

# In vitro investigation of the integration depth of oral fluids and disinfectants into alginate impressions

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## SUMMARY

**The objective.** The objective of this work is to prove that oral cavity fluids diffuse into alginate mass of impressions. In addition, the information is presented on the subject that disinfectants used for alginate impressions disinfection not only diffuse into alginate mass but penetrate deeper than oral cavity fluids.

**Materials and methods of the study.** Three examination groups were formed for the research, the results of which evidenced how deeply oral cavity fluids and disinfectants 'Alpha Guard GF' and 'Orbis' could possibly diffuse into alginate impression material 'Kromopan 100'. In the first examination group ten impressions from the upper jaw dental arch and mucosa were taken, firstly colouring oral cavity fluids with a special colouring tablet MIRA-2-TON (Hager Werken). Cuts were randomly selected from impressions and scanned aiming to establish the depth of the coloured oral cavity fluid penetration. In the second and the third examination groups taken alginate impressions were accordingly soaked in 'Alpha Guard GF' and 'Orbis' with pigment and later randomly selected cuts were scanned in the same manner as in the first research group.

**Results.** The research results establish that coloured dental cavity fluids maximum diffuse into alginate impression is up to 540  $\mu\text{m}$  with the presence of 95% of discolouring while disinfectants

'Alpha Guard GF' and 'Orbis' accordingly diffuse into alginate mass up to 710  $\mu\text{m}$  and 870  $\mu\text{m}$  with the presence of 95% of discolouring.

**Conclusions.** The results obtained show that disinfectants using them according to the recommendations of a manufacturer, diffuse into alginate mass deeper than oral cavity fluids at the time of impressions taking.

**Key words:** alginate impressions, disinfection of dental impressions, oral cavity fluids.

## INTRODUCTION

Most patients do not complain about their health and no visible signs of disease are observed, however oral cavities of patients contain many different pathogenic microorganisms. Many patients either do not disclose their health status or evaluate it inadequately. Expressed signs indicating some form of disease may be absent during the incubation period

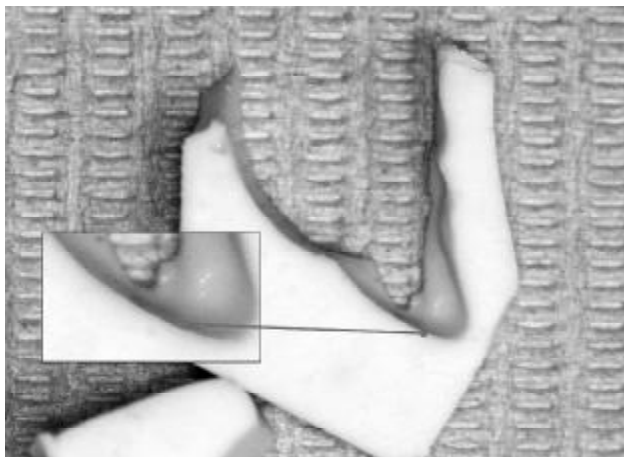
or throughout the course of a latent infectious disease. The soft tissues of the oral cavity are often hurt during odontologic interventions, thus a mix of blood with saliva can become a cause of blood-borne infectious diseases [1]. Studies have shown that alginate impressions and plaster models casted from undisinfected impressions have been massively contaminated with microorganisms [2]. Even alginate impression material itself is not sterile and microorganisms can grow in it [3, 4, 5, 6]. Though studies are carried out for many years to investigate possible spread of infection via dental impressions and intermediate parts for producing of dental prostheses from the oral cavity of patients to laboratories of dental technicians, this research remains equally important further [7]. Chemical disinfection remains the most popular method, because thermal disinfection

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**Fig. 1.** 1 Alginate impression tapes are prepared for the research

tion of impressions is used very rarely [8, 9, 10, 11]. But no one all-purpose disinfectant is available, which would not influence the superficial structure of the impression or its precision parameters with possible effect on precision of a prosthesis construction in future [12, 13, 14, 15]. It explains partially the reason why choice of chemical disinfectants used for disinfection of impressions is limited. Thus, we use soaking disinfectants 'Alpha Guard GF' and 'Orbis' for this research. Issues of impressions decontamination methods and infection control of prostheses or intermediate elements of their producing are examined rather on the theoretical level. Few references report about dental impressions and especially about microbiologic contamination of prostheses and intermediate elements of their producing. Our study is therefore aimed to establish how deeply alginate impressions could be contaminated with micro organisms of oral fluid while taking impressions and to compare how deep disinfectants, specially used for disinfection of impressions, could possibly penetrate. Microbiologic methods hardly enable us to establish the depth of penetration to alginate impressions and transparent colourless disinfectants are not seen in an impression, we researched coloured oral cavity fluid and coloured disinfectants making presumption that the limits of penetrated fluids colour in white solidified alginate mass would correspond to the possible micro organisms and disinfectants diffusion depth at the given time period.

## MATERIALS AND METHODS

Three examination groups were formed during the study. The first group tested the depth of diffusion of oral fluids into the alginate impression material 'Kromopan 100' during the taking of impres-



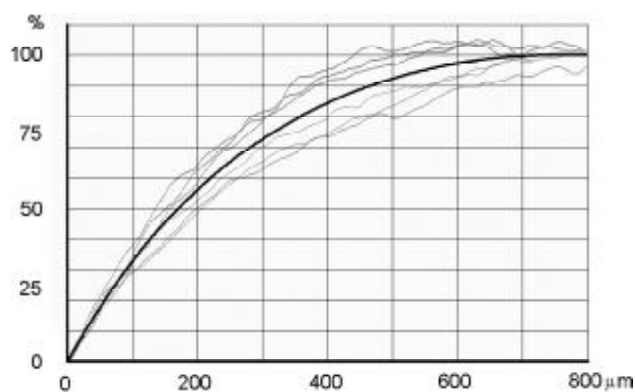
**Fig. 2.** Image of penetration of the coloured oral cavity mucosa fluid into the surface of an alginate impression

sions. The second and the third groups tested the depth of diffusion of disinfectants used for disinfection of impressions, 'Alpha Guard GF' and 'Orbis' correspondingly, into the alginate impression material 'Kromopan 100'.

### *Investigation methodology of the first examined group*

Before taking the impressions, an examined patient is administered to suck on a special colouring tablet MIRA-2-TON (Hager Werken). This tablet is used to dye dental plaque; however it dyes oral cavity and fluids containing numerous micro organisms. Later on we will observe how oral cavity mucous dyed fluids, containing numerous micro organisms diffuse into alginate mass. Alginate impression material mixed according to the manufacturer's recommendations is placed in the upper jaw impression trays. Ten impressions are taken from the dental arch and mucosa of the upper jaw. A tray is removed from the mouth upon hardening of alginate material. A taken impression is rinsed for 10 seconds with clean running water corresponding to potable water quality. It is vitally significant for this research to perform the measurement of samples from different examination groups after the same period of time after taking impressions from the oral cavity as alginate impressions could be characterized as having great contraction characteristics within a short period of time. Thus, in order to make uniform investigation time of groups to be examined, impressions of the first group are stored supplementary for five minutes in a wet environment (after rinsing they are immediately placed and sealed into plastic bags for five minutes).

Solidified alginate material is removed from a tray and cut into 2-3 mm thick tapes. Cuts are made crosswise, from the teeth of the right side,



**Fig. 3.** Diagram for the depiction of dyed oral fluid diffusion to the alginate impression material. X axis refers to penetration depth in micrometers, Y axis refers to discolouration of colorant in percent units.

through the palatal part and towards the left side. Six tapes are selected randomly from every dental impression. Sixty tapes have been examined in total in each of the examined groups.

Examined tapes were scanned by means of a Leica microscope using Photometrics CoolSnap-Pro cf monochromatic 12 bits cooling video camera and manageable XYZ coordination table. X and Y scales are equal to 3.2 micrometers in the image element, Z scanning step is 0.5 micrometer. Table management, image formation and registration algorithms have been generated using professional software Image-Pro Plus (MediaCybernetics, Inc. USA). Figure 1 represents an image of penetration of the coloured oral cavity mucosa fluid into the surface of an alginate impression.

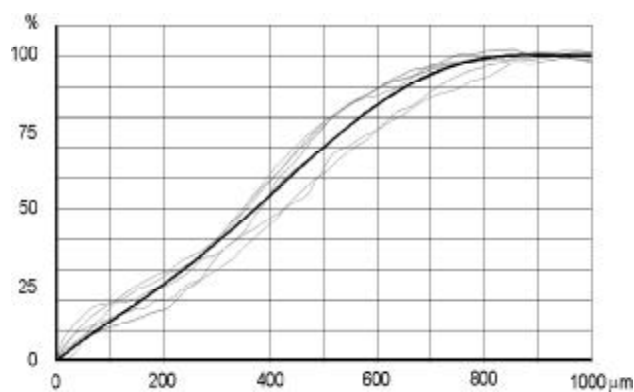
**Investigation methodology of the second examined group**

The disinfectant ‘Alpha Guard GF’ is prepared: 20 drops of Methylene Blue 1 % solution are added to 500 ml of ‘Alpha Guard GF’ poured into a special container; all is mixed together using a wooden stick.

Alginate impression material ‘Kromopan 100’, mixed according to the manufacturer’s recommendations, is placed in the upper jaw impression trays.

**Table** Penetration depths of investigated disinfectants

Discolouration of colorant %	Penetration depth $\mu\text{m}$		
	Dyed oral fluid	Dyed disinfectant ‘Alpha Guard GF’	Dyed disinfectant ‘Orbis’
25	70	200	150
50	170	370	380
75	310	530	640
90	460	650	810
95	540	710	870



**Fig. 4.** Diagram depicting "Alpha Guard GF" diffusion into the alginate impression material

A tray is removed from the mouth upon hardening of alginate material. Ten impressions are taken from the dental arch and mucosa of the upper jaw. A taken impression is rinsed for 10 seconds with clean running water corresponding to potable water quality and is immersed for 10 seconds in a previously prepared disinfectant ‘Alpha Guard GF’. After 10 seconds, the impression is moved some more for the disinfectant could penetrate to all holes and fissures. Then the impression is removed, is left undried for 5 minutes and is rinsed with clean running water.

Cutting of impressions and three-dimensional scanning technique of specimens are similar to those applied in the first examined group.

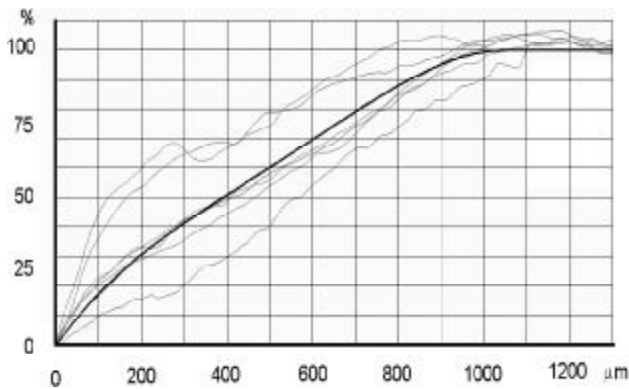
**Methodology of investigation of the third examined group**

Disinfectant ‘Orbis’ is prepared: 20 drops of Methylene Blue 1 % solution are added to 500 ml of ‘Orbis’ poured into a special container; all is mixed together using a wooden stick.

Alginate impression material ‘Kromopan 100’, mixed according to the manufacturer’s recommendations, is placed in the upper jaw impression trays. Ten impressions are taken from the dental arch and mucosa of the upper jaw. A tray is removed from the mouth upon hardening of alginate material.

A taken impression is rinsed for 10 seconds with clean running water corresponding to the quality of potable water and is immersed for 5 seconds in the prepared disinfectant ‘Orbis’. After 5 seconds, the impression is rinsed with clean running water corresponding to potable water quality.

Cutting of impressions and scanning technique are similar to those applied in the first examined group. Scanning is performed straight away after



**Fig. 5.** Diagram depicting 'Orbis' diffusion into the alginate impression material

decontamination of the impression in accordance with disinfectant manufacturer's recommendations.

An observation has been made during selection of research methodology: the longer the delay before scanning after hardening of the impression in the oral cavity, the greater is the deformation of the impression.

## RESULTS

The following was found in three examined groups by performing analysis of tapes scanning results:

1. For the first examined group, maximal diffusion of the dyed superficial oral fluid into alginate impressions during a control period of 6 minutes, when 95% discolouring of colorant is determined, is up to 540 micrometers deep to the impression ( $p < 0,05$ ) (Fig. 2).

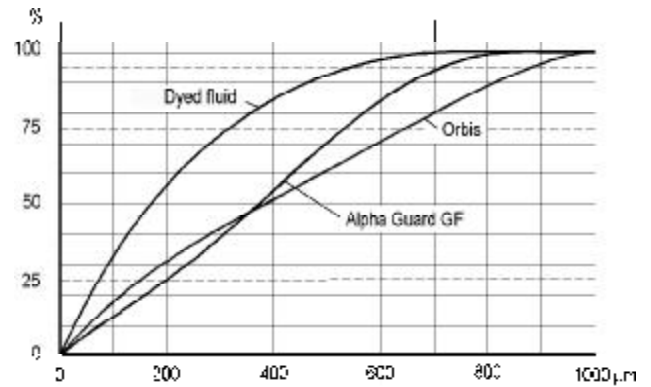
The diagram depicts 6 average penetration depths of the oral fluid corresponding to different places of impression cuts (red curves) and approximation of their mean (black curve).

Diffusion depth increases with time, but deformation of the impression increases as well. Such impressions become inaccurate and they should not be used in producing of prostheses, further diffusion depth therefore was not measured.

2. For the second examined group, maximal diffusion of disinfectant 'Alpha Guard GF' during a control period of 6 minutes when 95% discolouring of colorant is determined, is up to 710 micrometers deep to the impression ( $p < 0,05$ ) (Fig. 3).

The diagram represents 6 average penetration depths of the dyed oral fluid disinfectant 'Alpha Guard GF' corresponding to different places of impression cuts (red curves) and approximation of their mean (black curve).

3. For the third examined group, maximal dif-



**Fig. 6.** Comparative diagram of penetration depths of dyed fluid and dyed disinfectants 'Alpha Guard GF' and 'Orbis'

fusion of disinfectant ' during the period of 6 minutes when 95% discolouring of colorant is determined, is up to 870  $\mu\text{m}$  deep to the impression ( $p < 0,05$ ) (Fig. 4).

The diagram represents 6 average penetration depths of the dyed oral fluid disinfectant 'Orbis' corresponding to different places of impression cuts (red curves) and approximation of their mean (black curve).

Diagrams depicting penetration depths of dyed fluid, dyed disinfectants 'Alpha Guard GF' and 'Orbis' are presented for comparison in the figure 5.

The Table represents penetration depths at colorant concentrations of 25, 50, 75, 90 and 95 percent.

## DISCUSSION

Based on the results of performed research work, it has been established that alginate impressions, due to their composition, and hydrophilic mechanism of solidification, may be easily infected with microorganisms present in the oral cavity. Diffusion of coloured fluids is depicted in the figure 2. X axis refer to the oral fluids penetration depth into the alginate impression in micrometers; Y axis refers to the discoloration of dyed oral fluids in percent units at a certain depth. X and Y axes depict diffusion depths of different disinfectants in the figures 3 and 4. Based on the above mentioned diagrams, the table of the figure 5 is constructed. It shows that oral fluids diffuse less than disinfectants when discoloration is minimal (25 % discoloration in the case of the study). Oral fluids diffuse into the alginate impression about 70  $\mu\text{m}$ , disinfectant 'Alpha Guard GF' about 200  $\mu\text{m}$  and 'Orbis' about 150  $\mu\text{m}$  correspondingly. When discoloration is maximal, 95 %, oral fluids diffuse about 540  $\mu\text{m}$ , disinfectant

'Alpha Guard GF' about 710  $\mu\text{m}$  and 'Orbis' about 870  $\mu\text{m}$ . Intermediate results are presented in the table of the figure 5. We do not present values at full discoloration (100%), because there are no possibilities to observe full colour change even if digital method of data imaging is used. Besides it is not reasonable to wait for a full discolouration because of the fast changing dimensions of the alginate impression, which influence the accuracy of measurements.

The probability of the infection spreading through inadequately disinfected alginate impressions is not high in the laboratory of dental technician [16].

According to the data analysis of the survey carried out in England, only 4% of dental technician laboratories have considered impressions to be prepared properly before sending them to laboratories. Despite their distrust in effective decontamination of impressions, only 50% laboratories have disinfected the received impressions additionally [17]. It is insisted therefore that use of personal protection equipment such as protective gloves, glasses, facial masks should be observed during a longer contact with the source of possible infection. Besides, it is the duty of every odontologist to perform appropriate decontamination of impressions, seeking to protect every patient in contact with possible infection source [18].

Disinfection of impressions has to be carried out always, because disinfectants destroy vegetative forms of microorganisms present on the surface of impressions. Though microbiological efficacy control has been not used by our study, we have proved theoretically that use of disinfectants

'Alpha Guard GF' and 'Orbis' can be effective mean of decontamination from microorganisms on the surface of impressions, because their diffusion depth is greater than that of oral fluids. Though disinfectant 'Orbis' has penetrated deeper into the alginate impression than 'Alpha Guard GF' in this study, it is difficult to compare their advantages over each other. According to the manufacturer's recommendations, an impression is kept immersed in the disinfectant 'Orbis' about 5 minutes. The impression is affected longer and by higher concentration if to compare with 'Alpha Guard GF', in the case of which only 10 seconds exposition in the solution is recommended and 5 minutes left to dry.

It is very important to disinfect not only impressions removed from the oral cavity or intermediate elements in prostheses making, but also to pack them properly and tightly during transportation. That helps to prevent the spreading of microbial pathogens during transportation, process of producing and storage of prostheses.

## CONCLUSIONS

1. Alginate impression materials possess fluid absorbing properties, thus patient's oral cavity fluids which possibly could spread infection, diffuse into alginate impressions.
2. Examined disinfectants are characterised by better integration into alginate impressions than oral fluids.
3. Disinfection of impressions by means of soaking method has to ensure decontamination of impressions.

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