OPTICAL COHERENT TOMOGRAPHY IMAGING USEFULNESS IN IMPLANT TISSUE STUDY*

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Abstract. Optical Coherent Tomography is a competitive non-invasive method of osseointegration investigation. FD-OCT with Swept Source was used to obtain 3-D image of the peri-implant tissue (soft and hard) in the case of mandible fixed screw. Present work suggests that Optical Coherent Tomography is a proper technique to obtain the image of the contact tissue-metal screw.

Key words: OCT, dental implant, swept laser.

1. INTRODUCTION

A dental implant is essentially a substitute for a natural root and commonly it is a screw. Each implant is placed into a socket drilled. The implant can be screwed into position. The main aim during installation of any implant is to achieve immediate close contact with the surrounding bone. This creates an initial stability. The stability of implant is enhanced by further growth of bone into microscopic roughness on the implant surface.

Dental implants in use today are made from titanium. This metal has been shown over many years to be tolerated by bone. The term “osseointegrated implant” is used to describe dental implants that can develop and maintain a close union with bone in order to support replacement teeth.

Failure of a dental implant is often related to failure to osseointegrate correctly. Peri-implantitis is generally easy to see on standard panoramic X-rays. Repeatedly X-rays diagnosis is not preferred. Finding a non-invasive method to view the status of the peri-implant tissue at different times is a must.

Optical Coherence Tomography has been used to produce images of dental tissues [1, 2].

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Fourier Domain Optical Coherence Tomography (FD-OCT) achieves greater sensitivity and higher image speeds [3] than Time Domain-OCT. The most effective approach to do FD-OCT is to keep the single photodetector and to use a swept light source instead of superluminescent diode. The great advantage of the swept source technique is the simplicity of the interferometer.

The objective of this study was to determine if FD-OCT could be a challenge method for investigation of the peri-implant tissue.

2. MATERIALS AND METHODS

The sample was prepared in cooperation by Bucharest Faculty of Veterinary Medicine and Faculty of Stomatology. They prepared one piece of young dog mandible with a titan double-screw implanted. The piece (screw and surrounding bone) was extracted for evaluation after three months from the screw insertion (Fig. 1).

Fig. 1 – Both faces of sample.

FD-OCT measurements were performed with THORLABS Video Rate Swept Source OCT Microscope OCMP1300SS. An earlier study has proven the source of 1325 nm gives better images for bones compared with 800 nm similar swept source [4], because of the stronger light scattering produced by hard tissue. The SS-OCT imaging provides high resolution en-face (C-scan, Fig. 2a) and cross-sectional imaging (B-scan) of turbid media with high resolution. The design integrates a broadband high-speed swept laser (central wavelength 1325 nm), a fiber-based Michelson interferometer with a balanced detection scheme. The multifunctional microscope includes an integrated CCD camera which provides simultaneous en-face microscope imaging and cross-sectional OCT imaging of the sample [5]. The microscope image (Fig. 2b) was useful for identifying the position of scanning beam.
3. RESULTS

Figure 3 shows four 2-D images obtained with Thorlabs FD-OCT, at 1325 nm. Longitudinal scanning line \( x \), approximately parallel to the screw axis, has 10 mm length and image depth (\( z \) axis) of 3 mm. For easier understanding of OCT images we have also attached the corresponding CCD images. OCT image is a section at half of corresponding CCD image. We have selected 4 pictures from a series of 165.
Fig. 3 – Four frames from a series of B scan measurements (3339-3503) of face 1. The instrument recorded 165 frames of B-scan (x-z) on 5 mm length of y axis, \( x = 8 \) mm, \( z = 3 \) mm. 03390 is the image of sample between screws (bone tissue with black fibrous tissue).

On the picture taken by external camera we have marked with white lines the scanning line \( x-z \) corresponding to each OCT image. 03343 are images of the right screw, 3390 are images from the bone area located between screws, 3423 and 3447 are images of the left screw.

Figure 4 shows also the 2-D image of the sample with transversal (perpendicular to the screw axis) scanning line, between two higher lines of the screw.

Fig. 4 – Transversal scanning: a) CCD image; b) FD-OCT image (width \( x = 3 \) mm, depth \( z = 2 \) mm).
Finally, 3-D image (Fig. 5) is in fact a series of 165 bi-dimensional images, sequential saved on the computer HDD and projected on the monitor. Hard tissue examination at baseline indicated good contact bone-metal after 3 months.

![3-D view of the sample.](image)

**4. CONCLUSIONS**

OCT has the capacity to give 3-D image of the tissue at the implant sites for *in-vitro* investigations. FD-OCT images obtained at 1325 nm showed significant contrast and spatial resolution to study osseointegration of implants in the maxilla. 200 µm depths inside the bone could be investigated. Swept Source FD-OCT becomes a powerful tool for dental implants investigations, *in-vitro* for the moment.

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