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Impact of Sodium Hypochlorite Gel on Primary Molars Dentin Microhardness - Invitro Study

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Abstract

Introduction: Deciduous dentin structure is pointed to be different from permanent one. Sodium hypochlorite, that is available in various types and concentration, is the prime antibacterial material used in dentistry. Which makes it essential to understand its biocompatibility. This study aims to evaluate the effect of NaOCl gel on deciduous molars dentin microhardness.

Methodology: Fifty specimens of sound primary molars dentin, randomly distributed into five groups (n=10). Specimens of each group was treated with one of following materials for 20 minutes, before being rinsed with water for 5 minutes (NaOCl 5.25% liquid, NaOCl 2.2% liquid, one of two different commercial NaOCl 2.2% gels, sterile water). Then Vickers microhardness test was performed on each specimen, using a 200-g force for 15 seconds. By taking three measurements for each specimen and calculating their average. Data was analyzed at the significance level of 0.05, with SPSS 17.0. Kolmogorov-Smirnov, One-Way ANOVA and LSD multiple comparisons post-hoc tests were performed.

Results: One-Way ANOVA showed a significant difference between the groups ($P < 0.05$). However, it was observed between NaOCl liquid of both concentration groups with sterile water group ($P < 0.05$). There was also a significant difference between the NaOCl 5.25% liquid groups with the NaOCl gel 2.2% type groups ($P < 0.05$). Other comparisons showed no difference between groups ($p > 0.05$).

Conclusion: Appliance of commercial NaOCl 2.2% gel for 20 minutes, did not negatively affect primary molars dentin microhardness. NaOCl 2.2% gel showed better behavior than the liquid type of the same concentration on primary molars dentin.

Keywords: Dentin, microhardness, primary teeth, sodium hypochlorite gel.

Introduction

Deciduous dentin structure is pointed to be different from permanent one. Therefore, its reaction to chemical materials is different too.

Sodium hypochlorite is the prime antibacterial material used in dentistry. It is available in various types and concentration. Making it essential to understand its biocompatibility.

This study aims to evaluate deciduous dentin Vickers microhardness after exposing it to commercial NaOCl (5.25% liquid; 2.2% liquid; 2.2% gel), for 20 minutes.

Background

For decades irrigant solutions were used as a part of dental clinical practice, especially when it comes to endodontic instrumentation procedures. Irrigation is the best method of dentin debris removal, and tissue remains dissolvent during biomechanical preparation of root canals[1,2]. By means of Coolidge recommendations, sodium hypochlorite NaOCl has become the main irrigant in endodontic since 1919 [3].Used in different concentrations ranging between 0.5% - 5.25% [3–5]. NaOCl is well known for its broad antibacterial and antifungal activity, dissolving of necrotic tissue and rarely poisoning or irritating the vital tissues, it destroys microbial biofilm effectively, also it is a great haemostatic during vital pulp therapy[3,4]. In periodontics, sodium hypochlorite is able to reduce the super-gingival biofilm and plaque accumulation, inflammation and bleeding on probing when used as a mouth rinse[6]. Deproteinization of dentin before bonding is another suggested benefit of NaOCl, by its ability to dissolve and remove collagen layer exposed by acid etching[7]; which may increase, decrease or not interfere with bonding strength[8]. Even thought, NaOCl have an oxidative activity on both dentinal collagen and proteins, it seems that hydroxyapatite has a protective role reducing its effect to minimum[3]. NaOCl effect varies through its concentration, time of appliance, temperature, stimulation and volume[2].

Despite of NaOCl advantages, it still have some negatives. It is able to damage clothes, damage eyes, and even cause an allergic reaction in rare cases[3]. However, the most serious incidence during endodontic treatment is its extrusion to the periapical tissues through the apical foramen[3,9,10]. Which may be referred to both misuse of the material and difficulties of handling in the liquid form[7,11]. Zand et al. suggested that the NaOCl solution disadvantages can be averted by the use of NaOCl gel, with optimal effectiveness in smear layer removal[9]. Gel type was suggested to be a safe alternative during irrigation of immature teeth with an open apex upto 2.5mm[12]. Besides that gel form showed less post-operative pain during endodontic procedures[13]. On top of the NaOCl gel easy handling and control, it was as effective as the solution in deproteinization procedures[7] and preserved good antibacterial properties of the material[14,15]. The gel type of NaOCl improved MTA's setting time without effecting MTA's specification, making the treatment possible in one visit[16,17].

In pediatric dentistry, sodium hypochlorite used in several procedures. In Smaïl-Faugeron et al.[18] systematic review, the use of NaOCl was observed as an irrigating solution during primary teeth pulpectomy in diversified concentrations such as 1% - 2.25% and even 5%. In addition, it was used as a haemostatic in direct pulp capping of primary teeth with calcium hydroxide by applying a sterile cotton pellets soaked in the 1.25% sodium hypochlorite solution for one minute without pressure, and placing it over the exposure site; after which success rate reached 93%[18,19]. In the same review[18] the authors mentioned the use of NaOCl during primary teeth pulpotomy as both irrigant and alternative solution to ferric sulfate. Vargas applied sodium hypochlorite 5%

with cotton wool pellet on the pulp stump for 30 seconds; distinguishing a higher clinical and radiographic success than ferric sulfate[20]. The same was seen in the study of Kuo et al. with a clinical and radiographic success rate of 100% over diode laser or no medicament treat, with no significant differences between groups[21]. Chemo-mechanical elimination of carious dentin is suggested as a replacement to conventional caries removal procedure, in which sodium hypochlorite is used alone or as a part of the Carisolv™ material[22]. NaOCl 2.25% gel was suggested as an effective material for caries removal with minimum pain in proximal carious primary molars[23]. Primary and permanent pulp chamber dentin have undergone important changes of both organic and inorganic framework after NaOCl 1% 30 minutes exposure[24]. It is necessary to take the tooth bud beneath deciduous teeth into consideration, which must be protected during irrigation with NaOCl[4], as it makes the gel type a possible substitute.

Primary dentin featured special characteristics[25], distinguishing it from the microstructure of permanent dentin[26]. Calcospherites does not exist on primary dentin in contrary to permanent one[24]. Besides, in primary teeth dentine is thinner and the pulp chamber is relatively greater to its successor[24]. Dental chemical materials cause remarkable microstructural changes to teeth, that may or may not interfere with sealing ability and dentin bonding strength[11]. This is why studying dentin mechanical properties is fundamental[27]. Microhardness test is one of the basic mechanical property analysis that “measures the resistance of the dentin to deformation caused by penetration of an indenting stylus”[27].

This study aims to evaluate the impact of commercial NaOCl gel, in comparison to NaOCl liquid and sterile water, on the primary molars dentin microhardness. The null hypothesis defined as following commercial NaOCl gel has no effect on the microhardness of primary molars dentin.

Methodology

An in-vitro study. After determining a total sample size of N=50 dentin segments, using the G* Power 3.1.7 software {Faul, F., et al. "G* Power Version 3.1.7 [computer software]. Uiversität Kiel, Germany." (2013).}, {Effect size f= 0.6685305/ α err prob= 0.05/ Power (1-β err prob) = 0.95/ Number of groups= 5/ Critical F= 2.5787392}. Sound extracted primary molars without any caries or restorations, from healthy patients due to natural exfoliation or orthodontic requirements, were collected. The removal of the soft tissues from residual roots surfaces was performed with moisture gauze in sterile water; teeth were stored in chloramine-T 0.5% at 4°C for a week. Next, teeth were washed under flowing water, and kept in sterile water at 4°C up to six months, during which the trial was performed.

Each tooth was segmented into buccal and lingual dentin halves (4X4X2 ±0.5), using fin diamond bur on a water-cooled high-speed headpiece (NSK Nakanishi, Inc, Kanuma, Japan). Subsequently, specimens were embedded into acrylic resin. Then, polished with super fine and ultra-fine carbide paper.

Specimens were randomly distributed into five groups (n=10 for each); NaOCl 5.25% liquid group, NaOCl 2.2% liquid group (Clorox® Regular-Bleach 5813-100), NaOCl 2.2% gel group (Clorox® Bleach Whitening Gel CX0063HU), NaOCl 2.2% gel group (Harpic® Whight&Shine bleach gel D0060799 v5.2) and finally a negative control group of sterile water. To achieve researcher blinding, a different individual performed this, and groups maintained unrevealed until statistics were over. Each specimen was exposed to its tester for 20 minutes, before it was rinsed with water for 5 minutes.

Then Vickers (VHN) microhardness test (GALILEO MICROSCAN OD, Italy; 742030100) was done, using a 200-g force for 15 seconds. Three readings were performed for each specimen and average mean for each one was calculated.

For data analyzing SPSS statistics 17.0 (Statistical Package for Social Science, SPSS, version 17.0, SPSS, Chicago, IL, USA) was chosen. Kolmogorov-Smirnov normality test showed that data was parametric and normally distributed (table1) (figure1). Therefore, One-Way ANOVA and LSD multiple comparisons post-hoc tests, at significance level of 0.05 were used.

Results

Descriptive statistics reported as means, standard deviation, standard error, 95% confidence interval, maximums and minimums of each group in (table2). One-Way ANOVA confirmed a significant difference between groups (P= 0.008) (figure 2). Least significant difference (LSD) multiple comparisons post-hoc tests, (table3) showed that: there is significant difference between control group of sterile water and both liquids of NaOCl in two different concentrations of 2.2% and 5.25% (P< 0.05). While gel types decreased microhardness of primary molars dentin in comparison to sterile water without any significant difference between groups (P>0.05). Both liquid concentrations decreased dentin microhardness without any significant difference between them (P>0.05), with a higher effect of 5.25% one. The two gel groups showed similar attitude (P>0.05). There was no difference in primary molars dentin microhardness between both of NaOCl 2.2% gel groups and liquid NaOCl of 2.2% concentration group (P>0.05). However, liquid NaOCl 5.25% decreased microhardness significantly in comparison to gel type groups (P< 0.05).

Discussion

The aim of this study was to estimate effect of sodium hypochlorite various types on microhardness of primary molars dentin.

Two different types of NaOCl were used according to their viscosity. Commercial types have been chosen, as they are easier to be obtained. Gel type consists of sodium hypochlorite solution supplemented with activating vehicle of glutamic acid, leucine, lysine, carboxymethyl cellulose, and ultrapure water[6]. Which makes it important to understand if those additions have any effect on the deciduous teeth dentin properties. As long as commercial companies do not reveal their activating vehicle in the gel type, it was decided to choose two deferent companies gel types to be compared. In addition, to determine the effect of pure NaOCl on the deciduous teeth dentin properties two concentrations of liquid NaOCl were chosen. Finally, sterile water was chosen as a control.

Gel type of NaOCl have some good properties over liquid one. It is easier to handle[7], which is important in pediatric dentistry, and harder to extrude through apical formen[3,9,10,12]. Premature bud of permanent tooth beneath the primary one makes extrusion of irritants through apical foramen essentially important[4].

Recently both Vargas et al. and Kuo et al. used NaOCl in pulpotomy of deciduous teeth as an alternative to ferric sulfate in the first research, and as a comparison to diode laser in the second one. Both of them recorded an encouraging results of its success[20,21]. Because of those results, the pulp chamber of primary molars dentine was chosen to be studied.

The influence of dental materials on the mineral substances of dentin is the main agent in microhardness test[28]. Dentin microhardness is related to both the density of dentin tubes and the concentration of mineral ingredients of it[27]. Dentin is not identical, dentin density

differs from one place to another[29]. Near tooth pulp, tubules become denser, but mineral substances decrease. The least one may affect microhardness more grossly[27]. Microhardness test is performed by measuring dentin deformation by penetrating an indenting stylus[27]. In general, NaOCl decreases dentinal microhardness.

Most practitioners appear to deal with primary teeth the same way they do with permanent teeth, notwithstanding that significant chemical and morphological differences that exist between them[30]. Sumikawa et al.[26] characterized some differences between primary and permanent teeth dentin. They concluded that the density of dentin tubules is greater in primary teeth. Although, thickness of primary dentin is smaller. Numerical dentin tubules density of anterior primary teeth are greater than posterior ones. Despite the fact that permanent dentin tubules diameter is smaller than primary tubules, near the pulp they appear to have the same size. Those important differences between primary and permanent dentin may lead to some modification on bonding techniques'[26].

Garcia et al.[28] recognized a significant reduction in microhardness of root canal dentin of permanent teeth from the initial stage after using of NaOCl 5.5% gel, and NaOCl 2.5% solution for both apical and cervical thirds, without any significant difference between them. These results are similar to the ones in this study from the perspective of microhardness reduction. However, the gel concentration used by Garcia et al. was higher, which may clarify the non-significant microhardness decrease in this study with control group. In addition to that, Garcia et al. studied the root canal dentin in permanent teeth.

Ahmad et al.[1] recognized a reduction in dentin microhardness of root canal dentin in all its levels when exposed to NaOCl solution of both 2.25% and 5.25% solution from the initial stage, without any significance between concentrations. Similar thing was observed in this study for liquid type although it was performed on primary pulp chamber dentin.

Zand et al. concluded that the effect of debris and smear layer removal from root canal in all its levels is similar for both NaOCl gel and liquid 2.5%[9]. In this study it was concluded that gel type was less aggressive on the dentin than the liquid type, giving it an advantage over.

Microhardness of bovine dentin reduction increases by increasing the concentration of NaOCl, and the time of exposure (5 -10-20 min.); exposing dentin to NaOCl for more than 10 minutes increases the risk of microhardness reduction[31]. These results are similar to the ones mentioned in this study for both solutions when used for 20 minutes. Anyway, gel type did not remarkably affect primary teeth microhardness of the same concentration. Which can be referred to the activating vehicle used in it.

Under the limitations of this study, NaOCl can decrease the microhardness of primary teeth dentin when used as a liquid for 20 minutes for both 2.2% and 5.25%. With worse effect for the higher concentration. The 5.25% liquid decreased microhardness significantly more than the gel type did. The 2.2% liquid and the gel type of 2.2% microhardness reduction was nonsignificant. The gel type 2.2% reduction of microhardness is nonsignificant when compared with sterile water, regardless of the manufacturing. Suggesting it, as an alternative to the liquid one of the same or higher concentration.

Conclusion

Appliance of commercial NaOCl 2.2% gel for 20 minutes, did not negatively affect the microhardness of primary molars dentin. Additionally, NaOCl 2.2% gel showed better behavior than liquid type of the same concentration on primary molars dentin. Consequently these results are encouraging to use NaOCl gel in clinical circumstances, it is recommended to investigate NaOCl gel biomechanical probabilities furthermore.

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Legend Tables and Figure

Table 1: The descriptive statistic of primary molars dentin microhardness according to the used irrigant primary molars dentin microhardness

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Sterial Water	10	**122.0000**	25.09480	7.93567	104.0483	139.9517	90.87	163.43
NaOCl2.2% GelC[a]	10	**107.9400**	23.22277	7.34368	91.3274	124.5526	67.97	151.60
NaOCl2.2% GelH[b]	10	**107.0267**	24.45316	7.73277	89.5339	124.5194	74.67	162.30
NaOCl2.2% Liquid	10	**92.7533**	25.39605	8.03094	74.5861	110.9206	65.63	140.93
NaOCl5.2% Liquid	10	**84.8133**	15.82515	5.00435	73.4927	96.1340	65.47	117.93

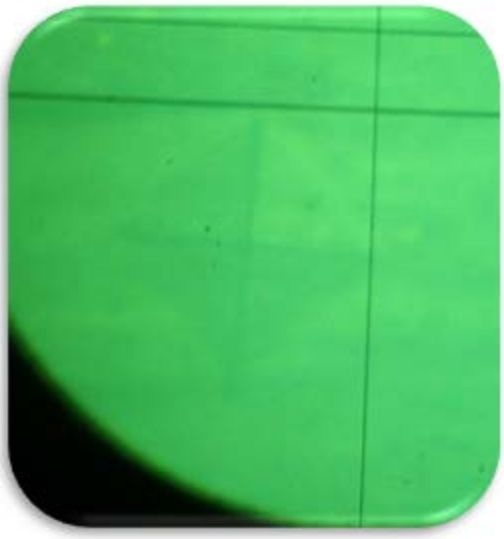
a.Clorox® gel2.2% group

b.Harpic® gel2.2% group

Table 2: Representing the Multiple Comparations Post Hoc LSD test between the groups

Primary Molars Dentin Microhardness LSD	(J) Irrigant	Sig.
Sterial Water	NaOCl2.2% GelC	.180
	NaOCl2.2% GelH	.154
	NaOCl2.2% Liquid	.007
	NaOCl5.2% Liquid	.001
NaOCl2.2% GelC[b]	NaOCl2.2% GelH	.930
	NaOCl2.2% Liquid	.148
	NaOCl5.2% Liquid	.030
NaOCl2.2% GelH[c]	NaOCl2.2% Liquid	.173
	NaOCl5.2% Liquid	.037
NaOCl2.2% Liquid	NaOCl5.2% Liquid	.446

Figure 1: Showing the Lozenge Created on Primary Teeth Dentine Exposed to NaOCl 2.2% Gel for 20 Minutes After Pressing it with a 200-g Force Needle of Vickers Microhardness Test for 15 Seconds.



Figure(2) Box plots representing the microhardness of primary molars dentin changes and means, after exposing it to differant irrigants for 20min according to the experimental groups.