„Materials and Technologies in the Implementation of the Loosening Detection Method in Dental Implant Abutments"

mgr inż. Grzegorz Jania

Abstract

Implant systems are characterized by a screw connection of the abutment with the intraosseous part of the implant. Unscrewing of the abutment screw and loosening of the abutment are among the most common failures, which is a nuisance for the patient and the doctor and often leads to serious complications. Currently available methods for detecting loosening of the abutment are not sufficient due to limitations in the accuracy of the visibility of the gap in the X-ray image in the range of more than 100 micrometers.

The aim of the work was to connect by welding - using technologies available in the conditions of the prosthetic laboratory and industrial technology - an element constituting an X-ray marker, which is used to increase the detection of gap in dental implant abutments according to the previously developed new detection method, which is the subject of implementation in the company.

The scope of the work included micro-computed tomography studies using implantology kits (MegaGen, Korea, Straumann, Switzerland)

to assess the correct functioning of the implant system and the abutment assembly under simulated conditions of abutment screw tension loss and to present a method for detecting abutment gap.

The weld obtained during the connection of the pure gold X-ray marker with the Ti6Al4V alloy using a laser beam was less uniform and wider compared to that obtained using an electron beam. The weld obtained with the laser beam showed traces of temperature gradient and microstructure changes over the length from 10 µm to 30 µm and the formation of the actual fusion zone reaching from 20 µm to 50 µm with a slightly lower average microhardness of the native titanium alloy 346.69 ± 7.88 µHV compared to the control sample made of alloy 351.56 ± 14.45µHV, while the average microhardness in the heat affected zone decreased to the value of 320.29 ± 4.58µHV. Electron beam welding allowed for obtaining a precise weld with a width of 1-2 µm, however, the increase in temperature

during welding contributed to the increase in grain size and the formation of an acicular microstructure in the entire volume of the sample, which was accompanied by a significant increase in microhardness to 374.19 ± 7.13 μHV and in the heat-affected zone to 380.05 ± 9.51 μHV. Both laser- and electron-beam-welded samples showed comparable or better corrosion resistance compared to the control samples made of Ti6Al4V alloy, and the observed corrosion foci in the laser-welded sample are also observed in gold alloys in other works on implants that are successfully used clinically. The tests of the structure, mechanical and corrosion properties of the samples confirmed that the laser beam welding technology in the technological conditions of a dental engineering laboratory is suitable for connecting the proposed X-ray marker made of pure gold with the titanium alloy Ti6Al4V. The verification of the method of detecting the abutment gap in in vitro conditions corresponding to clinical conditions showed an increase in the accuracy of detecting the abutment clearance by more than twenty times.