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Stability Assessment of Brånemark System Implants Following the All-on-Four Treatment Concept Using Resonance Frequency Analysis

Robert W. Slauch, BS[1,2]/ Thomas J. Balshi, DDS, PhD, FACP[1]/ Glenn J. Wolfinger, DMD, FACP[1]/Stephen F. Balshi, MBE[1]

[1]*PI Dental Center at the Institute for Facial Esthetics; Fort Washington, PA*

[2]*University of Maryland School of Dentistry; Baltimore, MD*

Purpose:

Resonance Frequency Analysis (RFA) is used to determine implant stability under immediate loading conditions. Previous studies[1] showed a decrease in bone-implant stability during the first month after implant placement, followed by an increase in stability in the second and third months, suggesting there was adaptive osteoblastic activity around the implant. The purpose of this prospective study is to examine the pattern of implant stability in immediately loaded Brånemark System implants in the All-on-Four treatment concept and determine if a difference exists between tilted and axial implants. It is hypothesized that implant orientation, gender, and bone quality will display similar stability patterns, suggesting both axial and tilted implants have equivalent rates of adaptive bone remodeling.

Methods:

Stability measurements were taken using RFA[2] on Brånemark System implants (NobelBiocare, Yorba Linda, CA). The Osstell implant stability meter **(Figure 2)** and SmartPeg **(Figure 3)** (Osstell, Göteborg, Sweden) were used to acquire measurements at the implant and abutment levels at the day of implant placement **(Figure 4).** Only abutment level RFA measurements were taken during the postsurgical examinations (12 and 18 weeks). Bone quality was also recorded. The meter recorded information as an implant stability quotient (ISQ): a function of bone-implant stiffness (N/µm) and marginal bone height. Linear regression models and ANOVA will be performed to statistically compare whether the ISQ values changed over the time periods according to bone quality, implant location (tilted vs. axial) and gender.

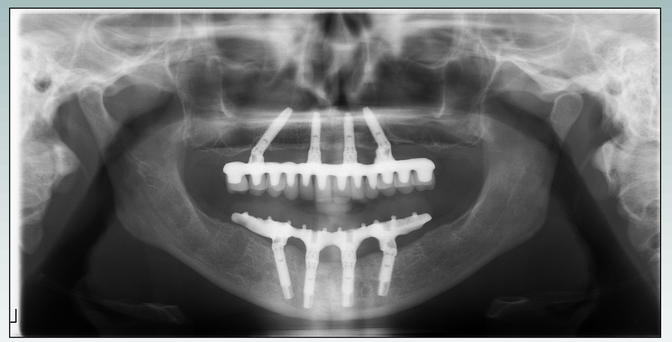


Figure 1: *Panoramic radiograph depicting maxillary and mandibular All-on-Four rehabilitation with definitive prostheses.*

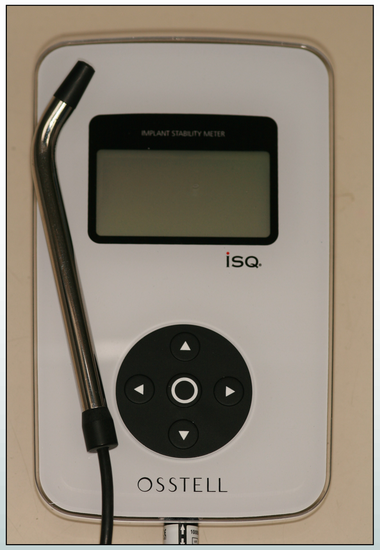


Figure 2: *Osstell Implant Stability Meter (Osstell AB, Göteborg, Sweden)*

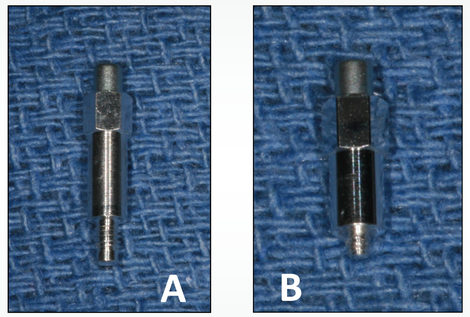


Figure 3: **A)** *Implant level SmartPeg for Brånemark System RP Platform* ***B)*** *Abutment level SmartPeg for multiunit abutments*

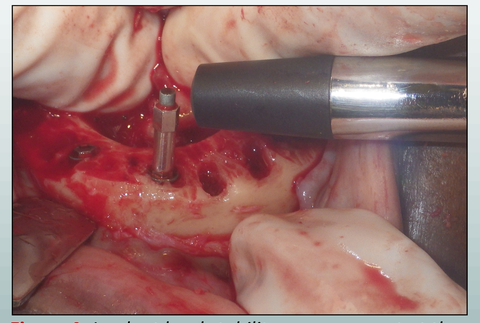


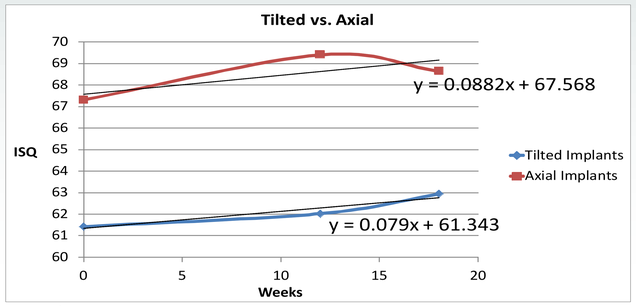
Figure 4: *Implant level stability measurement at the day of surgery.*

Results:

Table 1: Summary of Data

N (implants)	MAXILLA	MANDIBLE	MALE	FEMALE	BQ Type 1	BQ Type 2	BQ Type 3	BQ Type 4	Avg. DAY 0 ISQ **(IL)**	Avg. Day 0 ISQ **(AL)**	Avg. 12wk. ISQ (AL)	Avg. 18 wk. ISQ (AL)	Avg. RELATIVE STABILITY
116	**52**	**64**	**36**	**80**	**4**	**44**	**63**	**5**	**70.9** (±8.8)	**64.4** (±7.4)	**65.7** (±5.6)	**65.9** (±5.9)	**+0.087**

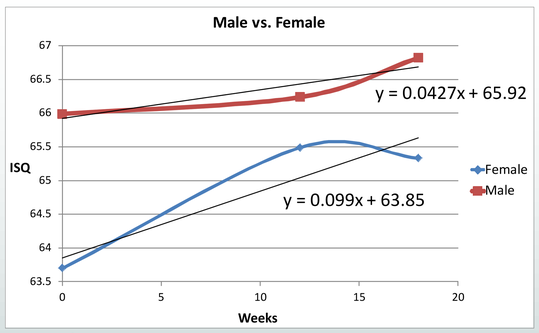
BQ= Bone Quality, IL= Implant Level, AL= Abutment Level; Only ABUTMENT LEVEL measurements are included in the graphs below. The two values taken per implant ,90° from each other, were averaged to find the mean ISQ for each time point.



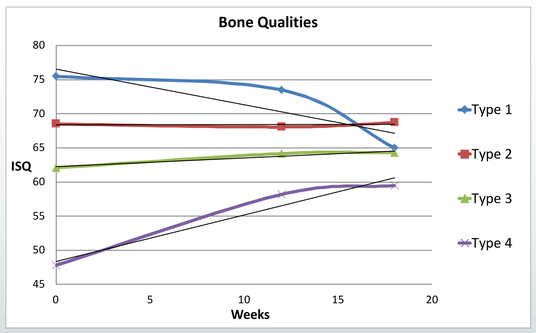
ISQ P-value= 0.00

Legend:

y= SLOPE (average relative stability)



ISQ P-value= 0.00



Type 2 vs. Type 3 ISQ P-value= 0.00
No P-value for Type 1 & 4 (small sample size)

Type 1: y= -0.5238x = 76.571
Type 2: y= 0.0045x = 68.387
Type 3: y= .1298x + 62.229
Type 4: y= .0681x + 48.357

Conclusions:

- This study is a preliminary report that suggests implant orientation, gender and bone quality do not effect the bone remodeling process around implants in the All-on-Four treatment concept.
- ISQ values for implant orientation, gender and Type 2 & 3 bone were found to be statistically significant suggesting these variables display similar stability patterns though the bone remodeling phase.
- Abutment level ISQ was predicted to be lower due to the increase in distance from SmartPeg to bone. Therefore, we expected the tilted implants to have lower initial ISQ because of the **1)** taller angulated abutment and **2)** generally softer bone.

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References:

1. Balshi SF, Allen FD, Wolfinger GJ, Balshi TJ. A resonance frequency analysis assessment of maxillary and mandibular immediately loaded implants. Int J Oral Maxillofac Implants 2005; 20:584-594.

2. Sennerby L, Neredith N. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications. Periodontology 2000. 2008; 47: 51-66.