

Can we predict the insertion torque using the bone density around the implant?

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Abstract. The purpose of this study was to examine the correlation between initial stability and bone density in patients undergoing implant treatment. Twenty-five screw-type dental implants were inserted in 12 patients. All patients underwent multi-detector computed tomography (CT) examination prior to implant insertion. The implant sockets were prepared according to the drilling protocol, and peak insertion torque values were measured. CT values around the implants were measured using preoperatively scanned CT data, which were combined with actual implant positions. Spearman's rank correlation coefficient was used to investigate the correlation between insertion torque values and CT values (in Hounsfield units, HU). Twenty-three implants (8 or 10 mm in length) were inserted in the mandibular molar region and two (10 mm length) in the maxillary molar region. The mean CT value of the 8-mm implants was 508.6 ± 187.0 HU and mean insertion torque was 27.2 ± 12.1 N-cm; for the 10-mm implants, these values were 579.6 ± 224.3 HU and 28.1 ± 14.6 N-cm, respectively. Statistical analysis revealed a strong positive correlation between the insertion torque and mean CT values ($r = 0.699$, 8 mm; $r = 0.771$, 10 mm). The results revealed that bone density around the implant is a useful index. This study indicates that preoperative CT may enable the prediction of initial implant stability.

Key words: CT value; insertion torque; prediction.

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Ensuring good initial stability after implant insertion is reported to be important for the initial success of implant treatment. Orenstein reported that the 3-year survival rate of implants that had mobility when inserted was 79.8%, compared to 93.4% for implants that were stable.¹ Initial stability can be evaluated by measuring the implant stability quotient (ISQ) and insertion torque values. The ISQ is a useful

index for the evaluation of initial stability and the change in implant stability over time. In fact, there are many reports on the correlation between bone density and the ISQ value.^{2,3} On the other hand, in an in vitro study, Ito et al. showed that the implant–bone contact in the neck region of the implant affects ISQ values more than the contact in the other implant regions. This means that ISQ values tend

to be high when implants are fixed in cortical bone, even when insertion torque values are low.⁴

Insertion torque is affected by a range of factors, including the implant body shape, size, and surface morphology, the surgical procedure used, and bone density.⁵ An in vitro study using pig bone showed a significant correlation between the density of the bone around the implant and insertion

torque values.⁶ It is thought that there may be a correlation in human subjects, as was found in the in vitro study. Although a few reports have addressed the correlation between bone density and initial stability in human subjects,⁷ very few detailed studies have been performed. This study was performed to investigate the correlation between insertion torque values and bone density in patients undergoing implant treatment.

Materials and methods

Twelve patients (nine females and three males, mean age 66.7 ± 6.9 years) who were scheduled for implant treatment consented to participate in this study. Patients who had undergone tooth extraction within the previous 3 months, those who required bone augmentation simultaneously with implant insertion, and patients with any systemic condition were excluded.

Twenty-five screw-type dental implants (Genesio Plus; GC Corporation, Japan) with a diameter of 3.8 mm and length of 8 mm or 10 mm were inserted.

All patients underwent a multi-detector computed tomography (CT) examination prior to the implant insertion procedure (LightSpeed VCT, GE Medical Systems, Japan). The implant sockets were prepared according to the drilling protocol using a 3.1-mm twist drill and a counterbore drill for final preparation, and peak insertion torque values were measured at the time of implant insertion. Insertion torque values were measured with a micromotor capable of measuring to an accuracy of 1 N-cm in real time (Surgic Pro+; NSK Co., Japan).

Measurements of CT values around the implant body were obtained using superimposed CT data. The working model for the provisional restoration, with 16-mm length provisional copings attached, was scanned. Surface rendering was then performed. Implant simulation software (LANDmarker v. 6.13; iLAND Solutions Co., Ltd, Japan) was used to superimpose the scanning data onto the preoperative CT data (Fig. 1). The provisional copings on the CT image were used as indicators for the placement of virtual implants, which were of the same shape and size as the actual implants. The mean CT values at a thickness of 0.5 mm around the outside of each implant were then measured. In addition, the mean CT values at a thickness of 0.35 mm inside the virtual implant, which undergoes compression by the implant body during insertion, were also measured (Fig. 2).

The data were analyzed using IBM SPSS Statistics version 20.0 software

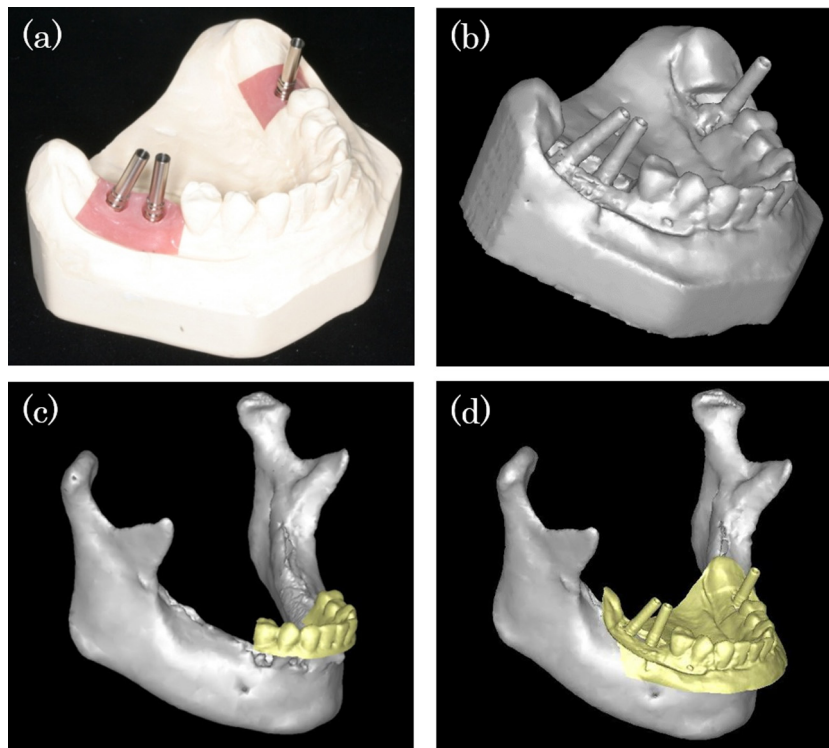


Fig. 1. Superimposition of the preoperative CT data and actual implant positions. (a) Provisional working model with 16-mm length provisional copings. (b) Scanning data of the working model after surface rendering. (c) Preoperative CT data. (d) Superimposition of the preoperative CT data and the scanned data of the working model.

(IBM Corp., Armonk, NY, USA). Spearman's rank correlation coefficient was used to investigate the correlation between insertion torque values and CT values. *P*-values of <0.05 were considered to be significant. This study was approved by the research ethics committee of the study institution.

Results

A total of 25 implants were evaluated in this study. The implant sites were in the mandibular molar region (23 implants) and maxillary molar region (two implants). The mean CT value for the 8-mm length implants was 508.6 ± 187.0 Hounsfield

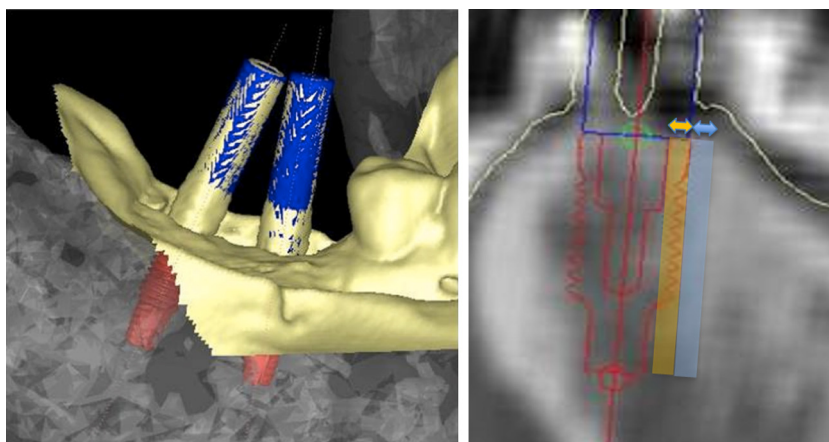


Fig. 2. Measurement of the CT values around the implants. The yellow area is 0.35 mm thick and inside the virtual implant. The blue area is 0.5 mm thick and outside the virtual implant. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

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