INVESTIGATION AND EVALUATION OF LASER WELDINGS COMPARED TO ELECTRICAL WELDINGS OF VARIOUS DENTAL ALLOYS

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REZUMAT

Componenta metalică a diferitelor proteze dentare prezintă deseori defecte ce trebuie reparate. In dorinta de a evita dezavantajele procedeelor clasice de reparație și solidarizare utilizate în tehnologia protezelor dentare, au fost dezvoltate noi metode de sudură. Implamed Argon Control Cremona system asigura solidarizarea diferitelor componente metale direct în cavitatea bucală. Scopul acestui studiu a fost evaluarea calității sudurilor cu laser, respectiv a zonei de sudură electrică, în funcție de structura și morfologia zonei, respectiv în funcție de metoda de solidarizare. Material și Metodă: Au fost realizate solidarizări prin două metode diferite, în situații întâlnite cel mai frecvent în practica curentă. Parametri optimi de sudură au fost stabiliți în funcție de tipul aliajului, de structura componentei metalice, de tipul de curgere, mărimea defectului, timpul de lucru, respectiv proceselele de sudură. Evaluarea calității zonelor de sudură a fost făcută prin metode distructive și nedistructive. Rezultate: Investigația comparativă a zonelor de sudură este importantă pentru a evalua calitatea sudurilor, respectiv pentru a putea determina pentru practica curentă limitele metodei de reparație utilizate. Concluzii: Pentru a obține maximum de precizie și o calitate înaltă a sudurilor, este important efectuarea unor analize moderne pentru fiecare caz în parte, implicând o colaborare interdisciplinară.

Cuvinte cheie: solidarizare, sudare cu laser, sincristalizare, metalografie.

ABSTRACT

Metalic frameworks of dental prostheses often present defects, which need to be repaired. In order to avoid the disadvantages of traditional joining procedures used in dental prostheses technology, new welding methods were developed. Implamed Argon Control Cremona system assures the direct soldering of metallic component in oral cavity. The aim of this study was to assess the quality of laser welding and electrical welding of dental alloys, depending on the structure morphology and joining method. Methods: The two welding procedures were oriented on those areas that require optimizations in practical use. The optimal parameters were correlated with the type of welded alloy, the framework structure, flaw type and size, working stage, and welding procedure. Nondestructive and destructive analyses served the purpose of assessing the welding quality. Results: Comparative investigations of the welded areas are important for weld quality evaluation and to establish the limitations of this repairing method in practical use. Conclusions: In order to obtain maximum precision and high quality welding that would fulfill current requirements, it is important that modern analysis concepts be used for each particular case, based on an interdisciplinary collaboration.

Key words: soldering, laser welding, syncristalization, metallographic.

INTRODUCTION

To obtain metallic infrastructures in fix partial dentistry supposes to perform technical steps that can be associated with errors: vicious adaptation on prosthetic field or defects in material that can lead to the prosthesis fracture.¹ ² ³ Solving the problems previously mentioned is difficult and sometimes the clinical-technical steps must be repeated.

There a lot of joining technique have existed: soldering, overcasting, micro impulse welding, laser beam welding, electrical welding, ultrasound welding, electric arc welding, gas flame welding, explosion welding, electron beam welding, friction welding.¹ ² ⁴ The metallic frameworks of dental prosthesis can present defects, which need to be repaired. For this
purpose, the most frequent used technologies are the common soldering procedures, but the final product is not corrosion stable, the welding procedures and the adhesive technique. In the dental technology, the most fervently used welding methods are: laser welding, which needs an initial high investment, micro impulse or plasma welding and the syncristallization method or electrical welding. Soldering of titanium infrastructure directly in oral cavity is possible by using the syncristallization method or electrical welding.

Dental alloys are subjected to functional influences in the oral cavity and interact with the intraoral environment. Laser welding is an advantageous method of connecting or repairing metal prosthetic frameworks because there are fewer effects of heating on the area surrounding the spot to be welded, and no further procedures, such as those used for conventional soldering, are necessary. Laser welding has been increasingly applied for fabricating the metal frameworks of prostheses and for other procedures, such as recovering the metal ridge and cusp, blocking holes on the occlusal surfaces after excess occlusal adjustment, thickening the metal framework, or adding contact points after excess grinding and adjusting of the crown margins.

In comparison to conventional or arc welding, laser welding scores several advantages like narrow welds with controlled bead size, faster welding with a higher productivity, less distortion, narrow heat affected zone and minimum contamination.

The choosing of the soldering technique is influenced by several factors such as: type of alloy to be soldered, functioning mode of the device (protective environment necessary or not), working parameters, penetration depth, expenses, using additional material or not, associated thermal modifications.

The aim of this study was to assess the quality of laser welding and electrical welding of dental alloys, depending on the structure morphology and joining method. Destructive analyses served the purpose of assessing the welding quality.

MATERIAL AND METHODS

In this study the samples were soldered using laser welding and electrical welding methods. The two welding procedures were oriented on those areas that require optimizations in practical use. Soldering of titanium infrastructure directly in oral cavity is possible by using Syncristallization System Argon Control, IMPLAMED. This type of welding is made through plastic deformation of material in the joint area; plastic deformation is favoried by local heating through Joule-Lenz after passing the electric power at the joining area.

For the laser welding we used pulsed Nd-Yag Laser equipment (Orotig) (Fig.1), with the following parameters: 1064 nm wavelength, 10 ms repetition rate and 6.58 kJ/cm² energy density (for Ti specimens) and 12 ms repetition rate and 7.49 kJ/cm² energy density for Co-Cr alloys. The relative position of the laser focus determines the quality and configuration of the weld. For welding of dental alloys only a few type of lasers can be used.

For the electrical welding we used Syncristallization System Implamed™ Argon Control unit used in this study.

For the electrical welding we used Syncristallization System Implamed™ Argon Control unit (Fig.2). This type of welding is made through points and pressure, performed in an argon protective environment. The
welding series are divided into three stages: pre-gase, welding, and post-gase. Pressure is exerted for a longer period of time than the welding. The welding stages are represented by: applying of the electrodes and exerting pressure without electric power, then the welding stage with combined action: pressure and electric, and finally the cooling phase when only pressure is exerted.

Figure 3. Probes included in acrylic resin

Figure 4. Probes were examined with a metallographic microscope (Olympus).

The advantages of the syncristallization methods are: working time is reduced, minimal thermal modifications, the oral tissues are not affected; comfort for the patient, soldering takes place in a short period of time.\textsuperscript{12}

The probes were soldered using syncristallization and laser welding, then were investigated through destructive metallographic technique (Fig. 3). After the joining, the samples were included in acrylic resin and prepared for the metallographic investigation.\textsuperscript{5,6,13}

Figure 5. Polyhedral structure, large grains of titanium in the main material.

Figure 6. In base material large titanium poliedric grains, the black point are traces left by the diamond tip of hardness device.

RESULTS

After microscopic investigations the following aspects were put in evidence: polyhedral structure, large grains of titanium in the main material; close to the thermic influenced area, the grains are distorted and have a dendritic shape, that keeps the granular aspect. At the junction area the grains are deformed, the polyedric structure was transformed into a dendritic one (Fig. 5-8).
Figure 7. In the thermic influenced area, the grains are distortioned and have a dendritic shape that keeps the granular aspect.

Figure 8. At the jonction area the grains are deformed, the poliedric structure was transformed into a dendritic one

CONCLUSIONS

Syncristallization is a welding technique that assures a high quality joint which does not need other thermic treatments. The soldering procedure needs a very short period of time, takes place without local heat variations. For high quality and precision of joints, it is important that the used parameters to be adapted to each case separately. In order to obtain maximum precision and high quality welding that would fulfill current requirements, it is important that modern analysis concepts be used for each particular case, based on an interdisciplinary collaboration.

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