An Evaluation of the Resonance Frequency Analysis Device: Examiner Reliability and Repeatability of Readings

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Initial stability at the placement and development of osseointegration are 2 major issues for implant survival. Many of the presently used noninvasive methods of evaluating the stability of implants are highly subjective. The resonance frequency analysis (RFA) device is claimed to offer a more objective means to assess implant stability. Limited information is available on the interexaminer reliability and repeatability of the RFA device, used to measure implant stability. Two blind in vivo studies were conducted using 50 implant cases. In the first clinical study, 3 investigators took implant stability quotient (ISQ) readings for each implant to check the interoperator reliability for the RFA device. In the second clinical study, implant stability was measured by the same operator using the RFA device for each implant 3 times on the same day with a 15-minute interval, to check the repeatability of the RFA device. Within the limitations of this study, the RFA device demonstrated a high degree of interoperator reliability and repeatability.

Key Words: interoperator reliability, repeatability, resonance frequency analysis, implant stability, Osstell

INTRODUCTION

Dental implants have been widely used to retain and support cross-arched fixed partial dentures.¹⁻⁷ It has been advocated that after implant placement, surgical sites should be undisturbed for at least 3 to 6 months to allow uneventful wound healing, thereby enhancing osseointegration between the implant and bone.³ The rationale behind this approach is that implant micromovement caused by functional force around the bone-implant interface during wound healing may induce fibrous tissue formation rather than bone contact, leading to clinical failure.³ In addition, coverage of an implant has also been thought to prevent infection and epithelial down growth.²⁻⁸ However, this discomfort, inconvenience, and anxiety associated with the waiting period remains a challenge for both patients and clinicians. Hence, loading implants right after placement has been attempted and gained popularity among clinicians.⁹ Current trends and demands have revealed the need for faster restoration of dental function using implants, which lead to the introduction of early and immediate loading protocols.

One of the major causes for implant failure is lack of primary stability (ie, the stability of the implant at the time of implant placement). Primary implant stability is a prerequisite for successful osseointegration, and that implant instability results in fibrous encapsulation.¹⁰,¹¹ Achievement and maintenance of implant stability are prerequisite for long-term positive outcomes for osseointegrated implants. Thus, implant stability is the key to clinical success.¹² Thus, the success of immediate or early loading implant techniques is dependent on the ability of the clinicians to determine the degree of primary implant stability and changes in the stability along with new bone formation and remodeling.¹³ Continuous monitoring in an objective and quantitative manner is important to determine the status of implant stability.¹⁴ Thus, there is a clear and demonstrable need for a rapid, user-friendly, noninvasive technique to clinically assess implant stability and osseointegration.
Primitive methods such as percussion and mobility testing by application of lateral forces with mirror handles have been used to determine primary stability. More recent methods have involved measuring cutting torque resistance and insertion torque values, both of which lack repeatability. The reverse torque test is invasive and destructive and hence impractical in a clinical setting.15,16 Other techniques such as the Periotest and dental fine tester were primarily developed for use on natural teeth and are subjected to several variables and hence questionable accuracy and reliability. Histomorphometric and histologic analysis of the bone-implant interface, while reliable, is not practical in a clinical setting.17–19 The need for a user-friendly, noninvasive, reliable, and clinically applicable technique to measure implant stability led to the development of resonance frequency analysis (RFA) by Meredith and coworkers in 1996.20 A commercially available electronic device, based on RFA, with the trade name Osstell, is used widely for clinical and experimental purposes.

To date, many studies are available on the reliability of the RFA device, in comparison with various other noninvasive and invasive methods of checking implant stability. But limited information is available on interoperator reliability and repeatability of this device. So the purpose of the present study was to evaluate interoperator reliability and repeatability of the RFA device.

**MATERIALS AND METHODS**

Blind studies were conducted using 50 consecutive implant patients reported to the Department of Prosthodontics and Implantology, Sri Ramachandra Dental College, Chennai, India. Implant systems used were either UNITI or ZIMMER. No predilections were given to the site, stage, or technique of implant placement.

In the first exercise, 3 investigators took 4 implant stability quotient (ISQ) readings (the Figure) on each implant individually with the same instrument, on the same day. The mean ISQ value for each implant was calculated for all 3 investigators. These readings were evaluated using a paired t test to check interoperator reliability.

In the second exercise, one investigator took ISQ measurements using the same device for each implant 3 times on the same day with 15-min intervals. Repeatability was evaluated by comparing all 3 readings to each other using a paired t test. Comparison was made between the first and second, second and third, and first and third readings.

All data were recorded, reviewed, and entered into a computing system. Analyses were performed using the SPSS-X package (SPSS Inc, Chicago, Ill) with a .05 level of significance.

**RESULTS**

For the first exercise, the mean ISQ value for the first, second, and third operator was found to be 58.075, 58.087, and 58.085, respectively. Table 1 shows the coefficient of correlation and P values of the paired t test done to check interoperator reliability. There were no statistically significant

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<td>1</td>
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<td>.998</td>
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differences found between the first and second operators \((P = .855)\), second and third operators \((P = .882)\), and first and third operators \((P = .972)\), with the coefficient of correlation being .998.

For the second exercise, mean implant stability for 3 different readings taken by the same operator on the same day were found to be 58.0750, 58.0650, and 58.0525, respectively. Table 2 shows the coefficient of correlation and \(P\) values of the paired \(t\) test done to check the repeatability of the RFA device. There were no statistically significant differences found between the first and second readings \((P = .878)\), second and third readings \((P = .737)\), or first and third readings \((P = .862)\), with the coefficient of correlation being .998. Table 3 shows the standard deviation between ISQ values.

**DISCUSSION**

The level of predictability and high success of current implant therapy have provided reasons for reassessing long adopted surgical and prosthetic guidelines. With the trend of shortening treatment time and reducing the patient’s discomfort and inconvenience, immediate loading implants have emerged as an alternate approach. Certain criteria and guidelines have to be followed to avoid any unnecessary failure.

Primary implant stability is a key factor to consider before attempting immediate implant loading as well as to consider long-term success of implant therapy. Thus, there is a need for a noninvasive diagnostic technique to assess clinically implant stability and osseointegration. Although RFA is extensively used in clinical research as one parameter to monitor implant stability, there is still a lot of controversy about RFA’s reliability.

Results of the present study strongly suggest that ISQ values are not influenced by the operator and are repeatable as well. An animal study of repeatability of ISQ values by Meredith et al. concluded that the RFA device exhibits a high degree of repeatability for an examiner using a given RFA device. The present investigation confirms these findings and, in addition, suggests that the RFA device also has a high degree of interexaminer reliability.

**CONCLUSION**

The results of these clinical investigations indicate that the RFA device exhibits a high degree of repeatability for an examiner using a given RFA device as well as high interexaminer reliability. Regular use of this noninvasive device to check implant stability is strongly recommended to prevent implant failure and to ensure long-term success of implant treatment.

**ABBREVIATIONS**

ISQ: implant stability quotient
RFA: resonance frequency analysis

**REFERENCES**