Effects of change in cortical bone thickness on the bone density assessed using multislice and cone beam computed tomography and primary implant stability

Sang-hoon Lee*, Deuk-won Jo, Pil-Young Yun, Yang-jin Yi, Young-Kyun Kim

Section of Dentistry ,Seoul National University Bundang Hospital

Abstract

Primary implant stability has been acknowledged as an important predictor for the success of an implant. Moreover, many researchers have reported that the primary implant stability positively correlated with the bone density. However, the role of cortical bone thickness in achieving primary implant stability is not clear.

Background and Aim

The aim of this study was to assess the effects of cortical bone thickness change on the bone density measured by multislice and cone beam computed tomography (MSCT and CBCT, respectively), and primary implant stability in an objective in vitro model.

Methods and Materials

- Forty fresh porcine ribs were divided into 4 groups based on the cortical bone thickness (Group 1, >3 mm; Group 2, 2–3 mm; Group 3, 1–2 mm; Group 4, <1 mm). Each group had 10 specimens.

Fig 1,2: Rib bone from a porcine & the measurement of cortical thickness

Fig 2. flow of the experimental procedures

- All ribs were mounted on a resin block and lead foils were attached to it to indicate the implant sites. Subsequently, MSCT(Brilliance 64 , Philips, Netherlands,120KvP, 300mA), CBCT with flat panel detector(Kodak 9500, Kodak, Japan,80KvP, 15mA), and inverse spiral motion CBCT(Pax-i3D, Vatech, Korea, 80KvP, 15mA) were used to analyze the bone density values at the implant sites.

Fig 3-a. MSCT , 3-b,c two CBCT

- Tapered design implants(4.0mm x 11.5mm, Osstem TS III ,Osstem Implant Co., Busan, Korea) were placed on the planned sites.
- Maximum insertion torque values were measured during the implant placement. The implant stability quotient (ISQ) was measured using Osstell(Osstell Mentor , Integration Diagnostics, Go™ teborg, Sweden); the implant insertion depth from the crestal bone to the implant platform and the removal torque value were measured after the implant placement.
- Pearson correlation was used to assess the correlations among the density values, maximum insertion torques, ISQ, implant insertion depths, and removal torque values.

Results

- As the cortical bone thickness decreased, the bone density values also decreased.
- Strong positive correlations were seen among the bone density values between MSCT and flat panel detector
- CBCT (CBCT 1, r=0.928, P<0.01), and MSCT and inversespiral motion CBCT (CBCT 2, r=0.924, P<0.01).
- The maximum insertion torque (r=0.811, P<0.01) and ISQ values (r=0.445, P<0.01) also showed significant positive correlations with the bone density values measured by MSCT.
- The implant insertion depth showed a negative correlation with the bone density using MSCT (r=-0.453, P<0.01) and maximum insertion torque values (r=-.0.372, P<0.05).
- Removal torque values did not show any statistically significant correlation with other measurement values.
- However, a negative tendency was noted between the cortical bone thickness and removal torque values.

Correlations

	MIT	ISQ	MSCT	CBCT 1	CBCT 2
MIT	1	.411**	.811**	.737**	.774**
ISQ	.411**	1	.445**	.462**	.363*
MSCT	.811**	.445**	1	.928**	.924**
CBCT 1	.737**	.462**	.928**	1	.931**
CBCT 2	.774**	.363*	.924**	.931**	1

** , P<0.01 , * P<0.05

Conclusions

- The increase in cortical bone thickness correlated with the increase in bone density values on CT and the primary implant stability.
- In low bone density regions, an increase in the implant insertion depth seemed to compensate the primary implant stability with tapered design implants.
- Flat panel CBCT and inverse spiral motion CBCT might be useful in evaluating the bone density in implant therapy preoperatively.
- Removal torque values might not be affected by cortical and trabecular bone ratio

References

1. Núria Farré-Pagès et al. Relation between bone density and primary implant stability, Med Oral Patol Oral Cir Bucal. 2011 Jan 1;16 (1):e62-7.

2. Mariana Marquezan et al. Does bone mineral density influence the primary stability of dental implants? A systematic review, Clin. Oral Impl. Res. 23, 2012 / 767–774

3. Isoda et al. Relationship between the bone density estimated by cone-beam computed tomography and the primary stability of dental implants, Clin. Oral Impl. Res. 23, 2012 / 832–83

Acknowledgement

This study was supported by the Industrial Strategic Technology Development Program (Grant No. 10049732) funded by the Ministry of Trade, Industry and Energy (MOTIE) of Korea.