MMP-2 and MMP-9 in the process of bonding degradation are minimum for self-etching adhesive systems, according to the study of De Munck *et al.* [16].

With regard to chlorhexidine digluconate concentration, it was observed a predominance of studies at 2%, ranging from 0.0001% to 5% [3-5, 7-13, 24, 27]. At 2%, satisfactory results were obtained with reduction and/or stabilization of adhesive interface degradation over time.

Most of researches employed the chlorhexidine application time for 60 seconds, and among the studies this time period varied from 15 to 120 seconds. Loguercio *et al.* [33] evaluated two application times (15 and 60 seconds) and concluded that at concentration of 0.002% of chlorhexidine digluconate for 15 seconds, it was already possible to slow the resin/dentine interface degradation for a period of six months in conventional adhesive systems.

Concerning to the storage time for posterior evaluation of the adhesive interface in *in vitro* studies, mostly immediate, six-, and 12-month tests were performed. The most used storage media was artificial saliva and distilled water [3, 4, 8-11, 13, 15, 24]. The storage mimics the adhesion aging, aiming to evaluate the bonding durability in *in vitro* studies, and the immediate analysis was performed to verify the initial resistance of the restoration [17].

In vivo studies were found in smaller number, probably because of the execution difficulty, and most studies were performed *in vitro* [3, 4, 11, 12, 21, 27, 50].

Based on the aforementioned discussion, it could be observed a great variation among the scientific studies regarding to methodology; however, the results seem to pint out to confirm the hybrid layer preservation with chlorhexidine digluconate use after acid etching, which would enable the increase of the longevity of restorations.

Conclusion

Based on the results obtained in the revised studies, it can be concluded that chlorhexidine digluconate application did not interfere in most of studies on immediate bond strength to dentin when conventional and self-etching adhesive systems were used.

Hybrid layer degradation occurred later and/or with less intensity when chlorhexidine digluconate was incorporated to adhesion protocols. Thus, it positively interfered in hybrid layer stability over time.

Therefore, changes in adhesion protocol aiming to incorporate this MMPs inhibitor agent can be considered and further investigated. However, further studies are necessary to incorporate this step to clinical restorative protocol.

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Literature Review Article

Clinical aspects and pharmacological treatment of trigeminal neuralgia

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Abstract

Introduction: Trigeminal neuralgia (TN) is defined as sudden, usually unilateral, severe and brief pain episodes within the distribution of one or more branches of the trigeminal nerve. In some patients a constant background pain may persist, additionally to pain attacks, which can make difficult to differentiate the trigeminal neuralgia from other orofacial pain types. **Objective:** To review the classification, physiopathological aspects, epidemiologic data and pharmacological options to control pain related to trigeminal neuralgia. **Literature review:** One of the proposed etiologies for this condition is a local-circumscribed demyelination of the trigeminal nerve resulting in neuronal hyperexcitability and generation of ephaptic coupling, which would be responsible for the pain paroxysms. Initially, the treatment of patients with these pain characteristics is based on the use of anticonvulsants, in order to attenuate the ectopic-generated pain impulses. Carbamazepine is the first-line drug, but other anticonvulsants may be employed and have shown variable efficacy in the treatment of trigeminal neuralgia. **Conclusion:** According to the new classification of the International Headache Society, classic trigeminal neuralgia is divided in purely paroxysmal and with concomitant persistent facial pain. The pathophysiology is unclear, but trigeminal neuralgia seems to be the consequence of vascular

compression of the trigeminal nerve near the brain stem. Although TN presents a low prevalence in general population (i.e. 5-30 new patients per 100,000), trigeminal neuralgia is an important clinical concern both by pain severity and difficulty of its satisfactory control. Anticonvulsants are the medication of choice in the treatment of trigeminal neuralgia; however, their use is associated with several adverse effects and possibility of treatment refractoriness.

Introduction

Neuropathic pain is defined as the pain resulting from a lesion or dysfunction of somatosensory system and characterized by either spontaneous pain or sensitivity exacerbated to different stimuli [22]. The most common type of craniofacial neuropathic pain is trigeminal neuralgia (TN), whose prevalence is estimated in 5-30 individuals at every 100,000 [43].

Trigeminal neuralgia may occur at any age; however, in 90% of the cases affects people aged more than 40 years [14], with greater incidence in females (2:1 ratio) [14, 26, 32].

This disorder has been described in the literature for centuries. References to unilateral facial pain responsible for facial spasms can be found in the writings of Aretaeus and Jujani, at 2nd and 11th centuries, respectively. In 1773, Fothergill described the typical features of trigeminal neuralgia, including its paroxysmal natural and association with triggering factors [13].

Trigeminal neuralgia is defined by the International Association for the Study of Pain (IASP) as a "sudden, usually unilateral, severe and brief pain episodes occurring in one the distribution of one or more branches of the trigeminal nerve" [32, 46] and characterized by severe, acute, electric shock-like piercing pain, followed by refractory period [3, 24]. Pain episodes are normally triggered by stimulation of specific areas, so-called trigger points or zones, localized in the area innervated by trigeminal nerve [26]. In most trigeminal neuralgia cases, only one branch is affected, mainly the maxillary, and about 30% of cases involve maxillary and mandibular branches. Both ophthalmic branch involvement and bilateral trigeminal neuralgia cases are rare [24]. Triggering stimuli of pain attacks include the acts of speaking, toothbrushing, shaving, drinking, soft touching on face, among other [14, 42]. The patients suffering trigeminal neuralgia have marked reduction in quality of life because they avoid any routine task that can trigger a pain crisis [24].

According to the new classification of the International Headache Society (IHS) [18], classic trigeminal neuralgia is caused by neurovascular compression more frequently through the superior cerebellar artery and is divided into classical trigeminal neuralgia purely paroxysmal and classical trigeminal neuralgia with concomitant facial persistent facial pain. Before this new classification, trigeminal neuralgia was also classified as symptomatic and included cases in which the neuralgia was associated with other disorders such as traumas, tumors and multiple sclerosis. Regardless of the etiology, neuropathic pain affecting trigeminal nerve reaches high rates in pain scales, which raises further interest in its study [17].

The treatment of choice of trigeminal neuralgia is pharmacological. Firstly, many patients have been beneficiated with anticonvulsants, such as carbamazepine, gabapentin and pregabalin. Notwithstanding, many patients do not respond to or become refractory to pharmacological treatment. Also, some patients have pain reduction together with side effects intolerable enough to justified pharmacological treatment suspension. The aforementioned cases require multimodal management, associating drugs with surgery [1]. Nevertheless, neither pharmacological nor surgical treatment for trigeminal neuralgia provides considerable pain relief in all patients, justifying the need of further studies to contribute in understanding the physiopathology of this disorder [7].

The aim of this study was to review the classification, physiopathological, epidemiological data and the pharmacological options for pain control associated with trigeminal neuralgia.

Literature review

Although trigeminal neuralgia (TN) is not a new disease, specific examinations and tests aiding in diagnosis does not exist [6, 12, 40]. Notwithstanding, many signs and symptoms characterized TN and their evaluation is the main tool for diagnosing this neuropathic pain type. TN main diagnosis

criteria are severe, recurrent, paroxysmal, electrical shock-like pain affecting only the areas innervated by trigeminal nerve, lasting from seconds to minutes, together with other signs and symptoms described in table I [2, 4, 6, 12, 18, 25, 39, 40, 45, 47]. Because TN is a rare pain type, many health professionals do not recognize it, making difficult the correct diagnosis. Accordingly, some studies have shown that TN diagnosis may take more than one year in patients suffering of facial pains [6, 40].

As aforementioned cited, recently a new TN classification has been proposed by IHS, in which TN is divided into classical trigeminal neuralgia purely paroxysmal and classical trigeminal neuralgia with persistent concomitant pain. The diagnosis of classical TN purely paroxysmal, the most common type, should comprise at least three signs and symptoms described in table I, including recurrent facial pain attacks, without persistent facial pain [18]. To diagnosis classical TN with persistent concomitant pain, one may detect at least three signs and symptoms presented in table I, including recurrent facial pain attacks, with persistent facial pain of moderate to severe intensity [4, 18].

To make easy and improve not only TN diagnosis, but also the diagnosis of many other diseases of difficult diagnosis, quantitative sensory test (QST) has been applied, composed of the sensory stimulation of the affected area and observation of the patients' reactions against stimulation [20, 45, 48]. Currently, a set of sensory tests comprising 13 thermal and mechanical parameters (i.e., evaluation of pain threshold against different temperatures and forces) was standardized also for sensory facial alterations, such as trigeminal neuralgia [45]. This test enables evaluating the particular features of each TN patient, thus contributing for a better treatment and better control of sensory alterations in orofacial area [20, 45, 48].

Table I – Trigeminal neuralgia diagnosis criteria

Signs and symptoms of trigeminal neuralgia diagnosis	
Pain in areas innervated by trigeminal nerve	- intense, spontaneous pain or pain presenting trigger reactions for its occurrence; - piercing-, electrical shock-, gunshot-, stabbing-, or cutting-like pain; - recurrent pain lasting from seconds to minutes;
Allodynia	- pain after non-painful stimuli;
Hyperalgesia	- exacerbated pain against non-painful stimuli;
Hypoesthesia	- loss or decrease of sensitivity against non-painful stimuli;
Hypalgesia	- decrease of sensitivity against painful stimuli;
Absence of other characteristic signs and symptoms of other facial dysfunctions	

Source: Adapted from the Headache Classification Committee of the International Headache Society [18]

Many studies have been developed aiming to clarify the physiopathological mechanisms involved in TN development and the correlation with some diseases' characteristics, i.e. paroxysmal attacks generally triggered by innocuous stimulus [18].

Since the observation of the correlation between the vascular compression of trigeminal nerve at brainstem area with TN development [8, 21], studies have aimed to confirm this correlation and identify the factors responsible for triggering the neuralgia associated with this alteration, which has been currently considered as TN main cause [18].

Accordingly, a study analyzed 41 TN clinical cases and observed the vessel contact with the nerve in 37 patients (90%); and of these, in 25 cases (68%) the contact was at the entering area of trigeminal nerve in brainstem. The compression origin was exclusively venous in 25% of the cases; exclusively arterial in 76%; and mixed in 13%. Of 33 patients submitted to vascular decompression, 23 (70%) reported significant pain relief. Control group comprised cadaver dissections after perfusion at physiologic pressure levels, and vascular contact with trigeminal nerve occurred in 40% of the cases, demonstrating that the vascular compression of trigeminal nerve is an anatomic abnormality with high correlation with TN [16].

Since vascular compression importance was established in TN, many advances have been obtained in the Discovery of mechanisms associated with the development of this clinical condition.

Many researches have been proposed that TN is probably consequence of specific abnormalities of trigeminal afferent neurons at trigeminal root area [11, 47]. Part of these abnormalities include structural alteration in the root affected by compression such as local-circumscribed demyelination and juxtaposition of demyelinated axons [19, 28]; presence of few thin-myelinated axons adjacent to demyelination zone, which may reflect both in demyelination and remyelination or partial demyelination of affected fibers; cases in which a single thin myelin sheath involving many adjacent axons suggesting the occurrence of aberrant remyelination [27, 28]; presence of great number of collagen fibers in extracellular matrix [34, 28], alterations in oligodendrocytes [30], among others.

In addition to both demyelination and lesions in axons and in central myelin found in vascular compression site, the literature has described abnormalities in peripheral myelin at the area close to the lesion, which were more pronounced in longest TN patients. Of these, a little number of peripheral axons was demyelinated; however, many axons were atrophic, hypertrophic, contracted or swollen, and the myelin sheaths that varied in shape and thickness [30].

Recently alterations in central nervous system of TN patients have been described by presenting significant reduction in the grey matter volume of many structures associated with pain processing and perception, such as thalamus and somatosensory cortex, among others [31]. Also, it has been found a correlation of the disease duration with the volume reduction of grey matter at anterior cingulate cortex, a structure that is likely involved in developing chronic pains [29, 31]. These alterations complement that aforementioned cited would justify partly the persistent facial pain reported by some TN patients.

Attempting to correlate the paroxysmal pain attacks with structural alterations observed in afferent sensory trigeminal neurons, Devor *et al.* (2002) [10] formulation the ignition hypothesis, which has been the most largely accepted to explain TN physiopathology. This hypothesis states that sensory neurons partially damaged become hyperexcitable and susceptible to cross excitation, which coming from the physical proximity of the neurons to the site of root compression. Therefore, the explosions of post-trigger neuronal activity recruit additional neighboring neurons leading to a rapid accumulation of electrical activity, which can be amplified by ephaptic interaction among neurons, since myelin sheath was damaged and nervous fibers maintain close contact among them. Thus, the stimulus of a single sensory fiber may lead to activate many others, and the explosions of neuronal activity triggered by an external stimulus many extended beyond the stimulus duration. According to this hypothesis, pain paroxysms experienced by TN patients would be the result of this synchronized phenomenon, which would be stopped by hyperpolarization coming from potassium ion influx making the neurons refractory to new excitation and would partly justify the refractory period after the crisis [10, 11, 33, 47].

Ignition hypothesis can explain part of the mechanisms involved in one of the main TN characteristics: paroxysmal pain attacks. Notwithstanding, other physiopathological process may contribute for the appearance of these and other symptoms, such as hyperalgesia and allodynia reported by some patients; and persistent facial pain, which is characteristic of one classical TN types.

Accordingly, some studies have suggested that alterations in voltage-gated sodium channels (Nav) may play an important role in TN physiopathology. Maybe the expression of sodium channels increased in demyelinated areas, which account for the greater neuronal excitability and ectopic shooting of afferent trigeminal fibers. This increased expression of sodium channels detected in gingival tissue samples of TN patients, which exhibited greater expression of Nav1.3 sodium channels than that of control group. Considering that sodium channels blocker drugs, as carbamazepine, have been normally effective in TN pain control, it is possible that sodium channels play a relevant role in TN physiopathology [37].

Many studies have provided advances in TN development. However, it is still necessary developing methodologies that allow elucidating TN physiopathological mechanisms to be correlated with TN extremely damaging clinical aspects, so that new treatment strategies can be developed.

Currently, the initial treatment of TN patients is pharmacological and based on anticonvulsants, and carbamazepine is the drug of choice. Surgical treatment can also be considered either when patients' symptoms do not improve, or patients cannot tolerate pharmacological treatment, or even in relapse cases. Surgical treatments are not the issue of this literature review, but a detailed description and indications, risks and benefits of each surgical procedure has also been presented and discussed by other authors [9, 24, 25, 39].

Carbamazepine has been used in TN pain control since the 1960s, and studies have been indicated that carbamazepine is effective in reducing

TN symptoms in up to 80% of the patients [5, 35, 36]. Mainly because the high effectiveness in TN treatment, carbamazepine has also been used for differential diagnosis between TN and other orofacial pains. Accordingly, it has been estimated that carbamazepine's number needed to treat (NNT) in TN is equal to 2.5, that is, at each 2.5 patients treated with carbamazepine, 1 is benefited from treatment [44].

Despite of the high effectiveness of carbamazepine in TN pain control, long-term treatment has been associated with many side effects including: sleepiness, dizziness, nausea, vomiting, ataxia, renal and hepatic toxicity, and symptoms relapse in up to 50% of the patients [9]. According to Wiffen *et al.* (2005) [44], 3.7 is the NNT required to cause adverse side effects with carbamazepine use. Moreover, carbamazepine is a potent inducer of its own metabolism, thus, the therapeutic level is not maintained whether the dose is not adjusted. It has been suggested to increase carbamazepine dosage approximately 20 days after the beginning of treatment. Carbamazepine half-life time is altered by longer use, ranging from 20-40 hours to 11-27 hours. These pharmacokinetic characteristics justify carbamazepine effectiveness loss whether dosage adjustments are not performed. Additionally, it is recommended to start treatment with low dosage (100 mg/day), which should be increased to 100-200 mg at every three days until patient reports pain relief. Maintenance dosage is generally of 400 to 800 mg/day (at every 12 hours), but some patients can need up to 2,400 mg/day, at every 6 hours [36, 39]. Taking into consideration both side effects and pharmacokinetic features of carbamazepine, the effectiveness of other drugs has been evaluated for TN treatment. Accordingly, it has been suggested that the anticonvulsant oxcarbazepine is also effective in controlling pain despite of the small evidences on its effectiveness, and longer oxcarbazepine use is related to smaller side effects than that of carbamazepine [15]. In case of intolerance (approximately 5 to 19% of patients are intolerant to carbamazepine) or lack of benefit with first- and second-choice drugs (carbamazepine and oxcarbazepine, respectively), the use of lamotrigine, baclofen, phenytoin, valproic acid and gabapentin can be considered [15, 25, 36]. Table II displays the pharmacological options to treat TN, the dosages recommended, and the time for pain relief of each drug [36].

The main mechanisms of anticonvulsant analgesic effects in neuropathic pains are blockage of sodium and/or calcium channels, increase of GABA inhibitory neurotransmission, reduction of GABA inhibitory neurotransmission [41]. Neuropathic pains result from the lesion of sensory neurons leading to alterations, among which the change in sodium/calcium channel expression changes. These alterations seemed to be associated with spontaneous pain development, hyperalgesia and allodynia, common symptoms in neuropathic pain cases. Many anticonvulsants act inhibiting both sodium and calcium channels, thus reducing GABA neurotransmission. This mechanism has been proposed by carbamazepine, oxcarbazepine and lamotrigine [23]. However, some differences have been observed in the mechanism of action of each one of these drugs, i.e. oxcarbazepine inhibits many voltage-gated sodium channels, which are not affected by carbamazepine [38]. These differences in the mechanism of action could explain the difference in anticonvulsant drug effectiveness in TN treatment. Finally, according to new IHS classification, while classical TN purely paroxysmal firstly responds well to pharmacological treatment with either carbamazepine or oxcarbazepine, classical TN with persistent facial pain does not respond well to both conservative and neurosurgical managements [18].

Table II – Pharmacological treatment of trigeminal neuralgia

Drug	Recommended dosage interval	Time period for effect (h)
Carbamazepine	400-800 mg/day	24-48 h
Oxcarbazepine	900-1.800 mg/day	24-72 h
Lamotrigine	150-400 mg/day	24 h
Baclofen	40-80 mg/day	*
Phenytoin	300-500 mg/day	24-48 h
Gabapentin	900-2.400 mg/day	on week
Valproic acid	500-1.500 mg/day	Weeks

* – not determined; adapted from Rozen [36]

Conclusion

According to the new classification of the International Headache Society, classical trigeminal neuralgia is divided into purely paroxysmal and with concomitant persistent facial pain. Trigeminal neuralgia physiopathology is not fully clarified, but it seems to be the consequence of the vascular compression of trigeminal nerve at the entry of the roots in the brainstem. Despite of the small trigeminal neuralgia prevalence in population (5-30 individuals at every 100,000), it is very clinically relevant because of both pain severity and difficulty in satisfactory pain control. Anticonvulsants are the drug of choice for trigeminal neuralgia; however, longer use has been associated with many side effects and possible treatment refractoriness.

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Literature Review Article

Systemic medication applied to endodontic treatment: a literature review

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Abstract

Introduction: A problem of endodontic origin is solved mainly by cleaning and disinfecting the root canal system. However, the use of medicines for systemic use is a great auxiliary in combating pain, inflammation and/or infection, making easier to treat the clinical status, that patient experiences less pain. **Objective:** To conduct a literature review evidencing the clinical indications of systemic medication application in endodontics, to aid the professional in achieving more effective and safer therapeutics. **Literature review:** There is a wide variety of drugs available on market. Consequently, the dentist is uncertain when prescribing systemic medication because a pharmacological arsenal is available. Also, the dentist frequently does not know the mechanism of action of these drugs and their interactions. Additionally to analgesics, anti-inflammatories and antibiotics, used to combat pain, inflammation and infection, respectively, dentists can still make use of anxiolytics, in cases of patients very fearful to endodontic treatment. **Conclusion:** It is of fundamental importance that the dentist knows about the medication type to be used in each case and whether systemic therapy is really necessary, through a comprehensive case evaluation.

Introduction

From manufacturing to consumption, many studies are concerned about medicines worldwide. Many of them aimed medical practice, emphasizing issues regarding adverse side effects, increasing and dissemination of bacterial resistance to antibiotics, pattern of medicine prescription and influence of medicine advertising on prescription [3].

Although endodontic treatment should be view from a surgical perspective, because local therapy must be firstly instituted, many clinical situations require the use of systemic drugs to act on problems coming from the treatment sequence, such as: inflammatory reaction, pain, and infection that provide more comfort and safety to patient [5].

In medicine, many drugs display analgesic, anti-inflammatory, and antimicrobial action. Depending on the clinical signs and symptoms and on the pharmacological effect desired, the professional can choose among a variety of drugs [24].

According to Leonardo and Leal (1998) [10], the cornerstone of endodontic treatment auxiliary therapy is the correct diagnosis of the pathology itself, from which and based on pharmacological knowledge, one can use the drugs available to treat the patient.

Additionally to the aforementioned pharmacological effects, one can count on anxiolytics. Such drugs act on the encephalon by modifying the psychic aspects consequently interfering on the individual's behavior [24]. Anxiolytics' goal is to relive and control the unfavorable the sequence of events as anxiety and fear, promoting muscle relaxation and domain of uncoordinated movements [8].

Concerning odontalgia, classified as superficial pre- and postoperative pain, non-narcotic analgesics can be perfectly used [4].

Analgesics are administered whenever patients feel pain, such as the cases of acute dentoalveolar abscess, mainly at initial and evolution phases; and pericementitis (either of traumatic, bacterial or pharmacological origin). Concerning pulpitis, analgesics have little effect and pain would be relieved only after biopulpectomy [4].

Non-steroid anti-inflammatory drugs are the most used in Dentistry. Still according to Cruz Filho and Pécora (1997) [4], anti-inflammatory drugs are mainly indicated in pericementitis after periapical surgeries. Analgesics or anti-inflammatory drugs are unusually prescribed after pulpectomies; however, some cases in which the patient exhibits mild pain sensitivity, these drugs are required.

Importantly, the dentist firstly must assure that antibiotics are necessary. According to Siqueira Júnior (1997) [20], in approximately 60% of infection human cases, the host defenses themselves account for the process cure, without antibiotics. If fever, swelling, prostration, lymphadenitis, and acute dentoalveolar abscess is present, indicating that the infectious process is not properly controlled by the host defenses, antibiotics are required. In the absence of these signals and whether the abscess is limited, antibiotics are not necessary [2, 7, 22]. Therefore, the aim of this study was to review the literature and discuss the use of systemic medication in Endodontics, aiming to guide the use of these drugs only when really necessary.

Literature review and discussion

This present study used the following scientific databases: Regional Library of Medicine (Bireme), Scientific Electronic Library Online (Scielo), and PubMed, Inclusion criteria comprised studies related to the subject studied – systemic medication applied to endodontics –, published between 1996 and 2013. The search used the following keywords: systemic medication, endodontic treatment, acute dentoalveolar abscess.

Anxiolytics

Anxiolytics or psycholeptics are drugs causing soothing effects, resulting in sleepiness. These drugs may act in agitation, excitability, anxiety, depression, apprehensiveness, psychosis, and neurosis state [24].

The patient showing signs of anxiety and fear is identified by either behavior or recognizing some physical signs, such as: dilated pupils, pale skin, excessive sweating, tingling of the extremities, and increasing of blood pressure and heart beating [1].

According to Haddad (2007) [8], anxiolytics are indicated in longer dental procedures, especially those performed in patients exhibiting heart diseases, diabetes, behavioral barriers and/or convulsive neurological disorders (epilepsy), and eventually in individuals with cerebral palsy and mental disabilities.

Andrade (1999) [1] pointed out other indications for anxiolytics use: 1. Whenever the signs of anxiety, apprehensiveness and fear is not controlled by verbal reassurance; 2. As pre-anesthetic medication in more invasive and traumatic dental procedures (parendodontic surgery, drainage of abscesses); 3. Immediately after accidental dental traumas; 4. Eventually, in some emergency medical cases,

such as hyperventilation syndrome and myocardial infarction.

Preferably, in Dentistry, minor anxiolytics from benzodiazepine group are indicated for anxious patients with fear of dental treatment [5, 24].

According to Tortamano and Armonia (2001) [24], anxiolytics can still be prescribed as auxiliary in treating pain phenomena because pain is closely related to psychic aspects.

Andrade (1999) [1] emphasized among the benzodiazepine group: diazepam, lorazepam, bromazepam and cloxazolam. Haddad (2007) [8] still included in this group midazolam, which in addition to the anxiolytic effect has hypnotic action (induction to physiologic sleepiness). The authors pointed out that such drugs have the same mechanism of action, differing from only the beginning and duration of anxiolytic action.

In addition to decrease anxiety, benzodiazepines (table I) have also other advantages, such as: decrease of basal metabolism, consequently delaying local anesthetic absorption and enabling a small amount of anesthetics; reduction of salivary flow and gag reflex; aid in maintain the blood pressure and glycaemia in hypertensive or diabetic patients, respectively [1]. Other advantage of anxiolytics is the role in preventing emergency situations, such as lipothymy and hyperventilation syndrome, because it seems already well established that emergency cases occur much more frequently in patients with anxiety and apprehensiveness poorly controlled [12].

The use of anxiolytics is contraindicated in pregnant women (both at first and last trimesters); patients with glaucoma or myasthenia gravis; children with severe physical or mental disabilities; patients addicted to other central nervous system depressants, including chronic alcoholics; and patients with allergy to benzodiazepines [1].

Table I – Benzodiazepines more commonly employed in Dentistry [5]

Generic name	Brand name	Presentation	Usual Dosage
Diazepam	Valium	5 or 10 mg tablets 10 mg vials	Adult: 5-10 mg Child: 0.1-0.3 mg/kg
Lorazepam	Lorax	1 or 2 mg tablets	Adult: 1-2 mg Elderly: 0.5-1 mg
Bromazepam	Lexotam	3 or 6 mg tablets	Adult: 3 mg Elderly: 1.5 mg
Midazolam	Dormonid	15 mg tablets	Adult: 15 mg

The protocol use for diazepam and bromazepam is single dosage administered 1 hour before appointment, through oral route. Lorazepam should be taken 2 hours before appointment. In extremely anxious patients, the dentist can prescribe one dosage at the night before the appointment, aiming at providing a calmier sleep [1].

Analgesics

Pain has been defined as unpleasant sensorial and emotional experience associated with tissue or other type of damage. Notwithstanding, the pain is essential for the human beings because of its defensive character, acting as a warning sign of eminent or real damage to any organ or tissue. However, because human being is not adapted to this situation, which frequently becomes extremely unpleasant, pain control through specific drugs is necessary [1].

Clinically, pain is classified as superficial or deep. Superficial pain normally is well localized (needle stick, incision of soft tissues, etc.), while deep pain can irradiate, be referred to other areas (i.e., apical abscesses) and be extremely unpleasant provoking nausea, paleness, and sweating [24]. According to Andrade (1999) [1], pain can occur both at pre-, trans-, and postoperative periods of invasive dental procedures in asymptomatic patients.

In Dentistry, the drugs employed in pain prevention and control includes local anesthetic solutions, and the so-called analgesic and anti-inflammatory drugs [1].

Tortamano and Armonia (2001) [24] classified the analgesics in three groups: 1. Centrally acting analgesics (opioids); 2. Peripherally acting

analgesics (non-opioids); 3. Anti-inflammatory acting analgesics.

Opioid analgesics comprise morphine, codeine, meperidine, propoxyphene and dextropropoxyphene. According to Neidle and Yagiela (1989) [14], such drugs are employed exclusively for pain control in Dentistry. However, pain of dental origin frequently comes from inflammation or it is followed by this latter. Consequently, non-opioid analgesics with anti-inflammatory action are the first option for dental pain relief. Opioid analgesics are particularly useful when additional pain relief is necessary. Opioid analgesics associated with aspirin, for example, are commonly employed because both central and peripheral analgesic mechanisms are involved, respectively. Among the opioid analgesics available for dental use, codeine is the drug of choice.

Generally opioids may cause physical and mental addiction, and respiratory depression. Other implications are related to possible drug interactions (with drugs prescribed by either the dentist or physician) [14, 24].

Jayakodi *et al*. (2012) [9] affirmed that in case of pain of endodontic origin, patients should be treated with non-opioid analgesics; however, if the pain is not controlled, opioid analgesic must be used.

In an study conducted with the members of the American Association of Endodontists to determine the preference regarding analgesics use, Mickel *et al*. (2006) [13] proved that non-opioid drugs were more employed than opioid analgesics for most of the clinical situations.

Peripheral acting analgesics include dipyrone and p aminophenol (paracetamol). Such drugs practically do not have anti-inflammatory action [24].

Anti-inflammatory analgesics are considered as peripheral acting drugs even they also have action on central nervous system. This group comprises acetylsalicylic acid, diclofenac sodium and potassium, among others. The usual dosage for acetylsalicylic acid acts as both anti-inflammatory antipyretic drug is 30% higher than the analgesic dosage. Adverse side effects have been gastric irritation, decreased platelet adhesiveness and teratogenic effects [24].

Leonardo and Leal (1998) [10] pointed out that systemic drugs for Endodontics is restricted to the use of analgesics to provide more comfort to patient. Preferably, the dentist should prescribe either paracetamol or salicylates. Andrade (1999) [1] also recommended analgesics but warned to performed the local or total intervention of root canals. And Raldi *et al*. (2002) [18] suggested the use of analgesics associated with anti-inflammatory drugs, in emergency cases.

According to Andrade (1999) [1], in elderly patients, the use of either paracetamol or dipyrone is recommended for mild to moderate pain control because they do not provoke gastric irritation and interference in hemostasis. In children, the prevention in mild to moderate pain control, either paracetamol or dipyrone solutions is recommended, as drops. Similarly, these aforementioned drugs can be used in pregnant women, respecting the limit of three daily dosages, at four-hour interval, restricted by time. Cruz Filho and Pécora (1997) [4] and Tortamano and Armonia (2001) [24] emphasized that p aminophenol group (paracetamol) is the most indicated for children and pregnant women.

As the pulp is at irreversible phase, drugs are ineffective and administering analgesics is worthless. The most adequate and effective pain management is to access the root canals. As the patient is at transitional phase (from acute reversible to acute irreversible pulpitis), analgesics are effective [4, 9, 26]. According to Lopes and Siqueira Júnior (1999) [11], analgesic/anti-inflammatory drugs are recommended due to chair time limitation; operator's inability; periradicular pain; morphological problems; and multiple-appointment endodontic treatment.

Andrade (1999) [1] emphasized that analgesics can be administered both in cases of pulp necrosis without periapical involvement, after accessing root canal and irreversible pulpitis which mild to moderate pain is already expected and can be prevented.

Analgesics together with anti-inflammatory drugs have been mainly indicated in cases of endodontic emergency cases such as acute pericementitis [5, 18]. According to Andrade (1999) [1], it is worth prescribing analgesics for postoperative pain control after canal instrumentation because the latter is an invasive intervention at greater risk of provoking pain.

In acute apical periodontitis of bacterial origin, to prescribe analgesics/anti-inflammatory drugs at 24/48 after the removal of the septic-toxic content inside root canal provides greater comfort to patient and stops the events following the acute phase [10]. Lopes and Siqueira Júnior (1999) [11] recommended the use of analgesics in cases of mild postoperative pain. Severe and persistent pain treatment will depend on the situation: a) satisfactory root filling

– to prescribe analgesics/anti-inflammatory drugs; b) unsatisfactory long root filling – to retreat the canal. Unsolved cases should be treated by either endodontic retreatment or periradicular surgery.

Andrade (1999) [1] pointed out that acute dentoalveolar abscess cases should be treated by dipyrone or paracetamol for pain control (table II). According to Lopes and Siqueira Júnior (1999) [11] and Raldi *et al.* (2002) [18], in cases of acute periradicular cases, analgesic and anti-inflammatory drugs are recommended at all phases. Cruz Filho and Pécora (1997) [4] emphasized that analgesics should be administered whenever the patient feels pain in cases of acute dentoalveolar pain, mainly at the two first phases.

Table II – Analgesics more commonly employed in Dentistry [5]

Generic Name	Presentation	Posology
Dipyrone	Tablets – 500 mg Drops – 500 mg/ml Solution – 50 mg/ml	Adults: 1 to 2 tablets, 6/6 h Children: 6 to 15 mg/kg/dosage (maximum dosage 4 g/day)
Paracetamol	Tablets – 500 mg e 750 mg Drops – 200 mg/ml Suspension – 160 mg/5 ml	Adults: 1 to 2 tablets, 4/4 h Children: 1 drop/kg (at maximum 4 times/day)

Anti-inflammatory drugs

Inflammation is the body's defense response against different injury types: physical, chemical, and biological [24].

Andrade (1999) [1] divided anti-inflammatory drugs into two groups: corticosteroids and non-steroidal anti-inflammatory drugs (NSAIDs) Table III shows the anti-inflammatory drugs more used in Dentistry.

Both betamethasone and dexamethasone are the corticosteroids of choice for dental use, through systemic route, because they have an action power 25 times greater than that of hydrocortisone, the standard drug of corticosteroids. Moreover, betamethasone and dexamethasone exhibit longer plasmatic half-life enabling their use at single preoperative dosage. It is important to emphasize that corticosteroids employed at restrained time, even massive dosages, practically do not show side effects of clinical significance [1].

Pochapski *et al.* (2009) [17] observed the effect of dexamethasone as preoperative drug. By evaluating the effectiveness of single dexamethasone dosage one hour before the procedure, the authors found significant reduction in postoperative pain for 4 to 12 hours.

Still according to Andrade (1999) [1], both betamethasone and dexamethasone has been contraindicated in cases of patients presenting: fungal systemic diseases and/or herpes simplex eye infection; active or inactive tuberculosis; allergy to any of the drugs. Caution should be taken with pregnant or lactating women; diabetic, hypertensive, cardiac, and immunosuppressed patients; and patients with active peptic ulcer, Acute disseminated bacterial infection, and bronchial asthma.

NSAIDs can also be indicated as pre- and postoperative drugs in dental procedures in which severe inflammatory response is expected aiming at preventing excessive pain and swelling. Similarly, NSAIDs can be employed as adjuvants to clinical procedures for pain control in cases that acute inflammatory events are already installed, such as pericementitis, especially those from diclofenac sodium and potassium [1].

Cruz Filho and Pécora (1997) [4] indicated anti-inflammatory drugs in cases of pericementitis and after periapical surgeries. In cases of pulpectomies, it is not common to prescribed analgesic/anti-inflammatory drugs, except if patient exhibits moderate pain, when anti-inflammatory drugs are employed.

In cases of pain due to endodontic treatment, especially in cases of over instrumentation or difficult instrumentation (atresic root canals, pulp calcifications), preoperative medication is advised (4 mg of betamethasone, 30 minutes before the appointment, at single dosage).

Raldi *et al.* (2002) [18] recommended the use of analgesic and anti-inflammatory drugs in cases of pulp pathology. Andrade (1999) [1] indicated the

use of corticosteroid because they do not provoke gastric irritation and interference in hemostasis.

According to Leonardo and Leal (1998) [10], in acute apical periodontitis of bacterial origin, one should prescribe analgesics/anti-inflammatory drugs at 24/48 after the removal of the septic-toxic content inside root canal.

In pericementitis with pup involvement, one should prescribe 4 mg of betamethasone or dexamethasone (at single dosage, through oral route), to instrument the root canal partially or totally, and adjust the patient's occlusion. In pericementitis without pup involvement (i.e. oclusal trauma), one should prescribe betamethasone or dexamethasone 4 mg (at single dosage, through oral route); or ibuprofen 600 mg, or nimesulide 100 mg at every 12 hours; or meloxicam, at single dosage, for at maximum 48 hour period, after tooth occlusion adjustment [1, 6].

Estrela (2004) [6] pointed out that in cases of symptomatic traumatic apical periodontitis, the absence of microorganisms is assumed, so that anti-inflammatory drugs are prescribed.

According to Andrade (1999) [1], both to prevent and control acute inflammatory responses of dental origin, treatment length of these drugs must be set at a maximum period of 48 hours. Chronic use of anti-inflammatory drugs (for more than 4 to 5 days) lacks of scientific support.

Table III – Anti-inflammatory drugs more commonly employed in Dentistry [5]. Adult use.

Generic name	Presentation	Posology
Acetylsalicylic acid	Tablets – 100 mg and 500 mg Drops – 10 mg/drop*	50 to 100 mg/day, 4/4 or 6/6 h (maximum dosage 3 g)
Ibuprofen	Tablets – 200 mg Drops – 50 mg/ml*	1 to 2 tablets – 3 to 4 times/day
Diclofenac	Capsules/ Tablets – 50, 75 and 100 mg	100 to 150 mg/day, 8/8 h or 12/12 h
Meloxicam	Tablets – 7.5 and 15 mg	7.5 to 15 mg/day
Nimesulide	Tablets – 100 mg	1 tablet, 12/12 h
Betamethasone	Tablets – 0.5 and 2 mg	0.1 to 0.25 mg/kg/day, 8/8 h or 12/12 h
Dexamethasone	Tablets – 0.5, 0.75 and 4 mg	0.75 to 15 mg/day, 6/6 h or 12/12 h

Antibiotics

Typical bacterial dental infection, either periodontal or periapical, is currently considered as mixed infection with involvement of aerobic, facultative anaerobic, and restricted anaerobic microorganisms. Dental infections are unlikely composed of pure cultures, that is, to be caused by a single microorganism. Accordingly, the dynamics of this infection is very complex and does not allow the establishment of standard evolution or course [1].

According to Andrade (1999) [1], antibiotics are chemically substances produced by either live microorganisms or semi-synthetic process aiming at inhibiting pathogens and eventually destroying these microorganisms. Antibiotics can be classified according to different criteria, but the most important criteria have been: 1) o biological action – bactericide (capable of destroying susceptible microorganisms) and bacteriostatic (only inhibits the growth and multiplication of susceptible microorganisms); 2) spectrum of action – antibiotics acting mainly against gram-positive bacteria (i.e., penicillins G, penicillins V, vancomycin); antibiotics acting mainly against gram-negative bacteria (i.e., aminoglycosides), antibiotics acting mainly against gram-negative and gram-positive bacteria (i.e., semisynthetic penicillins – amoxicillin, ampicillin –, cephalosporins, tetracyclines), antibiotics acting against anaerobes (i.e., penicillins, tetracyclines, metronidazole), antibiotics acting against spirochetes (i.e., penicillins, cephalosporins, erythromycin, tetracyclines), antibiotics acting

against fungi (i.e., nystatin) and antibiotics acting against other microorganisms.

Siqueira Júnior (1997) [20], Soares *et al*. (2005) [21] and Oliveira *et al*. (2010) [15] pointed out the occasions in which antibiotics have to be prescribed in Endodontics: a) acute periapical abscesses with signs of systemic involvement; acute periapical abscesses in immunosuppressed patients; b) prophylaxis of infection associated with tooth avulsion; c) treatment of persistent symptomatology and/or exudation after the performance of all available options to control inter-radicular infection; d) prophylaxis against bacteremia caused by endodontic treatment in immunosuppressed patients or patients susceptible to bacterial endocarditis according the guidelines of the American Heart Association (AHA) or the recommendations of the patient's physician ; e) abscess dissemination causing diffuse tumefactions.

Acute apical abscess with localized tumefaction without systemic involvement occurring in healthy patients can be properly treated by drainage through incision and/or root canal, followed by the complete chemical-mechanical preparation of root canal and application of intracanal medication, without requiring antibiotics.

In healthy individuals, the drainage of the purulent exudate enables the significant reduction of microbial irritants and inflammation chemical mediators, allowing the beginning of the healing process without antibiotics. Unlikely, in immunosuppressed patients, antibiotics should be prescribed even in case of effective drainage because systemic complication may occur even in mild infectious cases. When acute apical abscess is associated with diffuse tumefactions leading to develop cellulites with infectious process dissemination to other anatomic spaces, or when acute apical abscess exhibits evidences of systemic involvement, such as fever, malaise, regional lymphadenitis or trismus, antibiotics are necessary as adjuvant treatment to drainage because the patient's immune system is incapable of stopping the infection advance. Amoxicillin associated with clavulanic acid (three times per day) has been more effective and safer option because of the isolated bacterial profile of this lesion type [15].

According to Wannmacher and Ferreira (1999) [26], the duration of systemic therapy in abscess treatment should be until some days after the disappearance of clinical manifestations, generally, from 7 to 10 days. This period avoids relapses.

Pallasch (1996) [16] affirmed that longer antibiotic therapy does not destroy all resistant microorganisms and only selects resistant species. If professional's expertise and infection nature (orofacial infections last from 2 to 7 days) determine that the disease course will be from 3 days, then 3 days of antimicrobial therapy is enough; if 5 days are set, 5 treatment days are necessary, and so on. Accordingly, as the clinical disease evidences are practically solved, systemic therapy can be interrupted.

Vier-Pelisser *et al*. (2008) [25] studied which are the intracanal and systemic medications used in Brazilian School of Dentistry in emergency treatment of acute periapical abscess. By using a questionnaire to record intracanal and systemic medications, the authors concluded that antibiotics were the most used systemic medication, regardless of the abscess phase, with amoxicillin the drug of choice.

Tortamano and Antoniazzi (2007) [23] observed the effectiveness of chemical-mechanical preparation of root canals associated with the systemic use of azithromycin in acute periapical infections with systemic involvement. By conducting an open non-comparative study to evaluate the clinical evolution, antimicrobial activity and tolerability of azithromycin in 38 patients submitted to single dosage of 500 mg, for a period of 3 days, the authors deduced that azithromycin associated with chemical-mechanical preparation is a good option to treat acute periapical infections with systemic involvement thus being indicated for patients allergic to penicillin.

In cases of replantation of avulsed teeth, antibiotics favor the treatment prognosis [20]. The International Association for Dental Traumatology (IADT) published in 2007, a consensus on management of tooth avulsion cases in which recommended the use of doxycycline systemically administered (100 mg/day for 7 days) for these cases. Although tetracyclines have been associated with tooth pigmentation, this side effect generally is observed with dosages above 3 grams and periods longer than 10 days in children aged less than 8 years. However, doxycycline, different from other tetracyclines, does not seem to cause intrinsic tooth pigmentation. The option for young patients is penicillin V (phenoxymethylpenicillin – 40 mg/kg/day or 50.000 U/kg/day, at 6/6 hours for 7 days) [15].

Rarely, when intracanal procedures of chemical-mechanical preparation and intracanal medication are not enough to eliminate the infection agent (which can already be closely in the periradicular tissues), antibiotics can be used to control persistent signs and symptoms, such as persistent exudate

at obturation moment. Amoxicillin 875 mg, soluble tablets, at every 12 hours; amoxicillin 500 mg capsules at every 8 hours are the antibiotics of choice, as seen in table IV. Clindamycin (capsules of 300 mg, at every 8 hours) can be administered to allergic patients, but metronidazole is not indicated because frequently the microorganisms associated with these cases have been *Actinomyces* and *Propionibacterium*, generally resistant to this antimicrobial drug [15].

By detecting the resistance of bacterial genes to antibiotics in samples of acute and chronic endodontic infection, Rôças and Siqueira Júnior (2013) [19] observed that after root canal instrumentation, approximately 60% of the cases still presented bacteria, which disappeared after the use of antibiotics.

Root canal therapy is at low or negligible risk for developing bacterial endocarditis, since the main Endodontics's principle is respected: lack of periapical aggression, through instrumentation restricted to the canal. Thus, prophylactic antibiotics are not indicated. The same is indicated for intraoral anesthetic infiltration. Unlikely, intraligamentary anesthesia and endodontic procedures at risk of instrumentation beyond the foramen (i.e., apical resorptions) required antibiotic prophylactics in patients at risk of endocarditis [21].

The protocol proposed by the American Heart Association states that antibiotics must be administered one hour (oral route) or 30 minutes (intravenous route) before the procedure. The antibiotics of choice are amoxicillin 2 grams. Patients allergic to penicillin should receive clindamycin 600 mg [15].

Table IV – Therapeutic dosages for adults (oral route) [20]

Antibiotic	Dosage	Commercial brand
Amoxicillin	500 mg at every 8 h	Amoxicillin; Amoxil; Amoxifar; Amplamox; Clavulin (associated with clavulanic acid); Hiconcil
Clindamycin	150 mg at every 6 h	Dalacin-C
Metronidazole	400 mg at every 8 h	Flagyl; Metronix
Ciprofloxacin	500 mg at every 12 h	Ciflox; Cipro; Ciprex; Procin; Quinoflox
Penicillin V	500 mg at every 6 h	Pen-Ve-Oral; Meracilina
Erythromycin	250 mg at every 6 h	Erythromycin; Eritrex; Ilosone; Pantomicina; Ilotrex; Lisotrex
doxycycline	Initial (200 mg): 100 mg at every 12 h Maintenance: 100 mg per day	Vibramycin

It is very important emphasizing that in acute orofacial infections, the common reason of antibiotic failure is attributed to lack of infection source elimination. The dentist should be aware of direct clinical intervention attempting to eliminate the infectious foci, because in cases of endodontic infections, systemic treatment is worthless without the association of the local treatment of the disease [1].

Conclusion

In Endodontics practice, systemic medication is occasionally indicated as adjuvant to treatment by acting on pain, inflammation and infection control, thus providing greater comfort and more security to patient.

It is extremely important that the dentist know the drug type to be used in each case and whether

systemic therapy is really required, by carefully analyzing the clinical signs and symptoms.

Other important factor is to observe carefully the treatment time with such medications, mainly for antibiotics, because indiscriminate antibiotic use is the main cause of bacterial resistance. Thus, caution is necessary when using these medications, by respecting the results of well-controlled studies that show the best options for clinical use of such drugs.

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Case Report Article

Myiasis in maxillofacial region: series of three cases

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Abstract

Introduction: Myiasis is a disease caused by larvae of flies in organs and tissues of man or other vertebrate animals, where they install and evolve as parasites. The human myiasis is common in tropical countries, most frequently affecting rural people, immunocompromised patients and those with psychiatric disorders. It has great destructive potential and needs adequate prevention and treatment for resolution or non-occurrence of this manifestation. **Objective:** This paper aims to report a series of three cases of patients with presence of myiasis in face: 1) firearm injury postoperative complication in the mandible in a drug user patient; 2) wound after trauma in the region of the upper lip in a patient using illicit drugs; and 3) complication due to poor oral hygiene of a patient with neurological and motor deficits. **Case report:** The care required by these patients is different because this complication is easily prevented by basic and personal health care, although it represents a complicating factor for surgical procedures and/or dental care. **Conclusion:** The role of health professionals in patients with special needs and/or drug addiction become sometimes a challenge for dental practice, requiring individualized attention to each patient.

Introduction

Myiasis is an infestation in tissues and organs caused by dipteran larvae in humans or animals, by depositing their eggs in the human body. It affects mostly people of low socioeconomic level in tropical regions, immunocompromised and with psychiatric disorders. Due to the great destructive potential, prevention and appropriate treatment, performed in a timely manner, are extremely needed [5].

The name myiasis in English is derived from the Greek word "Mya", which means fly. The flies lay their eggs, which will hatch in larva and infiltrate tissues that led to degenerate this area [3]. Ambrose Pare, in 1557, was the first to realize the presence of larvae in battle wounds, a fact reported as a wound with foul odor, full of worms, with the presence of gangrene and putrefaction [14].

Risk factors for myiasis and other social problems are the low socioeconomic level, substance abuse and unemployment, with the young adult males at most risk for various diseases and to the comorbidities described. Mandible fractures are among the most frequently found injuries in trauma treatment centers, having as its main causes the physical aggression or for firearm consequences [4] discussed and reported in this article.

This paper aims to present a series of three patients with myiasis in face: 1) firearm injury postoperative complication, in mandible; 2) after trauma upper lip in a patient with drug addiction; and 3) complication due to poor of oral hygiene in a patient with neurological and motor deficits.

Case report

Case 1

Caucasian male patient, aged 27 years-old, arrived at the emergency room at the São José dos Pinhais Hospital and Maternity (SJPHM) in São José dos Pinhais City, Paraná State, Brazil, with firearm wound in the mandible (figure 1), with history of alcohol and illegal drugs abuse, but without medical comorbidities or systemic alterations.

Figure 1 – Clinical evaluation of the patient arriving at the emergency room of the hospital

After being submitted to tracheostomy and soft tissue suturing, the patient developed difficulty in swallowing due to posterior projection of the tongue by edema and failure of bone structure, which compromised the muscle action. It was opted to install a nasogastric tube, which remained until the condition improves, when the patient was submitted to surgical reduction and fixation of comminuted bone fragments (figure 2).

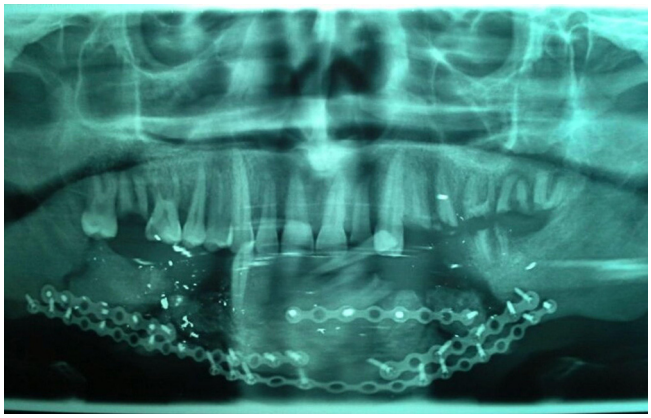

Figure 2 – Immediate postoperative of mandibular reconstruction after FAF

At seven months postoperatively, with no patient follow up for failure in outpatient appointments, he presented himself to the emergency room of the hospital complaining of pain in the jaw. At clinical examination, necrosis could be assessed

by the exposure of synthesis material, purulent collection, fetid odor and fly larvae in surgical wound area (figure 3). The patient was hospitalized and Ivermectin™ was prescribed to control infestation; antibiotics to control infection of the surgical site; and analgesic to control acute pain. After 48 hours, he was surgically treated towards mechanical removal of the infestation by sequestrectomy, synthesis material removal and cleanliness of the exposed operative cavity. At 8 months of following-up, the patient showed good clinical outcome, without postoperative intercurrences.

Figure 3 - Myiasis in operatory wound with presence of exposure of plates and screws and purulent collection

Case 2

Male patient, aged 43 years-old, victim of on running over remaining unconscious without hospital care for approximately 48 hours was referred to the Department of Oral and Maxillofacial Surgery of SJPHM 15 days after the accident complaining of wound on the upper lip and the presence of pain and swelling in the same region, without comorbidities or medical histories of systemic diseases, but referring abuse of drugs and alcohol.

The clinical examination showed upper lip edema with the presence of cavity on the internal side of the same region where it was observed local infestation with diagnosis of cutaneous myiasis (figure 4). It was performed mechanical debridement and sanitation of the infestation (figure 5). The patient recovered well without complications after treatment.

Figure 4 - Myiasis in the upper lip

Figure 5 - Transoperatively: mechanical removal of infestation

Case 3

Male patient aged 84 years-old with a history of stroke about 15 years ago, bedridden and in need of special care since the incident was referred to the emergency department of the aforementioned hospital with an intraoral bleeding and facial edema.

The patient exhibited midface swelling on the left side and gingival laceration lesion on the same side. At intraoral clinical examination, it could be observed larvae local infestation in maxillary sinus leading to the diagnosis of myiasis (figure 6).

Figure 6 – Clinical evaluation of myiasis in the maxillary sinus on the left side and larvae removed from the patient's left maxillary sinus

Mechanical removal was performed and abundant irrigation treatment of the disease. The patient evolved to death by medical problems before healing of the infestation.

Discussion

There are two criteria for the classification of myiasis: clinical and parasitological. Clinically, myiasis are classified according to their anatomical location in cutaneous, intestinal, and in cavity [10]. In cutaneous myiasis the larva can produce a similar process to a furuncle, invade the dermis or preexisting injuries causing respectively the wound myiasis. The cavitary myiasis is that in which the larvae develop in natural cavities of the human body such as the mouth, nose, ears, eyes, vagina or anus. They are sub classified according to the type of cavity: oral, nasal, anal, vaginal myiasis, among others. The parasitological classification is based on both the biological behavior of the larvae and the type of the invaded tissue, separating them into three categories: mandatory, optional and accidental [10].

This event is most common in bedridden or people requiring special needs, because the caregiver is responsible for patient hygiene [2, 6, 9, 15, 16]. Drug users sometimes cannot maintain basic postoperative care and they are exposed more easily to this type of situation. As can be observed in the reported cases, patients with a history of abuse of drugs, alcohol and neurological deficit were the carriers of parasitic infestation, due to lack of basic oral hygiene in surgical wound.

Mandible injuries are the most frequently injuries found in trauma treatment centers and constitute the second most frequent type in facial bones [8]; they can involve a high number of sub-regions of the jaw. Currently, its main causes are physical aggression or firearm injury, followed by car accidents [7, 8]. The main risk factors are drug abuse and unemployment [7]. The most affected age group is 27-35 years, approximately, and the proportion of men is around 72-89%, probably because it is this group that is most involved in activities related to risk behavior, such as crimes and drug use [4, 8, 15]. Accordingly, drug abuse is widely discussed in the literature as an etiological risk factor for mandibular fractures, as well as for the presence of infections and morbidities acquired directly or indirectly by alcohol abuse or illicit drugs [13].

Standard guidelines for the management of oral myiasis do not exist, but few authors note that the ideal approach is to remove all larvae and perform surgical debridement [1, 11], which was the treatment of choice in cases 1 and 2 with surgical mechanical removal of larvae leading to the healing of myiasis in both cases.

Treatment approaches other than procedural removal of the maggots include occlusion and administration of larvacides [11]. These techniques can be used in addition to manual removal, or when manual removal is not possible [5]. In the first reported case, Ivermectin™ was used to reduce the extent of mechanical debridement of the larvae, resulting in lower cosmetic and functional defects to the patient. Occlusion of the wound by pressure dressing promotes a decrease of oxygen which kills the larvae or induces them to move more superficially where they can be removed more easily. The choice of the combined treatment was due to the fact that the region has already surgically treated due to firearm injury with comminuted destruction of the patient's mandible. Through this procedure, a greater surgical access can be avoided resulting in a less aggressive myiasis.

Drug abuse results in various individual and social consequences and has a strong impact in terms of severe health complications, risky behaviors, violence, and social problems [18]. The use of alcohol and illicit drugs is a common theme in patients with traumatic injury referred to trauma centers. In addition, associated with patient care issues, these common precipitants of clinician contact and costly hospitalizations particularly challenges our trauma care systems and compromises their ability to provide conventional medical services [12].

Substance use can also affect the outcomes of fracture treatment strategies, such as maxillomandibulary fixation, which rely on the patient's ability to follow postoperative instructions and maintain adequate oral care [12].

Shekarchizadeh et al. [17] demonstrated that poor oral health behavior among addicts withdrawal treatment, especially those less educated and at greatest risk for oral diseases. Educational and preventive strategies on oral health should be integrated into other care provided for addicts, taking into account distinct patient subgroups [17].

Patients with debilitating diseases constitute a risk group for oral myiasis and prevention of this disease is a challenge for caregivers and family members, especially in the case of patients with absence of lip sealing. The information and instructions to families, caregivers and long-stay hospitals, in relation to oral and environmental care, and routine assessment of oral health status of these patients are the main preventive strategies for this group [17]. The care of patients with special needs for debilitating diseases or behavioral disorders (such as the case of patients with alcohol and illicit drugs abusive use) requires special attention. This type of complication reported in this study is easily prevented by basic health and personal hygiene. The installation of measures of basic sanitation care also provides a means of avoiding this type of manifestation.

Surgeons should be alert to several modalities of postoperative complications for their patients. The immediate attention and proper treatment for this manifestation type is essential for the satisfactory case prognosis.

Orientations of care given to the patient and caregivers are of paramount importance to avoid cases such as those described. Accordingly, preventive measures are still the best way to combat this infestation. Adequate corporal hygiene and sanitary education, by specific training of the population and health professionals are important factors and combat indirectly a series of other diseases, aiming to improve the quality of life of the general population [16].

The health assistance of people with drug and alcohol abuse becomes increasingly difficult to cure, to rehabilitate and to integrate them into society. Treatment and care for such patients becomes, thus, a challenge for the responsible team, requiring a multidisciplinary integration to improve prognosis and facilitate the resolution of the case.

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Case Report Article

Prader-Willi Syndrome: clinical case report

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Abstract

Introduction: Prader-Willi syndrome (PWS) is a neurobehavioral genetic disease whose cause is failure on chromosome 15. It is considered the primary genetic cause of obesity, since it is characterized by hyperphagia. Although the scientific literature will produce articles on Prader-Willi syndrome, few reported oral conditions of these patients. **Objective:** This study aimed to describe the oral health status of a patient diagnosed with PWS. **Case report:** A boy aged 10 years-old, leucoderma, attended the Discipline of Dentistry for Special Care Patients, Pontifical Catholic University of Paraná (PUCPR), with all the inherent PWS characteristics such as hyperphagia and obesity. Clinical, radiographic and laboratory tests were performed to verify the oral health conditions which showed the presence of biofilm accumulation, gingivitis and a high DMFT index. It was necessary to adequate oral environment through extractions, restorations, and prophylactic therapy. **Conclusion:** Considering the information obtained, it was concluded that the motivation to maintain oral health should be constant for this patient and involve family, since hyperphagia, which is a determinant for obesity, decisively contributes to the evolution of oral diseases.

Introduction

Prader-Willi syndrome (PWS), described by Prader, Labhart and Willi in 1956, is considered a neurobehavioral disease currently indicated as one of the most frequent cause of chromosome microdeletions [9]. PWS is the most common phenotype of genetic obesity. Additionally, Prader-Willi and Angelman syndromes are the main recognized human diseases determined by mechanisms of genomic imprinting, that is, a genetic phenomenon in which certain genes are expressed by only one allele [7]. In this case, deletion of the proximal portion of the long arm of the paternal chromosome 15 (15 q11-13) or, more rarely translocation of chromosome 15 occurs [8]. The prevalence is of approximately 1 for each 15,000 births on both genders [6].

PWS is characterized by two clinical phases. At first phase, the symptoms are neonatal hypotonia, difficulties to be fed, lethargy, weak cry and hyporeflexia. At second phase, starting from six months of age, a gradual improvement of hypotonia, hyperphagia, weight gain and obesity occur [7, 15]. Obesity is the major cause of the morbidity and mortality increasing among patients exhibiting the syndrome [3]. Clinical features comprised also respiratory problems during sleep, mild to severe mental retardation learning disability and short stature [7, 13, 15].

The syndrome diagnosis is clinical based on physical and behavioral data which can be confirmed by the analysis of chromosome 15 segment (q11-q13) through methylation or in situ hybridization [10].

With regard to oral health of PWS individuals, few studies have been conducted. Some authors reported an increasing in carious teeth and salivary flow reduction [4, 13], in addition to enamel hypoplasia [5, 6]. Although scientific literature is reporting on PWS, little studies focus on oral health conditions of these individuals. Therefore, the aim of this study was to describe the oral condition of a PWS individual treated at the Pontifical Catholic University of Paraná (PUCPR).

Clinical case report

This study was conducted on a leucoderma male patient born by normal delivery. Pre- and post-natal tests were normal indicating a healthy fetus/newborn. Until 6 months of age, the infant was formula-fed exclusively, period after which he started to be fed by solid food. The patient was diagnosed with PWS at three years-old by the medical team of the Clinical Hospital of the Federal University of Parana (UFPR), due to the presence of muscle hypotonia, delay in common psychomotor development phases, difficulty in sucking/swallowing, weak cry, and somnolence.

At 10 years-old, the patient started dental treatment at the Discipline for Special Care Patients (PUCPR). At anamnesis, marked physical alterations of the syndrome were noted, such as: myopia, strabismus, obesity, short stature (figure 1), maxillary lip and labial commissures facing down, small hands, and hypopigmentation of the hair, skin and eyes. The patient's mother reported during anamnesis that her pregnancy was uneventful and no other cases have been seen in the family. The mother still informed that her son had episodes of nervousness and anxiety due to dietary restrictions. The patient has been treated by a multidisciplinary team composed by nutritionist, psychologist, and endocrinologist. During his free time, the patient liked to play videogame, listen to music and sing.

During current medical history, patient exhibited cognitive deficiency characterized by learning difficulties, mainly related to writing. During past dental history, the mother reported that his first dental appointment was at seven years-old, at school, and the behavior was satisfactory.

Intraoral clinical examination revealed significant biofilm accumulation, gingivitis, dry mouth and angular cheilitis. Occlusion examination evidenced ogival palate, anterior crowding, and Class II malocclusion. Panoramic and periapical radiographic examination indicated delay in tooth eruption and tooth crowding at maxillary and mandibular anterior teeth (figure 2).

Figure 1 – Patient's physical characteristics. At 10 years-old, the boy showed obesity, short stature, small hands and feet and hair/skin hypopigmentation

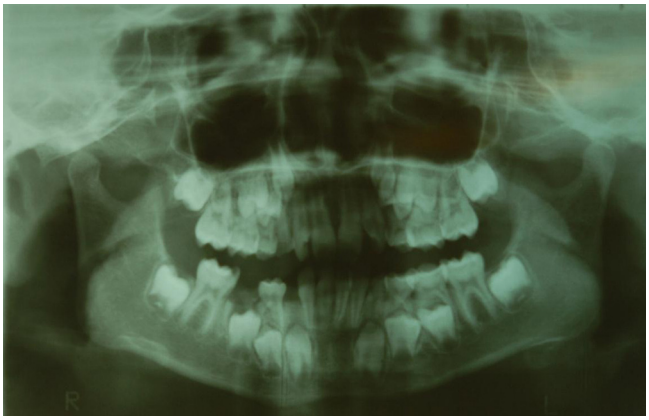

Figure 2 – Panoramic radiographic examination showing maxillary and mandibular anterior tooth crowding and giroversion of some teeth; presence of residual roots of teeth #53, #83, and #85; and loss of tooth #63. Radiographic examination also revealed caries in teeth #16, #26, #46, #73, #74 and #75

Discussion

In this present study, a boy aged 10 years-old was diagnosed with PWS and treated at PUCPR's dental clinic. The clinical characteristics of this syndrome reported in the literature, such as: neonatal hypotonia, difficulties in feeding, lethargy weak cry, hyporeflexia, hyperphagia, and obesity [7, 11, 15], were confirmed by the patient's mother during anamnesis. Short stature, small hands and feet, skin/hair/retina hypopigmentation, thin lips, labial commissures facing down, myopia, and strabismus also described in prior studies were also observed [4, 13, 14].

Randomized clinical trials have demonstrated the favorable effect of growth hormone (GH) reposition to reduce fat mass and increase lean body mass, complementing nutritional guidance. Not with standing, GH seems not to have significant effect on controlling hyperphagia in these patients [13].

Corroborating Cortés et al. [7], Olczak-Kowalczyk et al. [13], and Vargas et al. [15], the patient of this case report showed learning disorder related to writing; but with mild cognitive deficiency. PWS patients also presented bone mineralization decrease, fact explaining the high osteoporosis incidence associated with the syndrome [5].

According to the patient's mother, episodes of irritability were rare, mainly related to dietary restriction. Prior studies also reported this situation [1, 11]. Generally, this study's patient had a sociable and friendly behavior with all multidisciplinary team.

The peculiar facial characteristics of PWS patients were also observed in this case report: almond eyes, thin maxillary lips, labial commissures facing down, and dysmorphic face. Among the oral manifestations reported by Carvalho *et al.* [5, 6], this case report found the presence of caries, enamel hypoplasia, and malocclusion. On the other hand, ogival palate, delay in tooth eruption, supernumerary teeth, microdontia, micrognathia, taurodontism and candidiasis were not seen.

Hyperphagia, the most important PWS feature [7], can explain the high rate of carious teeth observed in this patient who exhibited a DMTF index greater than that of children at same age. Six teeth had caries, three were residual roots and one tooth was lost. The treatment executed comprised the extractions of teeth #53, #83 and #85; resin composite restorations of teeth #16, #26, #46, and #74; and light-cured glass ionomer cement restoration of teeth #73 and #75. Next, preventive measures were instituted with sealants on many teeth and fluoride varnish application.

Other important factor contributing to oral health deterioration is salivary flow decrease [4, 13], a feature clinically observed through dry mucosae. To evaluate the amount of produced saliva, we used the method proposed by Navazesh *et al.* [12] and Banderas-Tarabay [2]. The produced volume was very low, characterizing hyposalivation.

The next step was to instruct the family to adopt measures promoting oral health maintenance. The relatives were instructed regarding to proper oral hygiene, to make them also responsible by the treatment. The patient still continued being followed-up at the Discipline of Dentistry for Special Care Patients of the institution to preserve oral health.

Conclusion

Based on the information obtained after clinical and radiographic examination, it can be concluded that both PWS patient and the family should be constantly motivated to maintain oral health, because hyperphagia which is determinant for obesity, decisively contributed to increase DMTF index. Additionally, hyposalivation can contribute to develop bacterial biofilm and gingivitis.

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Short Communication

The role of the university and post-graduation courses in improving health and life of quality of the society

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Abstract

The relationship between health systems and higher education is of fundamental importance to establish oral health improvements for population. Currently, primary attention's goal is to determine the quality of life of a given population through total denture rehabilitation. Thus the aim of this study was to report the integrated actions between the Health Secretary of the city of Curitiba and the University during the training in Total Denture of primary attention professionals. Fifty dental professional from nine sanitary districts of the city of Curitiba were enrolled in the training. The project comprised theoretical and practical classes during a period of five weeks, from June to July of 2013. More similar actions reinforce the university's role in improving the quality of life of the population and the university integration with public service aiming at updating dental professionals.

Both the Brazilian health and high-education systems developed with separated guidelines. However, their constitutional role has been to promote the construction of less unequal, fairer, and better nation for all [2]. The relationship between these sectors is fundamental to assure improvements in population's health, and consequently, better conditions of the population's life.

Among the university roles stated by the UNESCO Conference held in Paris in 1998 [1], the university should contribute to the definition and treatment of problems affecting the well-being of the community in which the university acts. Moreover, the university's mission, through post-graduation programs, should foster the innovation, interdisciplinary and transdisciplinary, basing the orientation of the teaching, research, and extension on society's goals and needs [1, 3].

The Brazilian unified health system, guided by guidelines of the Health Ministry and Secretary, aims to improve basic and specialized oral health of the population through Centers of Dental Specialties (CEOs). Currently, the basic attention aims to reinforce the prevention, promote oral health, and recover the social rehabilitation of the population through constructing complete dentures.

The courses of Dentistry and Post-Graduation in Dental Clinics of Positivo University (UP) guided by the Brazilian curricular guidelines aim to achieve the generalist, humanist, critical, and reflexive formation of graduates' profile to act in all levels of attention to health, based on ethical and legal principles and on the comprehension of the social, cultural and economic reality of the population [3]. By setting the goals, both courses promote actions aiming at improving the oral health of the population of the city of Curitiba. Among the actions, the partnership between the university and the Health Secretary of the city of Curitiba is emphasized, in which the above-mentioned courses promoted the training (in dental prosthesis) of the dental professionals working in the basic attention of the city, also including the professionals working in the Brazilian Health Programme Strategic Units. Thus, the courses of Dentistry and Master Course in Dentistry through their coordination, professors and students, made available classrooms, clinics, parking lots and materials needed for training. Fifty professionals were enrolled in the training from nine sanitary districts of the city of Curitiba (figure 1).

During the Project, theoretical and practice classes were taught comprising five weeks, starting in June and finishing in July of 2013. The following contents were taught: clinical examination, initial dental impression, functional dental impression, border impression, intraoral records, tooth proof, and installation of prostheses. Twenty-five patients from the health units closest to University received no-cost prosthetic treatment. Both the University's dean and the Secretary of Health of the city of Curitiba participated at the moment of the delivery of the total dentures. After training, nine basic unities (one from each district) were chosen to start constructing total dentures, immediately generating 50 total dentures delivered to the population of the city of Curitiba in primary attention.

The knowledge acquired by the professionals acting in the Health Service of the city of Curitiba during the training in total denture held at university provided dental rehabilitation to the population of the city of Curitiba. More similar actions reinforce the university's role in improving the quality of life of the population.

Figure 1 – Dental professionals performing totals denture treatment.

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