

5680 We–Th, no. 3 (P62)  
**Dental implant osseointegration investigation via radiography image processing**

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Osseointegration level of dental implants is a very important factor for biomechanic evaluation and, consequently, for the prosthesis success.

Traditionally, radiographies has been used in order to evaluate dental implant osseointegration level, mainly due to its simplicity, low cost and trustworthiness. Despite of these positive features, some non-objective characteristics of this methodology impose constrains for the exact evaluation of a dental implant osseointegration level. As a non-objective criteria one may consider dentist's qualitative interpretation of the radiographies.

Alternatively, it is possible to increase the objectivity of this method by means of an automatic computational image processing of radiographies based on matching images. This procedure allows to evaluate dental implant osseointegration level, presenting the density augmentation of the implant surround bone areas.

In this work, it is presented a software specifically developed in order to assist dental implant osseointegration level evaluation, using techniques of image processing applied to a set of radiographies. The methodology consists on registering two or more images taken in different periods of time during the osseointegration process. The image registers are obtained through the application of a projective transformation or a polynomial relation, which parameters are achieved by means of an automatically identification of homologous points identified in two or more images.

Clinical applications are also presented showing the performance of the image processing methodology. An osseointegration level coefficient is also proposed.

4659 We–Th, no. 4 (P62)  
**The influence of superstructure materials on distal single implant: a 2-dimensional finite element analysis**

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The influence of implant superstructure materials to stress/strain distribution of implant surrounding bone had been widely discussed. It has been showed in prior static finite element studies that resin superstructure materials did not lead to difference in stress value at implant surrounding bone comparing to porcelain or metal. The aim of this study was to evaluate the biomechanical stress/strain distribution in supporting bone around an implant and adjacent natural teeth using finite element analysis under more clinical guidance masticatory force assumption. Two-dimensional finite element models of a distal single implant first molar–second premolar in mandible and their antagonists in a segmental maxilla were constructed. Resin and porcelain superstructure materials were used in this study. Natural teeth and implant in mandible were under even contact condition with their antagonists in maxilla. Static loading from 100 N to 500 N to simulate masseter muscle contraction force were applied. The result showed that the highest equivalent stress in implant-cortical bone interface was lower about 15–16% and the highest equivalent strain in implant-cancellous bone interface was lower about 2–3% under resin superstructure condition compared to porcelain superstructure condition. Under static loading, superstructure with lower elastic modulus like resin could shear stress/strain to adjacent teeth. Therefore, the lower peri-implant stress/stain values were demonstrated under resin superstructure in this study. Under the condition of this study, it is concluded that implant superstructure with lower elastic modulus material may help to share the force to adjacent teeth and to avoid higher stress/strain generated in implant-bone interface.

4657 We–Th, no. 5 (P62)  
**Influence of off-axis loading upon an anterior maxillary implant: a 3-dimensional finite element analysis**

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Biomechanical factors play an important role in maintaining the bone–implant interface. Because of the severely upper palatal resorption of the residual ridge post dental extraction in anterior maxillary area, the placement of dental implants would be more inclined to produce an unfavorable off-axis load. The purpose of this study is to evaluate the influence of the stress/strain distribution in bone around an anterior maxillary implant using two types of bone and under

three different off-axis loads. A premaxillary finite element model featuring an implant and its superstructure was created. Six different testing conditions incorporating two different types of cancellous bone (high density and low density) under three different loading angles (0°, 30° and 60°) relative to the implant's long axis were applied in order to investigate resultant stress/strain distribution. The maximum equivalent stress/strain increased linearly with the increase of loading angle. For each 30° increase in loading angle, the maximum equivalent stress in cortical bone increased, on average, 3–4 times compared with that of the applied axial load. In addition to loading angle, bone quality also demonstrated a great influence upon resultant stress distribution. For the low-density bone model, a substantial strain in the cancellous bone was not only found near the implant neck but also observed at the implant apex. Within the limit of this experiment, it is concluded that to achieve a favorable prognosis under off-axis loading on an anterior maxillary implant, careful case selection for appropriate bone quality and precise occlusal adjustment should be attempted to optimally direct occlusal force towards the long axis of the implant.

5522 We–Th, no. 6 (P62)  
**Biomechanical properties of healing periodontal ligament after replantation of teeth treated with PDGF**

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Tooth replantation is a useful model for investigating healing of the periodontal ligament (PDL). The risk of ankylosis of the alveolar bones and teeth can be minimized using platelet-derived growth factor (PDGF), which is primarily used to promote fibroblast proliferation. In the present study, we investigated whether topical application of PDGF accelerates restoration of the support function of the healing PDL in replanted teeth. Eighty-seven rats, aged 6 weeks, were divided into three groups. Under anaesthesia, the left maxillary first molars were extracted, placed in phosphate-buffered saline containing 0.7% atelocollagen with PDGF-BB (5 µg/50 µl/tooth; PDGF group) or without PDGF (AC group) for 5 min, and replanted into their sockets. In the normal control (NC) group, the teeth were not extracted. Groups of rats were killed at 7, 14, and 21 days after replantation. The replanted teeth in dissected maxillae were extracted from their sockets at 5 mm/min using a testing machine, and the extraction forces were considered as the mechanical strength of the healing PDL. Using another nine rats, each maxilla dissected at 21 days after replantation was scanned with a micro-CT, and histological sections were then prepared. The tooth roots and alveolar bones were fractured during mechanical testing, due to ankylosis, in most of the replanted teeth of the AC group, but in only a few in the PDGF group at 14 and 21 days. The mechanical strengths of the healing PDL in the PDGF group were 30, 55, and 52% of those in the NC group, on average, at 7, 14, and 21 days, respectively. Specimens from the PDGF group had minimal ankylosis and thick PDL collagen fibres with a functional arrangement. In contrast, specimens from the AC group had severe ankylosis and only thin PDL fibres. These results suggest that the topical application of PDGF to the roots effectively promotes restoration of the support function of the healing PDL.

6263 We–Th, no. 7 (P62)  
**Novel experimental technique for testing the periodontal ligament**

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The aim of this study is to develop an experimental setup allowing for the multiaxial testing of the periodontal ligament (PDL). In the literature [1,2], three main types of tests can be found: uniaxial, shear and *in vivo* whole tooth tests. Each of those tests has advantages and drawbacks; the simple geometry characterizing the specimens used in the first two tests allows for an easy computation of stresses and strains and definition of the tissue's mechanical response. They represent however an open system, where the fluid present in the PDL does not contribute to the mechanical response. Testing of the whole tooth take into account the fluid's pressure, but the control of this test and the characterisation of the PDL's constitutive response become quite complicated. In this work a 6 mm diameter cylindrical specimen is placed in a custom-made pressure chamber built to allow for a lateral pressure to be applied to the tissue during simultaneous cyclic axial loading (tension-compression). The imposed stress path is such that the specimen is first loaded to reach an isotropic stress state at a specific pressure level. Afterwards a harmonic cyclic load is applied in the axial direction of the specimen.

Experimental results show consistent differences as compared to the results obtained for the uniaxial tests without lateral pressure. This is noticed in the compressive part of the test, and suggests that the fluid pressure plays a significant role in the mechanical response of the PDL.