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Short Communications

The disinfecting effect of glutaraldehyde and peracetic acid on tensile load at failure of orthodontic elastomeric chains

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Abstract

Introduction: The purpose of this study was to compare the effect of peracetic acid with glutaraldehyde on tensile load at failure of elastomeric chains after disinfection.

Materials & Methods: Tensile load and extension to failure in 30 elastomeric chains were allocated in three groups was measured using Universal Testing Machine. The results were analyzed using ANOVA and Tukey's post hoc test with a significant level at $p<0.05$.

Results: Glutaraldehyde and peracetic acid decreased the tensile load and elongation to failure of elastomeric chains compared to the control (P=0.03 for tensile load and P=0.01 for extension to failure). There were no significant differences between these two disinfectants (P=0.07 for tensile load and P=0.09 for extension to failure).

Conclusion: There tensile load and elongation to failure in chains decreased in both glutaraldehyde and peracetic acid, which is not clinically significant.

Keywords: Disinfection, Orthodontics, Peracetic acid, Glutaraldehyde

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اثر ضد عفونی گلوتارالدهید و اسید پراستیک بر نیروی کشش در زمان شکست زنجیرهای الاستومریک ارتودنسی

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چکیده

مقدمه:.هدف این مطالعه مقایسه اثر اسید پراستیک با گلوتارالدهید بر نیروی کشش و شکست زنجیرهای الاستومریک بعد از ضد عفونی با انها می باشد.

مواد و روش ها: نیروی کشش و مقدار کشیدگی زمان شکست در ۳۰ عدد زنجیر الاستومریک در سه گروه مطالعه با استفاده از دستگاه آزمایش یونیورسال اندازه گیری شد. نتایج با تست ANOVA و Tukey آنالیز شده و سطح آماری معنی دار $p<0.05$ بود.

یافته ها: گلوتارالدهید و اسید پراستیک نیروی کشش و مقدار کشیدگی زمان شکست را کاهش دادند ($p=0.03$) نیروی کشش($p=0.07$) و مقدار کشیدگی ($p=0.09$)زمان شکست تفاوت آماری معنی دار بین دو گروه ضدعفونی کننده وجود نداشت.

نتیجه گیری: نیروی کشش و مقدار کشیدگی زمان شکست زنجیرهای الاستومریک در هر دو ماده ضدعفونی کننده گلوتارالدهید و اسید پراستیک کاهش یافت که این مقدار کاهش از لحاظ کلینیکی حائز اهمیت نمی باشد.

واژگان کلیدی: ضدعفونی کردن، ارتودنسی، اسید پراستیک، گلوتارالدهید

Introduction

Nowadays, orthodontic springs and elastomeric products are very commonly used because of their high efficiency and relatively low prices. Since orthodontic elastomers might be contaminated with different germs during production process, extensive exposure to disinfectants is inevitable to prevent localization of microorganism infection in oral cavity. [1,2] Chemical interaction of these disinfectants with elastomeric chains and consequent adverse effects on their physical properties has been the major concern in previous investigations. In some studies conducted on glutaraldehyde 2% with different times of exposure, the elastomeric chains have shown no significant decrease in tensile strength until 30 minutes after exposure (disinfection process); however, by further increase in the exposure time (sterilization process), their strength has significantly decreased. [3]

Peracetic acid has been preferred by some investigators as a new disinfectant because of quicker degradation and minimal leftover residues. In contrary to glutaraldehyde, peracetic is self-degradable, nontoxic and nonteratogen. It has been shown that sterilization by autoclave might adversely affect the mechanical characteristics of elastomers and latex elastics compared to chemical disinfection e.g. glutaraldehyde which saves the elastics' strength. [4,5] In health care guidelines, peracetic acid 0.2% would be used to reduce infection rate in hospital. [6] The elastomeric chains are not heat resistant and generally sterilized via cold sterilization. Some studies indicated that disinfection of a elastic can destroy of the cross links available in the

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long chain molecules of polyurethane polyesters. [7] In a study, tensile strength and glass transformation temperature of elastomeric ligatures not disinfected are found significantly different from those exposed to phenol and glutaraldehyde. [2] In another study conducted by Losito et al. (2014), it was reported that there was no significant difference between chlorhexidine 0. 12 and peracetic acid 0.2% on mechanical properties of elastomeric chains and they could be clinically used up to 28 days. [8]

Since orthodontic elastomers might be contaminated with different germs, the purpose of current study was to compare the effect of disinfection by glutaraldehyde 2% and peracetic acid 0.25% on tensile load and elongation to failure of elastomeric chains.

Materials &Methods

This study was approved by the Ethics Committee of Babol University of Medical Sciences, Babol, Iran (with the code of MUBABOL.REC.1395.69). In this in vitro study, according to the previous study, [9] 30 elastomeric chains without space obtained from Orthotechnology (Orthotecnology inc. , West Columbia , US) were divided into three groups: 10 cases as control without disinfection soaked in sterile normal saline, 10 cases disinfected with glutaraldehyde 2% (Behsa Pharmaceutical Co. , Tehran , Iran) for 30 minutes [3] and 10 cases disinfected with peracetic acid 0.25% (BehBan Pharmed Lotus company , Tehran , Iran) for 30 minutes. [8] All chains were irrigated with distilled water for 1 minute. Each chain was inserted between metallic pins of Universal Testing Machine (Koopa, Iran) and fixed with acrylic glue (Bison International B.V., Rotterdam, The Netherlands). The length of all chains was fixed at 12 mm. Each chain was elongated at speed of 20 mm per minute until rapture occurred. [9] At rapture point, the tensile load in Newton (N) and extension to failure in millimeters (mm) were recorded. All data were analyzed by SPSS 17 using one-way ANOVA test and Tukey comparison test with a 95% significant level.

Results

The mean of tensile load at failure and extension to failure are presented in table 1.

Table 1. The mean and standard deviation of tensile load at failure and extension to failure in groups of study

Disinfectant	Glutaraldehyde 2% Mean±SD	Peracetic acid 0.25% Mean±SD	Control Mean±SD	P value According to ANOVA
Tensile load at failure (N)	38.7±4.5	38.1±3.5	42.85±4	P=0.01
Extension to failure (mm)	38.3±0.45	37.9±0.55	45±0.35	P=0.001

(N =Newton) (mm = millimeter)

According to statistical test of ANOVA for both the tensile load at failure and extension to failure, there was a significant difference between study groups (P=0.03 for tensile load at failure and P=0.01 for extension to failure). The Tukey's Post hoc test demonstrated that there were no significant differences between glutaraldehyde and peracetic acid groups neither in tensile load at failure nor in extension to failure (P=0.07 for tensile load at failure and P=0.09 for extension to failure). However, compared to the control group, there was significant decrease in the tensile load at failure and in the extension to failure of both disinfectant groups (P=0.03 for tensile load at failure and P=0.01 for extension to failure).

Discussion

Disinfection with peracetic acid and glutaraldehyde in this study decreased the tensile load at failure of elastomeric chains in comparison to control group. Macedo et al. (2015) has already displayed that the high temperature changes characteristics of elastomers, and the sterilization with autoclave decreases the strength of elasomeric chains. [4] In addition, it was found that the chemical disinfection with hypochlorite sodium 1% and glutaraldehyde 2% decreased the strength of chains which was in accordance to our study. [5] Because of acidic pH, glutaraldehyde had less effect on the strength of chains compared to hypochlorite sodium with basic Ph. [3]

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Evangelista et al. (2007) evaluated the strength of ligature elastomers from American Orthodontics® (AO), 3M® and Rockey Mountain® (RMO) in glutaraldehyde 3.4% and Vital Defense®-D composed of 9% o-phenylphenol and 1% o-benzyl-p-chlorophenol [Vital Defense Company, Denver, Canada] at different times. They claimed that disinfectants could significantly decrease the tensile load at failure of elastomeric chains , which is in complete agreement with our present study results. At that experiment, after 8 hours immersion in disinfectants, the strength of chains reached to a plateau form and was compared to their original tensile load (79% for AO, 86% for 3M and 70% for RMO). The researchers have stated that this decrease is not clinically significant since only 10-20% of tensile load at failure is enough for clinical use. [2]

Singh (2016) evaluated the effect of disinfection by glutaraldehyde at two concentrations of 2% (Glutarex®) and 1.5% (Cidex®) on elastomeric chains made by five different companies. Before 0.5 hour, the tensile load at failure of elastomeric chains for all brands decreased significantly except for one brand, indicating the reduction in tensile load of failure decreased after 0.5 hour. This different result in brands might be owing to different primary materials and production processes. [1] The results of our study are in concordance with those of Singh′s investigation ones.

Losito et al. (2014) declared that disinfection with chlorhexidine 0.2% for 10 minutes and peracetic acid 0.2% for 30 minutes declined the tensile load at failure of chains in a constant elongation. [8] Their results are in agreement with those of the ongoing study, too. They found that chains after 28 days had significant decrease in load and were ineffective in clinical use so they should be replaced.

Pithon et al. (2015) investigated the effects of different sterilization/disinfection methods (70°GL alcohol, autoclave, ultraviolet, peracetic acid and glutaraldehyde) on the mechanical properties of orthodontic elastomeric chains. Ultraviolet treatment was not completely effective for sterilization. No loss of mechanical properties occurred through using different sterilization methods, which is similar to that of our study. [10] The limitation of this study was that only two disinfectants were compared and it is proposed to compare different cold sterilization materials and heat sterilization with each other in future studies. Although the tensile load at failure decreases significantly with both disinfectants (since only 150-200 gram force is needed in the clinical use (about 10-15% of tensile load at failure), this reduction is not clinically important and both these two disinfectants can be used clinically. Nevertheless, according to other study in which the force decreased after 4 weeks [8], the elastomeric chains should be replaced monthly.

Conclusion

There was less tensile load at failure and elongation to failure in chains immersed in glutaraldehyde and peracetic acid, which is not clinically important. This finding might justify the use of newly introduced disinfectant, peracetic acid, in orthodontic procedures if it could show advantages in other aspects.

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Conflict of interest disclosure: The authors state that they have no conflict of interest.

Author's Contribution

The study was designed by Valiollah Arash and Manouchehr Rahmati Kamel. Mohammad Saleh Barati and Ebrahim Zabihi defined the conceptual content of the research. The study data were collected by Mohammad Saleh Barati and Omid Teymournejad and Mohammad Hadi Pashaei. Statistical analysis and interpretation of data were accomplished by Reza Ghorbanipour. The manuscript was prepared by Reza Ghorbanipour and revised by Ebrahim Zabihi contributed to the design and implementation of the research. Study supervision was performed by Valiolah Arash Manouchehr Rahmati Kamel.

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