Short note

IMPROVEMENT OF BIO-COMPATIBILITY FOR SOME DENTAL MATERIALS USING NON-CONVENTIONAL TECHNIQUES[#]

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Abstract. In order to select the best physical methods to treat the surfaces we considered both the effects of the applied treatments and the qualities of the material used during the process. We used 23 teeth, both healthy-taken from patients whose oral pathology did not allow keeping them on the arcade and included teeth. The other material used in the study is C-Bond. During this study we used two modalities to prepare the surface before applying C-bond.

Key words: human teeth, dental surface, plasma treatment.

INTRODUCTION

The objective of our study was to optimize the adherence of dental surfaces of the C-Bond.

A perfect material bio-compatible should not absorb elements from living organism, a fact that does not happen in reality. This is why the surface of materials is often modified through different methods/techniques depending on their destination. In order to achieve an ideal restoration, a strong adhesion to the interface between the teeth and the dental materials is essential [1]. Generally, the adherence of a liquid to a solid surface depends on the physical-chemical properties of the surfaces and on the energetic characteristics of the two phases (liquid and solid). For instance, if a dental surface, natural or artificial (obtrusion, denture, dental implants) is more rough the adherence of micro-organisms is bigger. The adherence differs depending on the chemical composition of the materials used to restore. Also, on a surface that presents high values of the surface energy the adherence is different from those having smaller values of the surface energy [2, 3]. Plasma is defined to be the fourth status of matter, along with solid, liquid, and gas, a neutral mixture from the electrical point of view, made from electrons,

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neutral atoms, excited atoms, ions, photons in a continuous movement and interaction. It is a physical system to organize the substance in the highest energetic status. 99% of the natural substances are organized as plasma, so we can say we are immersed in this status. Plasma can be upload with different radicals that operate supplementary on the exposed surfaces, without macroscopical modifications or also that produce sediments, in certain conditions. It has been observed that plasma increases the hydrophilia of polymeric materials without affecting the physical properties of the resin, they being able to keep the mechanical properties needed for their function. Plasma treatments offer a series of specific advantages comparing to other methods that modify the material surface: they improve the characteristics for the surface without affecting the properties of volume for the material, they realize a stability in time for the surface properties, local treatments can be done, controlled in a sterile and dry medium, they have an accessible price and they are easy to implement [4]. The materials designed to implants must present the same structure, properties and functions as the organs that are substituted. The implant success depends not only on the qualities of the bio-material, but also on the local and general factors. The dental bio-materials that come in contact with the oral cavity are being presented in two sorts: tissular substitutes-the bio-materials come directly in contact with the tissue (denture, lio-philisated bone, hydroxyapatite) and protetical substitutes-the bio-materials come in contact with the oral medium [5].

The stability of the effects of plasma treatment in case of dental surfaces has the role to increase the adherence to these of the C-Bond (a universal photo-polymerisable bond that establishes the connection between the dental surface and the obtrusion material).

MATERIALS AND METHODS

During the study we used 23 teeth, both healthy, extracted from patients whose oral pathology had not allowed keeping them on the arcade (periodontal disease) and included teeth. After extraction these teeth were kept in sodium hypo-chlorate (Fig. 1). The other material used in the study is the C-Bond (W + P Dental, Bramstedt, Germany), a universal photo-polymerisable bond that adheres to the dental surface. C-Bond realizes the liaison between the dental surface and the final obtrusion material. The teeth were sectioned using a diamond disc fixed to a mandrill from the piece of the micro-engine Schick CN (Georg Schick Dental GmbH, Germany), using a speed up to 50.000 rot/min. (Fig. 2). Through this procedure we obtained flat surfaces presenting the least rough, having dimensions of approx. 0.5 cm × 1 cm (Fig. 3). Plasma treatments are efficient because they are realized in a dry medium and they can be used on any surface.

After applying the C-Bond we prepared the surface with photo-polymerisable lamp (40 s) and with plasma (10 s).

Fig. 1. C-Bond and extracted teeth.

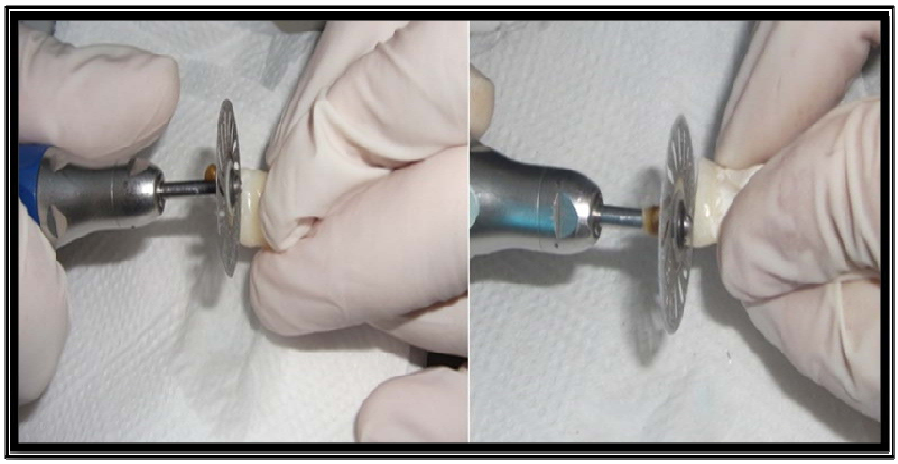

Fig. 2. Sectioned teeth.

Consequently, the different interactions between the plasma constituents determine processes of emergence and disappearance of charge carriers.

In order to improve the adherence properties of dental surfaces we used two methods to prepare the surface before applying the C-bond (called pre-treatment), namely:

- treatment with a common photo-polymerisable lampconsists in applying the lamp installment on the dental surface. This was realized with a LED lamp (light-emitting diodes);
- using a plasma jet.

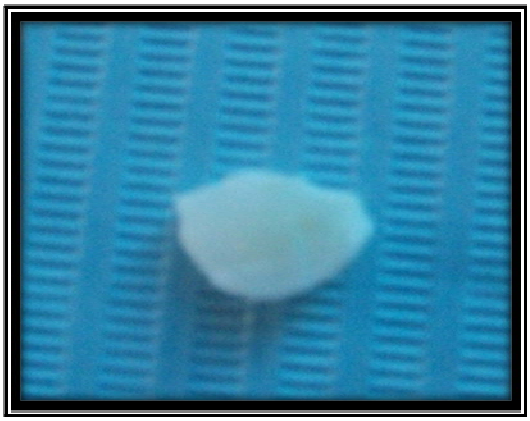

Fig. 3. Flat surface.

For the second technique we used a plasma jet on atmospheric pressure, in pure spectral helium, device made in the Plasma Physique Laboratory, "Al.I. Cuza" University, Iaşi. The plasma jet, among UV radiations closed and visible, also contains neutral and excited particles, ions and electrons. The positive particles are atomic ions and molecular ones, and the negative particles are usually electrons (though negative ions may also exist). Neutral particles are atoms or molecules in their fundamental quantic state or in an excited one.

The distance between the energy source and the dental surface was 1 cm, and the time for pre-treatment was 40 s for the photo lamp and 10 s for the plasma lamp. After the pre-treatment stage using the two methods we apply on the dental surface the C-Bond using a mini-dropper. There were applied 10 drops on each surface and the result of the contact angle was obtained from the average of values resulted from measurements. We also evaluated the polar and dispersive components of the surface energy of the C-Bond because each liquid substance has its own energetic characteristics very well determined that depend, not only on the chemical constituents, but also on their adherence.

RESULTS AND DISCUSSION

The effects induced by the plasma treatment are represented by: the modification of surface energy, of the polarity and chemistry of the surface, the modification of the rough – favoring the increasing of adherence and absorption to the surface of the bio-materials, the establishment of the surface characteristics, deposing or implanting ions having protective role to corrosion, binding antiseptics and bacteriostatics. In order to compare the effects of the two techniques the contact angles of distilled water chosen as test liquid were measured. We also measured the contact angles for the C-Bond applied on the dentine. We must

mention that the treatment of the dental surface with plasma jet was of 10 s. The results are presented in Table 1 and graphic representation is marked in Fig. 4. From the results obtained we observed that the photo-polymerisable lamp treatment does not modify the values for the contact angle, either for water or for C-Bond.

Table 1

Contact angle in the treatment of the dental surface with plasma jet for 10 s

	Without plasma treatment	Treatment with the photo-polymerisable lamp	Plasma treatment
Water	60^o	60^o	4^o
C-Bond	15^o	15^o	~0

If we refer to the plasma treatment, we can observe a decrease for the contact angle and the dental surface is super hydrophilique (it presents a contact angle smaller than 5). We must specify that this kind of decreased angle was both in case of water and C-Bond. This fact is also confirmed by the mechanical work of adherence of water to the dental surface.

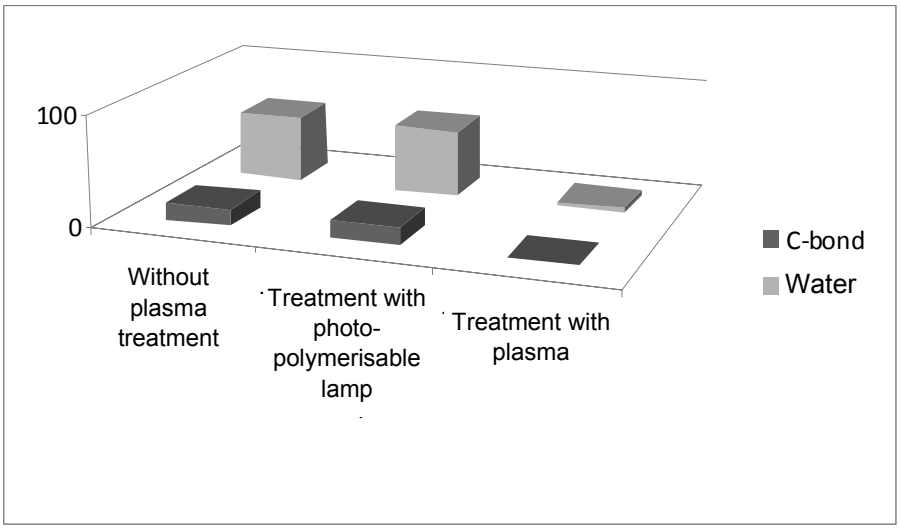

Fig. 4. Graphic represention of values for the contact angle, for water and for C-Bond.

After the treatment with plasma jet, the value of mechanical work of adherence of water increased with 33%. After plasma treatment we observed a growth for the adherence properties of C-Bond to the dental surface. This adhesive solution spreads on the dental surface without creating any drops on it. So, the mechanical work of adherence of C-Bond has got higher values in case of plasma

treatment, but in case of the photo-polymerisable lamp the mechanical work of adherence is the same as the one in case of untreated surfaces. We also observed that the use of LED lamp does not modify the energetic characteristics, but the plasma jet does modify significantly these surface characteristics. Plasma treatment has got absolute positive effects in case of surfaces wettability, representing a non-invasive alternative to the mechanical surface treatment. The elements to be followed are the level of hydrophobia after applying the plasma and the possibility that a microscopic hydrophil layer may be deposited on the treated surface. The efficiency of the treatment with plasma jet increases the adherence mechanical work of the C-Bond and so we can exclude the chemical treatment/the acid engraving.

CONCLUSIONS

Plasma jet is a physical procedure that can be used to optimize the adherence of some liquids that have a protective role for the dental surface. We used this technique to improve the adherence of C-Bond to the dental surface, this way excluding the corrosive profound action of the chemical treatment. When covering the dental surface with plasma, the adherence of the C-Bond to the dental surface increases, fact that could determine the replacement of classical chemical demineralization with ortho-phosphoric acid. Plasma techniques can be used instead of UV lamps to initiate the polymerization reaction. The preliminary results showed that 10 seconds are enough to induce this process. For final conclusions there are necessary more experiments to the dental surface with plasma treatment and a statistical analysis of data.

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