EFFECT OF INSERTION FACTORS ON DENTAL IMPLANT INSERTION TORQUE/ ENERGY

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Summary

Insertion torque and insertion energy for dental implants are influenced by bone density, implant geometry, surface roughness, and drill protocol to different degrees. The aim of this study was to investigate the influence of these factors on insertion torque and energy. Torque, displacement, and twist angle were measured during the insertion procedure. Energy was calculated from the torque-twist angle curve. Bone surrogate density and drill protocol were primary factors of insertion torque and energy, which may be associated with threads forming during the first insertion.

Introduction

Stable anchorage of dental implants relates to positive clinical outcomes [1] and is typically assessed clinically with maximum insertion torque. Recently, Kim reported insertion energy could help to predict implant stability [2]. However, torque and energy are measurements that combine multiple factors such as: bone mineral density, implant geometry, implant surface roughness, and drill protocol. Each factor contributes to insertion torque to a different degree. It is important to quantify the relative contributions to insertion torque and energy. In this study, a full-factorial experiment was performed with four factors at two levels to investigate the effects of these factors.

Methods

Materials and experiment design: The experiment's factors were: bone density (20 vs. 30 PCF), drill protocol (2.4/2.8 vs. 2.8/3.2 mm), implant surface roughness (polished -P vs. rough -R) and implant geometry (with -CF vs. without cutting flute -NCF). Dental implants (Nobel Active NP 3.5×13 mm, Nobel Biocare AB) were inserted into solid rigid polyurethane foams (Sawbones®) with dimensions of 40 mm×40 mm×8 mm. Implant sites were prepared with twist step drills (2.4/2.8 mm, 32261, or 2.8/3.2 mm, 34638, Nobel Biocare AB) to 13 mm depth. A full factorial analysis at two levels was performed with four factors.

Insertion test: The implant, held in the lower grip, was rotated clockwise with respect to the bone block, with a speed of 7.5 rpm. The block, held in the upper grip, was moved vertically down with an axial speed of 0.3 mm/s matching the thread pitch. Once the block reached 11.5 mm, the implant was rotated counter-clockwise and the block was moved upward to the original position. Each implant was inserted and removed three times per test. Torque, axial displacement and angle of twist were measured during each test (Figure 1a). All tests were performed with five repeats on Electroforce 3230-AT Series III (TA Instruments), at room temperature and dry conditions. Insertion energy was calculated from the area under the torque-twist angle curve. Unpaired, two-tailed, student's t-test was performed ($p \leq 0.01$)

Results and Discussion

Figure 1b and d show the results of first insertion torque and first insertion energy respectively. To protect the test machine, tests were not completed for implants with rough surface inserted with 2.4/2.8 mm drill protocol into the densest bone surrogate, which were estimated (red dots). The main factors affecting first insertion torque and energy were bone density and drill protocol.

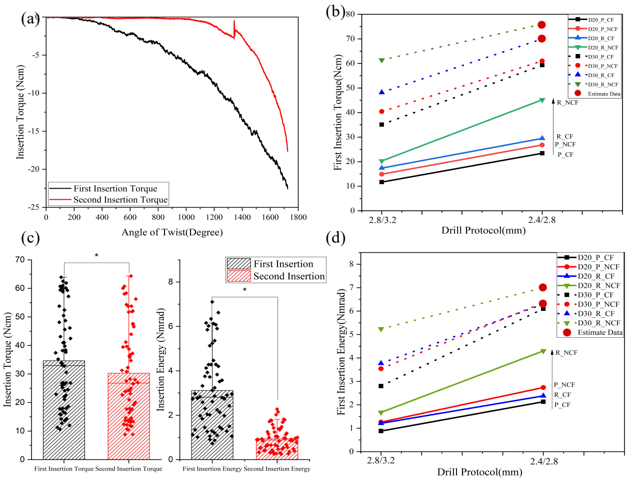

Figure 1: (a) Torque vs. angle of twist. (b) Maximum first insertion torque (c) Insertion torque and Energy (d) First insertion energy.

During the first insertion, threads were formed, and the pilot hole was enlarged. As mechanical properties are related to density, bone surrogate density significantly affected first insertion torque and energy. The energy to form the threads is the difference between the first and second insertion energy (Figure 1c).

Conclusions

Bone surrogate density and drill protocol were the principal factors of first insertion torque and energy.

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References

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