BIOMATE PROPOSAL

The osseointegration of various implant surfaces have been well established. However, the compromised bone quality remains challenging for the clinician. The standard implant surface treatment based on SLA technology has the concern of residual chemicals and particles which might affect the bone healing around the implant.

The innovative Precision Dimensional Laser (PDL) implant surface modification technique creates a unique micro-nano complex 3D pores which gives a better hemocompatability surface, stimulate bone cell proliferation and differentiation, yield a higher bone-implant contact area.

Olmedo et al [1] examined the periimplant soft tissue around failed Ti implant and reported the presence of macrophages loaded with Ti particles which was associated to corrosion related process. In a rat model, they also detected higher level of Ti particles in organs such as liver, lung compared to zirconium particles [2]. Hence, zirconia (Zr) implant was an alternative choice of implant material besides for its esthetic purpose.

A good biological seal of the soft tissue around implant is crucial to maintain the osseointegration of the implant in the hard tissue. Any disturbance of the biological seal may lead to peri-implantitis. The peri-implant tissue consists of peri-implant epithelium and connective tissue. The epithelial attachment on the Ti implant surface via hemidesmosoms has been reported [3]. However, unlike the gingival fibers around the tooth which was attached perpendicular to the tooth, the connective tissue fibers around the implant running mainly circumferentially and longitudinally without much perpendicular fibers attachment. This feature forms a weaker supporting tissue compared to dento-gingival tissue around the tooth [4 5].

Research gap

Can the PDL surface stimulate perpendicular attachment of peri-implant connective tissue?

Can the PDL create the similar surface topography on the zirconia surface for the purpose of enhancing both bone and soft tissue response on Zirconia implant?

Research methodology

We have developed a three-dimensional oral mucosal model (3D OMM) for the study of implant-soft tissue interface [6]. The tissue-engineered oral mucosal model consists of epithelial layer and connective tissue. A test surface was prepared on a Ti disc, in which it was included into the oral mucosal construct. At the end of 10-14 day of culture period, the model was process into ground section for histological examination. Epithelial attachment on the Ti surface was noted along the tested surface (Figure 1) [6].

For ultrastructural analysis under transmission electron microscope, ultrathin sections were prepared using focus ion beam (Figure 2) and electropolished (Figure 3) techniques, in which the Ti was remained and removed respectively in the sections. Transmission electron micrographs showed hemidesmosome-like structure of epithelial attachment at the interface (Figure 2&3) [3]

Ground sections limit the study of the interface at 2 points for each specimen. A contour technique was developed using impression technique that allowed the examination of the angle of the soft tissue and implant interface for more than 2 points in each specimen. The angle of the soft tissue contour could be categorized into favorable soft tissue attachment which has an angel >45°. An angle < 45° suggests non-favorable soft tissue attachment at the interface (Figure 4) [7].

In order to quantify the quality of the seal between the soft tissue and implant interface, a permeability test using radioactive water (HTO) on the model was carried out. The amount of HTO that leaked through the interface was measured. A good seal at the interface will have less leaking of the HTO through the model (Figure 5) [8].

Figures and legends

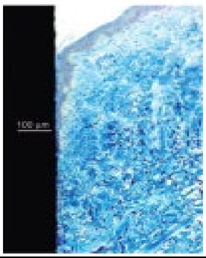

Figure 1. A ground section of the tissue-engineered oral mucosal model. Noted epithelial attachment on the Ti disc with a polished surface [6].

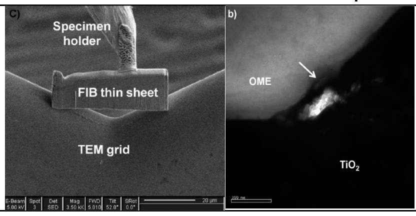

Figure 2. Transmission electron micrograph of ultrathin section prepared using focus ion beam. A peripheral density (white arrow) suggests a hemidesmosome-like structure [3].

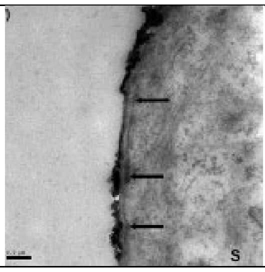

Figure 3. Transmission electron micrograph showing hemidesmosome like structure (black arrows) in the electropolished section [3].

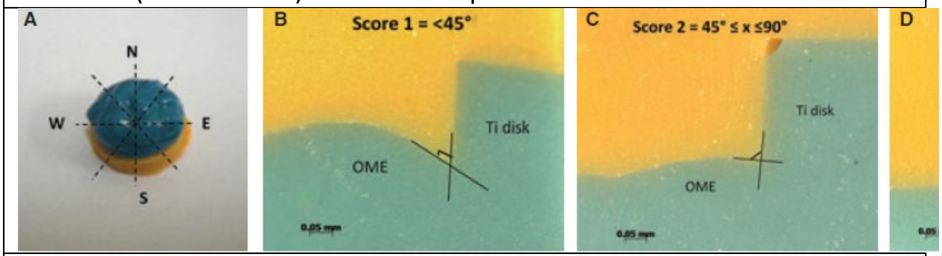

Figure 4. Contour analysis using impression technique. The angle between the oral mucosal model (OME) and Ti surface were measured and scored [7].

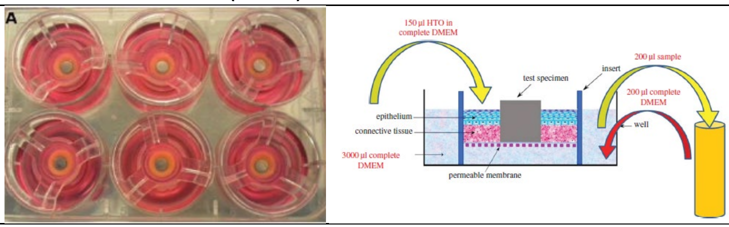

Figure 5. Permeability test was carried out using radioactive water (HTO) on the model. The amount of HTO leak through the model was measured to quantify the quality of the seal at the soft tissue-implant interface [8].

Proposed experiment

The PDL surface has great potential to enhance connective tissue attachment which may form better biological seal around the implant. The contour and permeability test based on the three-dimensional oral mucosal model could provide data on the soft tissue response of the PDL surface. In addition, the laser treatment could be tested on the zirconia implant and their soft tissue response could also be analysed based on the 3D OMM. This project could be a PhD projects with the title as 'The evaluation of soft tissue response on the PDL treated Ti and zirconia surfaces using 3D OMM' .

The previous experiments on the ground sections, focus ion beam, electropolishing techniqes were collaboration with Professor Peter Thomson, Dr Anders Palmquist in University of Gothenburg, Sweden. The 3D OMM was developed during my PhD project in University of Sheffield, UK. Currently, a PhD student of mine is working on the study of zirconia-implant interface based on the 3DOMM. She is at a stage of writing her thesis. An estimated budget for the project was attached.

Prepared by Associate Professor Dr Chai Wen Lin on 18/5/19.

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