Evaluation of Fatigue Fracture Life for TiN Coated Abutment Screw in Dental Implant

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(Abstract) In this study, fitness and fatigue test were performed to estimate the coating effects of abutment screw for implant system after fatigue test. The purpose of this study was to investigate fatigue fracture phenomena of dental implant fixture used titanium nitride coated abutment screw under cyclic load.

1. Introduction

Dental implant system: subject to failure in the screw connection part which can occur due to screw loosening or fracture. Mostly limited to 5~7 years of follow-up with only a few that have a maximum follow-up beyond 9 years. In 15-year study, researcher found an implant fracture incidence of 3.5% with most of the fractures occurring after 5 years of clinical function. For escape from loosening, had carried out the TiN coating on the abutment screw, while fatigue and fitness of abutment screw and fixture may still be not researched as an issue of coating materials.

2. Experimental

TiN coated abutment screw (ShinHeung MST: TiN Screw RP/Luna), the fixture(Luna ϕ4.0 x 11.5mm), abutment (Duo Abut. ϕ4.5G/H2.0 H5.5 Hex) of internal hex type were prepared after repeated loosening and tightening 5 times. The abutment surface and cross-sectional surface were observed using EDS and FE-SEM. For fatigue characteristics of implant system with coating materials of abutment, in accordance with ISO14801:2003(E), the maximum fracture load was studied by giving the pressure load of 5 mm/min using tensile and compression tester (AG -10kNX, Shimadzu, Japan). After selecting the loads corresponding to 80 % and 30 % of compressive load(711N) and setting the minimum load of each load as 10 %, the cyclic loading condition was determined.

After fixing, the loading condition of sine type of cyclic loading from the minimum loadings and the maximum was applied at 30° of angle, and the load cycle was set as 15 Hz maintaining constant temperature and humanity (temperature 25 ℃, humidity 40 %). And by setting the maximum number of repetition as 106 times.

Samples were cut for observation of fitness between abutment screw and fixture with non-coated and TiN coated abutment screw.

3. Conclusions

The fitness between abutment screw and fixture was improved in the case of TiN-coated abutment screw compared to non-coated abutment screw. The fracture cycle drastically decreased as repeated load increased. Especially, in the case of TiN-coated abutment screw, fracture cycle increased compared to non-coated abutment screw. The fatigue crack was propagated fast as repeated load increased, the step of striation increased from 0.5 ㎛/cycle to 2.0 ㎛/cycle for TiN-coated abutment screw, from 1.0 ㎛/cycle to 2.0 ㎛/cycle for non-coated abutment screw, as repeated load increased. The plastic deformation region decreased, whereas, cleavage fracture

region increased as repeated load increased. Especially, the plastic deformation region of TiN-coated abutment increased compared to non-coated abutment screw, whereas, cleavage fracture region decreased as repeated load increased.

Reference

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