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Influence of disinfecting agents on the spatial dimensions of alginate mass impressions

Wpływ środków dezynfekcyjnych na wymiary przestrzenne wycisków z mas alginatowych

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Summary

Aim: Disinfection of dental impressions is a compulsory procedure performed in order to break the chain of infection. Disinfectants used for this purpose are divided into two large groups. These are ready-to-use disinfectants applied directly over the surface of the impression in the form of a spray and concentrates, which are used to prepare a solution in which the impressions are immersed for a specific period of time. This study aims to evaluate the influence of disinfectants on spatial dimensions of alginate mass impressions.

Material/Methods: Ninety cubic impressions were prepared using metal matrixes with external dimensions of 28 x 28 mm. Each impression was measured in two planes. The impressions were divided into three equinumerous sets of 30: Group I was disinfected with Zeta 7 Spray (n = 30), Group II was disinfected with Zeta 7 Solution (n = 30), and the control Group III (n = 30). The dimensions of the samples were measured in two planes after 24 (T1) and 120 (T2) hours. The obtained data was analysed statistically.

Results: The dimensions of the samples after 24 and 120 hours in the first group were significantly different from those of the control group and the differences were statistically significant ($p < 0.05$). There was no statistically significant difference between the second and the control group after 24 and 120 hours.

Conclusions: Ready-to-use disinfectants influence the dimensional stability of alginate-mass impressions. The time between taking the impression and preparation of the cast should be considered while choosing the disinfecting agent.

Keywords: impressions disinfectants • spatial dimensions • alginates

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INTRODUCTION

Alginate impression materials remain the gold standard in the initial stages of prosthodontic and orthodontic treatment. Frequently, these are the only dental impression materials used during the whole process of treatment. Patients easily accept the taste and smell of alginates. For an experienced clinician, these materials are convenient both in handling and manipulation. Alginates are classified as irreversible, hydrocolloid and elastic impression materials [3]. Alginate colloid is a non-homogeneous mixture consisting of two phases: a continuous phase (water) and the dispersed phase (powder). The process of gelatinization starts after mixing the alginate powder with water in an appropriate proportion. The transition between sol and gel state is irreversible and follows the chemical reaction between sodium alginate and calcium sulphate, which produces an insoluble calcium alginate. According to Choudhary and associates, the alginate material impressions contain approximately 70% of water [2]. Hence, the vulnerability of the alginates to the dimensional instability. Leaving the alginate impression after setting in a dry environment causes synaeresis and evaporation from the outer surface, which leads to a shrinkage. However, on the other hand, once the alginate impression is immersed in water, the mass absorbs it, which leads to swelling. This process is called imbibition [11]. The influence of storing conditions such as temperature and humidity on the dimensional stability of alginates has been scientifically proven [7, 19]. The accurate representation of the prosthetic field, dependent upon the dimensional stability, is the crucial element of the dental treatment success. Changes in linear dimensions of the inappropriately stored impressions, relatively low mechanical durability and too high elasticity are the main drawbacks of the alginate materials.

Disinfection of the dental impressions is a compulsory procedure. The impressions removed directly from the patients' oral cavity are often covered with biological materials such as blood and saliva, which can be considered as a microbiological hazard. It is widely accepted that the first step consists of the mechanical removal of these contaminations with a stream of cold running water. After being rinsed with water, the impression should undergo disinfection in order to break the contamination chain [3]. Apart from self-prepared sodium hypochlorite solutions, there are many surface disinfectants that are generally available on the market. Manufacturers of dental materials recommend a wide range of disinfectants designed specifically for dental impressions. Disinfectants used for this purpose are divided into two large groups. These are ready-to-use disinfectants applied directly over the surface of the impression in a form of a spray and concentrates used to prepare a solution in which the impressions are immersed for a specific period of time. The purpose of these agents is independent of the impression material type. Taking into consideration the percentage of water in the alginates compared to other dental impression materials, it seems highly reasonable to suspect the alginate impressions to be more susceptible to dimensional changes. This study aims to evaluate the influence of disinfectants on the spatial dimensions of alginate material impressions.

MATERIALS AND METHODS

Ten identical metal matrices with external dimensions of 30 x 30 mm and internal dimensions of 28 x 28 mm were prepared and were used to make cuboid alginate samples. Matrices were filled with an alginate material (ALG: Kromopan, Lascod SpA, Italy). Two packs (900g) of material were prepared by manual mixing with water, following the proportions and instructions presented by the manufacturer. Thus, ninety alginate samples were prepared and divided into three equinumerous groups (n = 30).

Different disinfection protocols were applied to each group: I- samples were rinsed with cold running water and then disinfected with a disinfectant spray (Z7SP: Zeta 7 Spray, Zhermack SpA, Italy), II- samples were rinsed with cold running water and then disinfected with a self-prepared solution of a disinfecting agent (Z7SO: Zeta 7 Solution, Zhermack SpA, Italy), III- control group, samples were rinsed with cold running water. Chosen agents vary between each other not only with the form of application, but also have different ingredients and mechanism of action (Tab. 1). In Z7SP the active agents are 83% ethanol solution and 10% propan-2-ol. The action of Z7SO, on the other hand, is based on the biological action of quaternary ammonium salts- contains 7.7% Dodecyldimethyl-ammonium *chloride* and 15% phenoxyethanol. Materials used in the study mentioned in Tab. 2 were used according to the manufacturers' recommendations.

After being released from the matrices, points were marked on four different surfaces of each sample. Marked points were indicators for the stable and movable arm of the gauge. Spatial dimensions of the samples were measured in two planes with a digital micrometer caliper with measuring accuracy of ±0.02mm. After the measurements, the samples were placed in ziplock storage bags, which provided optimal humidity (65%), and then stored in a cooling appliance at the temperature of 7.5°C. Conditions in which the alginate samples were stored are agreed to be optimal for the long-term storage of the impressions [19]. The temperature and humidity were controlled with a digital thermo hygrometer with a movable head. Then, T_1-24 and T_2-120h measurements

Table 1. Composition and instructions for use of the disinfecting agents

Name of the disinfecting agent:	Composition and active agents (bolded):	Directions for use:
Zeta 7 Spray	83% Ethanol 10% Propan-2-ol Non-ionic surfactants, additives, water.	After rinsing with cold running water, spray the agent over the whole surface of the impression and allow the agent to evaporate.
Zeta 7 Solution	15% Phenoxyethanol 7.7% Dodecyldimethylammonium chloride Non-ionic surfactants, additives, water.	After rinsing with cold running water, immerse the impressions for 10 minutes in a previously prepared 1% solution of the disinfecting agent. After a specific time rinse once again with running cold water.

Table 2. Used materials

Code	Brand name	Type	Manufacturer	Ratio
ALG	Kromopan	Alginate impression material	Lascod	W/P (ml/g) – 20/9
Z7SP	Zeta 7 Spray	Impression disinfectant	Zhermack	-
Z7SO	Zeta 7 Solution	Impression disinfectant	Zhermack	W/Z7SO (ml) – 100:1

were collected again with the same measuring appliance using the previously marked points. Measurements were taken by the same researcher. Obtained data was statistically analysed with descriptive statistics and then with the Kolmogorov-Smirnow test in order to determine the normality of variance. One-way analysis of variance ANOVA and post-hoc Duncan test were performed to determine whether the statistically significant differences between groups are present.

RESULTS

From 90 prepared samples, 180 measurements were obtained, 60 for each group. Mean change in the samples' dimensions in control group in T1 time was -0.19 ± 0.57%. In the first group disinfected with Z7SP the highest mean change in the dimensions was noted (–0.56 ± 0.36%), whereas the second group disinfected with Z7SO demonstrated the lowest mean change in the spatial dimensions -0.04 ± 0.54% (Figure 1). One-way analysis of variance (one-way ANOVA) was performed. Materiality level of $\alpha = 0.05$ was adopted. Value of $p < 0{,}0001$ was obtained – differences between groups were found statistically significant. Post – hoc Duncan tests were performed. Statistically significant differences were proven between the results obtained in the first and the third group as well as between the values in the second and the third group. No statistically significant differences between the second and third group were found. In T2 time mean change in spatial dimensions in the control group was –0.06 ± 0.53%, which was the lowest change is spatial dimensions of the examined samples. In the first group the highest change of –0.67 ± 0.53% was noted, whereas in the second group it was –0.08 ± 0.43% (Figure 2). Results obtained from the measurements in T2 were analysed statistically in the same way as the variables obtained in T1. Having met the conditions for testing of the variance homogeneity, ANOVA test was conducted and the result of $p < 0.0001$ was obtained. Post – hoc Duncan tests have proven statistically significant differences between the first and the third group, as well as between the first and the second.

Table 3. Changes in spatial dimensions of the samples

Time	T1			T2		
Group	I	II	III	I	II	III
Mean change in spatial dimensions (%)	–0.56	–0.04	–0.19	–0.67	–0.08	–0.06
Maximal value (%)	0.14	1.13	1.34	-0.04	1.09	1.82
Minimal value (%)	–1.40	–1.18	–1.47	–2.10	–0.97	–1.11
Standard deviation	0.36	0.54	0.57	0.53	0.43	0.53

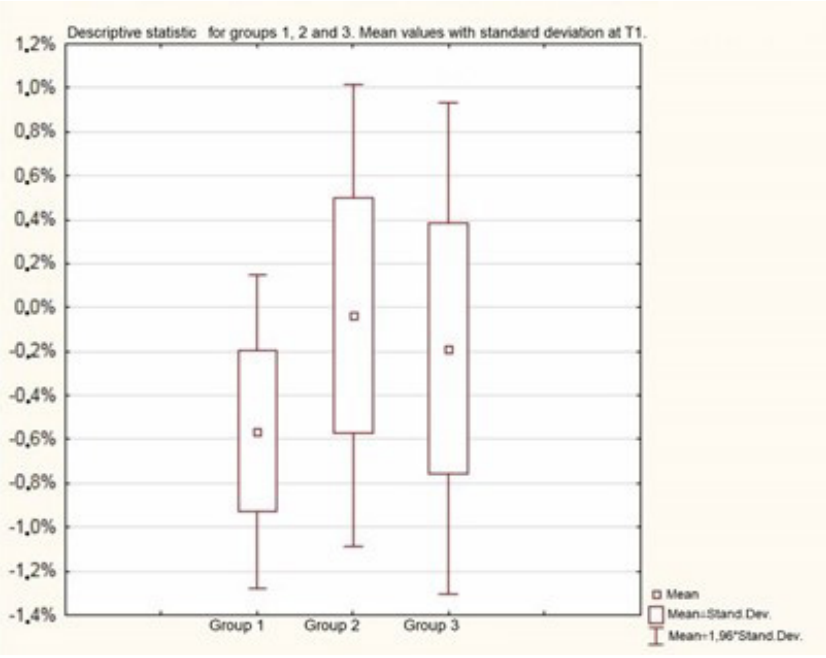

Fig. 1. Descriptive statistic for groups 1, 2 and 3 at T1

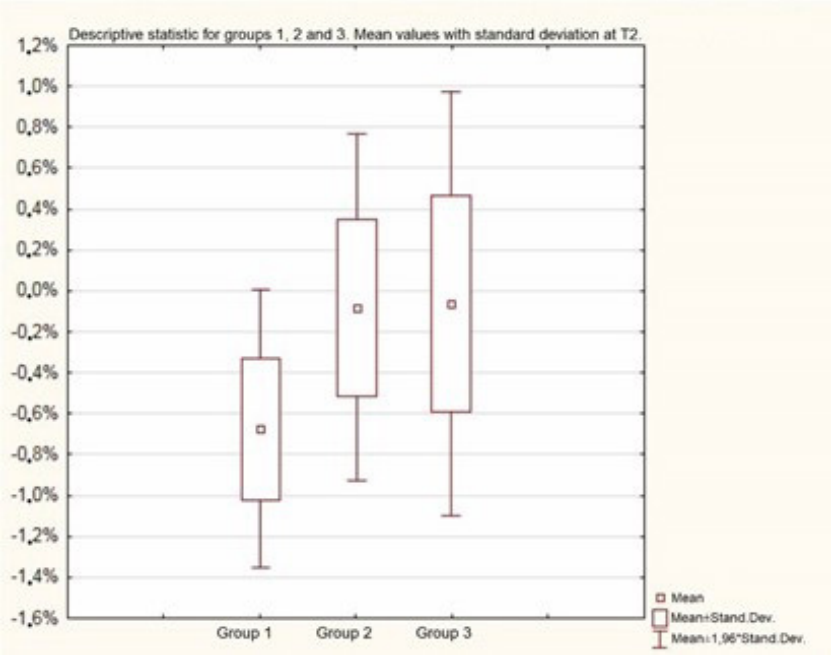

Fig. 2. Descriptive statistic for groups 1, 2 and 3 at T2

DISCUSSION

The study shows that different dental impression disinfectants may influence the changes in the spatial dimensions of the impressions, which has also been proven by Nassar et al. in their systematic review [15]. Taking into consideration the literature reports, which indicate the negative influence of alcohol solutions on the spatial dimensions of alginate impressions [16], a conclusion may be reached that 83% ethanol in Zeta 7 Spray is the factor leading to the highest shrinkage of the examined samples. However, Demajo proves in his studies that the alginate shrinkage was reduced after having been disinfected with alcohol-based disinfectants. This was proven, though only in the first 90 minutes after the complete setting of the mass [4]. Kotsiomiti et al. claims that interactions between the impression material and the disinfectant may occur but should not have any influence on the spatial dimensions [10].

Muzaffar et al. conducted a study which has proven the shrinkage of the alginate to be present both when the disinfectants were not used and after having used sodium hypochlorite solution and Perform ID agent (PID, Schulke and Mayr, Germany). In their study, however, no statistically significant differences were proven between the groups [14]. Muzaffar et al. in another study also indicate that the differences in linear dimensions of the samples over time are determined by the thickness of the alginate samples. By comparing 3mm and 1.5mm thick samples of the same alginate material, he has proven that lower thickness is inevitably connected to higher shrinkage [13].

Literature describes two types of research on the differences in spatial dimensions of the alginate materials. Research based on the alginate samples alone [4, 13, 19] and research in which data is obtained from the casts prepared on the basis of alginate impressions [8, 9]. Bearing in mind that plaster casts also change their dimensions during the setting process, it seems reasonable to include this data in the research [12, 18]. Hiraguchi et al. described in their research changes in dimensions of the plaster casts after various alginate materials having been disinfected with 0.5% sodium hypochlorite for 15 minutes. This research led them to a conclusion that immersion of NaOCl does not significantly influence changes in dimensions of the alginates, which have been previously dipped in water and have not changed their dimensions. According to their research, the stability of the dimensions is dependent upon the type and the manufacturer of the alginate material [8].

Despite many years of research concerning this matter, it is still recommended to prepare the plaster casts directly after having taken the impression with alginate materials [6, 17]. However, it is not always possible, especially when the impressions have to be transported to the laboratory. In such cases, usage of the materials which have longer dimensional stability proven by the manufacturer is recommended. Authors of this paper proved in previous research [19] that lowering of the storage temperature to 7.5ºC has a positive impact on the dimensional stability of the alginates. The same research proved that optimal storage humidity is 65% [19], whereas some authors claim that 100% humidity should be desired without taking temperature changes into account [8].

The highest limitation in setting specific recommendations regarding both storing and disinfection of the alginate impressions is the lack of standardisation in the research techniques [15]. Defining the standards of the research conducted on alginate impressions seems to be an adequate solution in order to specify the influence of different disinfectants usage and storage conditions. Consensus can only be reached by means of a meaningful wide-range comparative research.

The manufacturer in both cases of tested disinfectants guarantees stability of spatial dimensions of the impressions. Hence, it is particularly important to verify your knowledge about the performance and properties of disinfectants in scientific sources. Mistakes that occur at the time of taking impression may lead to mistakes during the further stages of the prosthodontic treatment, necessitating having to repeat several clinical procedures or, what is worse, leading to imprecise manufacturing of the prosthetic restorations. Erbe et al. indicate that inappropriate storing of the impressions may lead to clinically significant inaccuracies [5].

Despite the rapid development of prosthodontics in recent years and increasing popularity of the intraoral digital methods of imaging, alginates are still widely used. Cervino et al. conclude that the high price of intraoral scanners may imply that the (alginate) impressions will remain a method of prosthetic field mapping for a long time [1].

CONCLUSIONS

Tested ready-to-use disinfectant, Zeta 7 Spray, influences the spatial dimensions of alginate impressions leading to their shrinkage both after 24h and 120h (5 days). Statistically irrelevant both after 24h and 120h is the influence of the Zeta 7 Solution compared to the impressions only rinsed with water. The time between taking the impression and preparation of the cast should be considered while choosing the disinfecting agent.

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