Evaluation of the primary stability of dental implant using two different systems- A comparative study

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ABSTRACT:
Aim: Aim of the present study was to evaluate the primary stability of dental implant using two different systems. Materials and Methods: Total of twenty partially edentulous patients were selected for the study following recording of clinical history and thorough oral examination. During the pre-surgical phase, CBCT was done to measure the height and width of the alveolar bone. Diagnostic casts were prepared. Following stringent asepsis, drilling was performed using external irrigation with cool saline. The implant fixture was inserted using torque-controlled wrench. Then the implant stability was recorded using following systems. Group 1: Resonance Frequency Analysis, Group 2: Periotest. The mean values of each individual were statistically analyzed by Mann–Whitney U-test and Spearman Rank correlation method to find the correlation between the groups. Statistical significance was established at P ≤ 0.05.
Results: In RAF The maximum primary stability found in mesial area (69.01±1.30) and in periotest highest primary stability found in distal area (10.27±1.08). The results show that there was a statistically significant difference between periotest and resonance frequency values. Conclusion: The present study concluded that, both periotest and resonance frequency analysis systems are reliable in terms of the measurement of implant stability.
Keywords: Implant stability quotient, periotest, primary stability, resonance frequency analysis

INTRODUCTION:
Dental implants are considered as a treatment for completely or partially edentulous patients. Successful treatment depends on patient-related parameters and the surgical procedure. Preoperative assessment of available bone and its quality affects the selection of surgical technique and implant site and design, which will improve the success rate of implantation.¹

Dental implants have become increasingly important in many disciplines in oral rehabilitation. Dental implant stability is main reason for the surgical success, is determined by the quantity and biomechanical quality of bone tissue around the implant.² Two kinds of implant stability may be distinguished. The primary stability occurs at the moment of implant surgical insertion within bone tissue. Dental implant primary stability should be sufficiently high in order to avoid micromotion at the bone-
implant interface after surgery, but should not be too high to avoid bone necrosis due to overloading of bone tissue. Secondary stability is obtained through osseointegration phenomena, a complex phenomenon of a multi-time and multiscale nature, which strongly depends on the implant primary stability.3

A stable implant displays mobility on microscale where as a failed implant shows mobility on macroscale due to fibrous tissue that could be due to failed osseointegration after initial healing or gradual disintegration. Therefore, it implies that an initially successful but failing implant shows an increase in degree of micromobility. Implant stability, being the key element, needs to be evaluated at different time points to ensure successful osseointegration.4 Measuring implant stability helps to arrive at decisions as to loading of an implant, allows protocol choice on a patient-to-patient basis and provides better case documentation. Various methods are developed to assess implant stability such as histologic analysis, radiographs, percussion test, reverse torque test, cutting torque resistance analysis, periotest, and RFA (resonance frequency analysis) device.5 Hence the present study was conducted to evaluate the primary stability of dental implant using two non-invasive systems.

MATERIALS AND METHODS:

Patient selection:

The present study was performed in the department of periodontics, Kalinga institute of dental sciences, Bhubaneswar, India. Total of twenty partially edentulous patients were selected for the study following recording of clinical history and thorough oral examination. Patients aged 18–40 years with single or multiple missing teeth, systemically healthy patients, bone width (greater than 4 mm) and adequate bone height (greater than 10 mm) at the sites planned for implant placement, patients maintaining good oral hygiene were included in the present study. Chronic smokers, Patients with cardiac pacemakers, patients with bleeding disorders, patients with parafunctional habits such as bruxism were excluded from the study.

Surgical procedure:

During the pre-surgical phase, CBCT was done to measure the height and width of the alveolar bone. Diagnostic casts were prepared to assess the crown space; ridge mapping was done and transferred to diagnostic casts. An autopolymerizing acrylic stent with acrylic tooth was fabricated. A 2 mm hole is drilled through it matching the prosthetic and surgical centers. All patients underwent a pre-surgical preparation followed by draping. Following stringent asepsis, local anesthesia was administered by infiltration employing 2% lignocaine hydrochloride containing 1:200000 adrenaline which was injected both buccally and on the lingual or palatal side to attain anesthetic effects. Standard surgical protocol was performed under aseptic conditions. Sequential drilling was performed using external irrigation with cool saline. The implant fixture was inserted using torque-controlled wrench. Then the implant stability was recorded using following systems.

Group 1: Resonance Frequency Analysis:

The RFA response of the implant was measured using the Osstell device. For this measurement, a transducer with 8.5 mm length was placed on the fixtures. The resonance frequency (RF) transducer consisted of two piezoceramic elements attached to an offset cantilever beam. Stimulation of the elements causes vibration of the beam. The stimulating signal is a sinusoid wave with frequency of 5 to 15 Hz and amplitude peak of 1 V. RF values are recorded as implant stability quotient (ISQ) on a scale from 1 to 100.

Group 2: Periotest:

The Periotest was used to measure the primary stability. It was positioned at horizontal posture, and a certain distance between (0.6mm and 2.5 mm) between the tip of the probe and the implant to get valid readings displayed on the screen during seconds and recorded according to the device manufacturer instructions.
Statistical analysis
Data were analyzed using the SPSS statistical package, version 20.0. The mean values of each individual were statistically analyzed by Mann–Whitney U-test and Spearman Rank correlation method to find the correlation between the groups. Statistical significance was established at P ≤ 0.05.

RESULTS:
The comparison of mean areas of primary implant stability of two different systems by using Mann–Whitney U-test is statistically significant (P<0.001). In RAF The maximum primary stability found in mesial area (69.01±1.30) and in periotest highest primary stability found in distal area (10.27±1.08). The results show that there was a statistically significant difference between periotest and resonance frequency values.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Groups</th>
<th>(Mean ± SD)</th>
<th>Sum of ranks</th>
<th>Z</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal/labial</td>
<td>RFA</td>
<td>68.56±4.57</td>
<td>147.00</td>
<td>-3.848</td>
<td>0.001</td>
</tr>
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<td></td>
<td>Periotest</td>
<td>10.97±1.39</td>
<td>47.00</td>
<td></td>
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<tr>
<td>Palatal</td>
<td>RFA</td>
<td>68.89±3.02</td>
<td>147.00</td>
<td>-3.848</td>
<td>0.001</td>
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<tr>
<td></td>
<td>Periotest</td>
<td>10.28±2.97</td>
<td>47.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mesial</td>
<td>RFA</td>
<td>69.01±1.30</td>
<td>147.00</td>
<td>-3.848</td>
<td>0.001</td>
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<tr>
<td></td>
<td>Periotest</td>
<td>10.74±2.66</td>
<td>47.00</td>
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<tr>
<td>Distal</td>
<td>RFA</td>
<td>68.22±7.48</td>
<td>147.00</td>
<td>-3.848</td>
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<tr>
<td></td>
<td>Periotest</td>
<td>10.27±1.08</td>
<td>47.00</td>
<td></td>
<td></td>
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</tbody>
</table>

The correlation between periotest with resonance frequency analysis values at different areas showed in Table 2. The Spearman correlation method has given R value and t value when correlated with periotest values which were as follows: r = 0.9562, t = 6.1538 for ISQ on buccal/labial and palatal side, r = 0.8248, t = 5.7411 for ISQ on mesial and distal sides. The probability values obtained were P < 0.001, which shows a significant correlation between the resonance frequency analysis and periotest values.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Spearman R</th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal/labial</td>
<td>0.9562</td>
<td>6.1538</td>
<td>0.001</td>
</tr>
<tr>
<td>Palatal</td>
<td>0.9562</td>
<td>6.1538</td>
<td>0.001</td>
</tr>
<tr>
<td>Mesial</td>
<td>0.8248</td>
<td>5.7411</td>
<td>0.001</td>
</tr>
<tr>
<td>Distal</td>
<td>0.8248</td>
<td>5.7411</td>
<td>0.001</td>
</tr>
</tbody>
</table>

DISCUSSION:
The use of dental implants in oral rehabilitation has been increasing significantly owing to their enormous success rate. Successful dental implant outcome may be counted as a result of primary implant stability following placement of dental implants; thus, the implant stability is a key to clinical success. The primary stability of implant in the surrounding bone is crucial in the bone healing, by resisting implant micromovement and the consequent damage to the bone healing process.6

Many authors have described changes of implant stability over time. Most of these studies showed a similar pattern of consecutive reduction and increase in ISQ value. There remains debate on the timing of stability changes. Studies have reported an ISQ reduction period from the 1st to 8th week after implant installation.7 According to Simunek et al.,8 only implants with low primary stability showed increase of ISQ during the healing period, while implants with high primary stability showed reduction of stability values. Martinez et al.9 showed that primary stability was different among various bone densities.

Resonance frequency analysis is a widely used clinical, noninvasive measure of implant stability assessment. The magnetic resonance analyzer used in this study consists of a probe that is connected to
the ISQ instrument and a SmartPeg, which is a metallic rod with a small magnet on top of it, which can be screwed to the implant or abutment. The transducer probe was held so that the probe tip was aimed at the small magnet on the top of the SmartPeg at a distance of 2–3 mm. The probe was held still during the pulsing time until the instrument beeped and displayed ISQ value. The results of as RFA were expressed as ISQ on a scale from 1 to 100, which represents a standardized unit of stability. In general, the ISQ has been found to vary between 40 and 80 ISQ for clinically stable implants.10,11

Periotest is intended to assess tooth mobility through detecting the damping capacity of periodontal ligament at first time. The structure of periotest is a hand piece with a built-in metal slug. Periotest calculates the time needed for the tapping head to create contact with the tooth with an accelerometer. The software on the instrument correlates the contact time with tooth mobility. The periotest scores vary from −8 to +50. The lower values represent more rigidity. It is affected by both implant size and bone quality.12

The method is highly beneficial during implant placement to verify the degree of primary stability existing and then take a call accordingly to load implants immediately or not. If there is questionable primary stability, it is better to load the implants in a conventional manner. The evaluation of stability is equally important in the postsurgical phase. A decrease in resonance frequency during function is indicative of failure of osseointegration. This is a warning signal to the clinician that the implants are failing and there is a need to do some rescue procedure.13 The inference of the results shows, both periotest and RFA systems are reliable in terms of the measurement of implant stability. The timing of loading is entirely dependent on the clinician based on a number of factors. A combination of methods should be used for the evaluation of primary implant stability rather than depending on a single tool.

CONCLUSION:
The present study concluded that, both periotest and resonance frequency analysis systems are reliable in terms of the measurement of implant stability.

REFERENCES:

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