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Resonance Frequency Analysis (RFA) technique

1. Immediate vs. early loading of SLA implants in the posterior mandible: 5-year results of randomized controlled clinical trial. Kokovic V, Jung R, Feloutzis A, Todovoric V, Jurisic M, Hämmerle C. Clinical Oral Implants Research, 00, 2013, 1-6

Abstract

Objectives:

The aim of this study was to compare clinical results of immediate and early loading (EL) self-tapping implants placed in posterior mandibles.

Material and methods:

Twelve patients with bilateral edentulous posterior mandibular were randomly assigned to treatment either with immediate (test) or early loaded implants (control). Seventy-two self-tapping implants with SLA surface (Ø 4, 1/4, 8 mm; length 8 and 10 mm) were analyzed in this study. Test implants (36) were loaded on the day of surgery and control implants 6 weeks later. The measuring of implant stability quotient (ISQ) was performed on 0, 6th, 12th, and 52nd week after implant insertion. The bone resorption, modified plaque, and bleeding index were notified at 1 and 5 years later.

Results:

After 5 years, survival in the both groups was 100%. The mean value of primary implant stability was 76.92 ± 0.79 ISQ. In the first 6 weeks, ISQ values significantly increased in the test group (77.92 ± 1.16 vs. 79.61 ± 0.90) as well as in the control group (7.92 ± 1.05 vs. 77.55 ± 0.99). A significant longitudinal increase in ISQ value was recorded in test and control group. The differences between immediate and early loaded implants were statistically insignificant ($P > 0.05$). At the 5 years, no statistically significant differences were found between immediate and early loaded implants with respect to mean crestal bone loss measurements (0.4 ± 0.24 vs. 0.8 ± 0.15 mm), mean bleeding index (0.22 ± 0.11 vs. 0.25 ± 0.11), and mean plaque index (0.17 ± 0.15 vs. 0.19 ± 0.20).

Conclusion:

Based on these results, the self-tapping implants inserted in posterior mandible can provide adequate primary stability value as the main factor for immediate and EL protocol.

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2. Early Loading of Nonsubmerged Titanium Implants with a Chemically Modified Sand- Blasted and Acid-Etched Surface: 6-Month Results of a Prospective Case Series Study in the Posterior Mandible Focusing on Peri-Implant Crestal Bone Changes and Implant Stability Quotient (ISQ) Values. M Bornstein, C Hart, S Halbritter, D Morton, D Buser, Prof. Dr. med. dent. Clin Implant Dent Relat Res 2009

Abstract

Purpose:

The aim of this prospective case series study was to evaluate the short-term success rates of titanium screw-type implants with a chemically modified sand-blasted and acid-etched (mod SLA) surface after 3 weeks of healing.

Material and methods:

A total of 56 implants were inserted in the posterior mandible of 40 partially edentulous patients exhibiting bone densities of class I to III. After a healing period of 3 weeks, all implants were functionally loaded with a screw-retained crown or fixed dental prosthesis. The patients were recalled at weeks 4, 7, 12, and 26 for monitoring and assessment of clinical and radiological parameters, including implant stability quotient (ISQ) measurements.

Results:

None of the implants failed to integrate. However, two implants were considered "spinners" at day 21 and left unloaded for an extended period. Therefore, 96.4% of the inserted implants were loaded according to the protocol tested. All 56 implants including the "spinners" showed favorable clinical and radiographic findings at the 6-month follow-up examination. The ISQ values increased steadily throughout the follow-up period. At the time of implant placement, the range of ISQ values exhibited a mean of 74.33, and by week 26, a mean value of 83.82 was recorded. Based on strict criteria, all 56 implants were considered successfully integrated, resulting in a 6-month survival and success rate of 100.0%.

Conclusion:

This prospective study using an early-loading protocol after 3 weeks of healing demonstrated that titanium implants with the modified SLA surface can achieve and maintain successful tissue integration over a period of at least 6 months. The ISQ method seems feasible to monitor implant stability during the initial wound-healing period.

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3. The Predictive Value of Resonance Frequency Analysis Measurements in the Surgical Placement and Loading of Endosseous Implants.

Abstract

Purpose:

The purpose of this study was to investigate the predictive value of resonance frequency analysis in assessing implant survival. This was accomplished by determining the correlation between implant stability quotients (ISQs) and implant survival following different placement staging (1-stage vs 2-stage) and loading (early vs traditional) protocols.

Material and methods:

A retrospective study was performed on implant patient data collected over a 5-year period. Patients ranged in age from 16 to 91 years. We analyzed 703 implants during placement and 1,254 implants before loading. All implants were placed with respective ISQs recorded by 1 oral and maxillofacial surgeon. Receiver operating characteristic (ROC) statistical analysis was used to calculate sensitivity and specificity values corresponding to various ISQ cutoff points for different placement staging and loading protocols; $\chi(2)$ tests were used to identify significant differences.

Results:

In predicting implant failure, sensitivity progressively increased and specificity decreased as ISQ cutoff values increased. All failures occurred at an ISQ less than 66 for the placement staging protocol and an ISQ less than 67 for the loading protocol. When ISQ values were below 60, higher survival rates were observed when implants were placed using a 2-stage rather than a 1-stage placement staging protocol ($P < .05$). The area under the ROC curve for placement staging was 0.80, and the area under the ROC curve for loading was 0.89. An implant survival rate of over 98% was achieved.

Conclusion:

Resonance frequency analysis is a noninvasive technique used to measure the stability of implants and to help guide placement staging and loading protocols. This study showed that increasing ISQ values correlated with increased sensitivity in detecting implant failure. Given the high survival rates of dental implants, additional studies can further elucidate the relationship between ISQ values and survival rates.

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4. Diagnosis of Implant Stability and its Impact on Implant Survival: A Prospective Case Series Study.

Abstract

Objectives:

To assess the predictability of implant stability assessment either clinically or by resonance frequency analysis (RFA).

Material and methods:

This prospective case series study evaluated 4114 consecutive SLA Straumann implants in two private clinics. Primary stability was classified in four categories, depending on the degree of implant rotation when tightening the healing cap: A (no rotation at all), B (light rotation with a feeling of resistance), C (rotation without resistance) and D (rotation and lateral oscillation). In one clinic (n=542 implants), RFA method was also used the day of the surgery (Osstell 1) and at restoration placement (Osstell 2). Survival rates were stratified according to the clinical classification categories using life table analysis. The association between Osstell 1 and 2 and the clinical classification was tested with ANOVA.

Results:

3899 implants were classified as stable (A) and 213 as unstable (B-D). Their survival rates were 99.1% and 97.2%, respectively. The unstable implants were further classified in B (158), C (51) and D (4), with survivals of 98.1%, 94.1% and 100%, respectively, being these differences statistically significant (P<0.009). Using Osstell, implants were stratified in two groups according to a predefined threshold of implant stability quotient (>or=60). At the Osstell 1 measurement there was no significant association between primary stability and implant survival (P<0.753). In Osstell 2, however, the association was significant (P<0.001).

Conclusion:

Only secondary stability RFA values were able to significantly predict implant outcomes, but not primary stability values. There was a good correlation between RFA and the proposed clinical classification of primary stability.

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5. The relationship between resonance frequency analysis (RFA) and lateral displacement of dental implants: An in vitro study.

Summary

This *in vitro* investigation was conducted to study the relationship between resonance frequency analysis (RFA) and lateral displacement measurements of dental implants. A total of 30 implant sites were prepared in nine fresh bovine bone specimens. The bone density around each preparation was determined by using cone beam computerized tomography (CBCT) and imaging software. Dental implants were then inserted during continuous registration of insertion torque. RFA measurements were performed in perpendicular and parallel to the long axis of the specimens. The bone blocks were embedded in plaster and fixated in a specially designed rig for displacement measurements. A lateral force of 25 N was applied via an abutment perpendicular and parallel to each implant and the displacement measured in µm. In addition, a flex constant (µm N^{-1}) was calculated for each measurement. There was a significant inverse correlation between RFA and lateral implant displacement (µm) measurements and between RFA measurements and the flex constant in both perpendicular and parallel directions in bone ($P \leq 0{\cdot}001$). Moreover, both RFA and displacement measurements correlated with bone density ($P \leq 0{\cdot}001$). It is concluded that RFA measurements reflect the micromobility of dental implants, which in turn is determined by the bone density at the implant site.

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6. Early loading of titanium dental implants with an intra-operatively conditioned hydrophilic implant surface after 21 days of healing.

Abstract

Objectives:

The aim of the present observational medical device performance study was to test whether implants with an intra-operatively conditioned hydrophilic surface can be safely reconstructed when applying an early loading protocol after 21 days in partially edentulous posterior mandibles.

Material and methods:

Partially edentulous patients with missing teeth in the posterior mandible were recruited. Immediately after implant placement, the implant position was indexed using a pickup impression technique. ISQ values were measured after 21 days of healing. When ISQ values were ≥70, the implants were directly restored with provisional reconstructions in occlusal contact allowing an early loading protocol. ISQ values were repeated again at 1, 3, and 6 months postloading. Clinical parameters (mPLI, mSBI, PPD, DIM, and CAL) were assessed. Standardized periapical radiographs were obtained after surgery, at implant loading and 3 and 6 months later. Changes over time were analyzed for statistical significance using the nonparametric method by Brunner & Langer (SAS Proc Mixed).

Results:

Fifteen partially edentulous patients with healed sites in the posterior mandible received 20 implants. All implants healed uneventfully. At 21 days, all implants achieved an ISQ value of ≥70 (mean of 3 measurements) and were reconstructed at this time point with provisionals. ISQ values showed a gradual increase from baseline to 3 and 6 months postloading. The assessment of clinical parameters revealed stable tissue integration. The evaluation of the radiographs showed that 3 and 6 months after loading the median mesial and distal marginal bone levels had stabilized at the border between the rough surface and the 1-mm machined implant collar.

Conclusion:

Functional occlusal loading of implants with a hydrophilic, moderately rough endosseal surface 3 weeks after placement appears to be a safe and predictable treatment option in healed sites in the posterior mandible without need of bone augmentation procedures.

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7. Immediate vs non-immediate loading post-extractive implants: a comparative study of implant stability quotient (ISQ).

Abstract

Purpose:

This study aims to evaluate differences in implant stability between post-extractive implants *vs* immediately placed post-extractive implants by resonance frequency analysis (RFA).

Material and methods:

Patients were grouped into two different categories. In Group A 10 patients had an immediate post-extractive implant, then a provisional, acrylic resin crown was placed (immediate loading). In Group B (control group) 10 patients only had an immediate post-extractive implant. Both upper and lower premolars were chosen as post-extractive sites. Implant Stability Quotient (ISQ) was measured thanks to RFA measurements (Osstell®). Five intervals were considered: immediately after surgery (T0) and every four weeks, until five months after implant placement (T1, T2, T3, T4,T5). A statistical analysis by means of Student's T-test (significance set at $p<0.05$) for independent sample was carried out in order to compare Groups A and B.

Results:

The ISQ value between the two groups showed a statistically significant difference ($p<0.02$) at T1. No statistically significant difference in ISQ was assessed at T0, T2, T3, T4 and T5.

Conclusion:

After clinical assessment it is possible to confirm that provisional and immediate prosthetic surgery in post-extraction sites with cone-shaped implants, platform-switching abutment and bioactive surface can facilitate osseointegration, reducing healing time.

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8. Influence of cortical bone and implant design in the primary stability of dental implants measured by two different devices of resonance frequency analysis: An in vitro study.

Abstract

Background:

This study aimed to evaluate the effect of the implant design and the presence of cortical bone in the primary stability, as well as analyze the differences between the stability measurements obtained by two different resonance frequency analysis (RFA) devices.

Material and methods:

A total of 80 Klockner implants of two different models [40 Essential Cone implants (group A) and 40 Vega implants (group B)] were used. The implants were placed in two polyurethane blocks that simulated the mechanical properties of the maxillary bone. One block featured a layer of cortical bone that was absent from the other block. The primary stability of all implants was measured by insertion torque and RFA using two different devices: Penguin RFA and Osstell IDX.

Results:

Primary stability was superior in the cortical bone in both torque and RFA. In the block containing cortical bone, group A implants obtained a greater insertion torque than did group B. The insertion torque was lesser in the bone lacking cortex. Regarding the ISQ of the implants, group A presented higher values in the block with cortical bone, but the values were lower in the block without cortical bone. There were no significant differences between the values obtained from the Osstell IDX and Penguin RFA.

Conclusion:

The presence of cortical bone positively influences the primary stability of dental implants. The design of the implant also has a statistically significant influence on implant primary stability, although the impact depends on whether there is coronal cerclage or not. There were no statistically significant differences in the implant stability measurements obtained by two different devices. **Key words:**Implant stability, resonance frequency analysis, torque, osstell, penguin, cortical.

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Penguin RFA is reliable & repeatable

1. Resonance frequency analysis: Comparing two clinical instruments.

Abstract

Background:

Numerous studies indicate implants placed immediately after extraction or with minimally invasive procedures have excellent long-term success and survival rates. There is general agreement that implants must be stable after implant placement. This study evaluated implant stability changes from the time of implant placement to second stage (prior to restoration). Resonance frequency analysis (RFA) was determined for two commercially available units (Osstell, Osstell USA, Columbia, MD and Penguin, Penguin Integration Diagnostics, Sweden). The unit of measurement was the implant stability quotient (ISQ).

Material and methods:

Prior to treatment patients were given medical and dental evaluations. Periapical and panogram radiographs were taken Computerized tomography images were taken for sites where adequate bone volume or quality were uncertain. Thirty patients were enrolled in this study (13 females, 17 males, mean age 73.4 years, (maximum age 90, minimum 47 year total of 38 implants were placed. One implant was lost. Computerized implant planning (Nobel Clinician) Nobel Biocar United States (Nobel Biocare, Yorba Linda, CA) was performed for all patients. Implants were placed utilizing a surgical guide. Using Resonance Frequency anal this study compared two RFA systems for determining implant stability (ISQ; Osstell and Penguin). Measurement pegs were screwed into the implants, and RFA measurements were taken at mesial, distal, lingual, and buccal implant surfaces. Stability measurements were taken at implant placement and at second stage. Clinical data and RFA measurements were recorded on data sheets. The average interval between first and second stages was 144.1 days (range 21.3) RESULTS: Average interval between implant placement and second stage was 141.1 days. One implant was lost prior to second stage. The results are based on 30 patients with 38 implants. At second stage, the RFA measures were slightly higher than first stage with a mean increase of 1.15, SE = 0.3, P-.067. The Penguin RFA values were marginally higher than Osstell (mean increase 1.10, SE = 0.64, P < .08).

Conclusion:

RFA values between implant placement and second stage differed slightly between implant placement and second stage (P < 0.10). These differences were not clinically or statistically significant. At second stage, Penguin RFA values were slightly higher when compared with the Osstell device (P < 0.67). Bone quality appears to be an important factor when determining RFA readings. Type I bone had significantly higher readings when compared with other less dense bone types (P < .029) Resonance frequency evaluation data were similar for both instruments, indicating their reliability in determining implant stability. Neither instrument predicted implant failure. While subjective, Penguin was less cumbersome to utilize and the window revealing the readings was very easier to read. Further, the pegs are magnetized making insertion easy.

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2. Diagnosis of implant stability and its impact on implant survival: a prospective case series study.

Abstract

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To assess the predictability of implant stability assessment either clinically or by resonance frequency analysis (RFA).

Material and methods:

This prospective case series study evaluated 4114 consecutive SLA Straumann implants in two private clinics. Primary stability was classified in four categories, depending on the degree of implant rotation when tightening the healing cap: A (no rotation at all), B (light rotation with a feeling of resistance), C (rotation without resistance) and D (rotation and lateral oscillation). In one clinic (n=542 implants), RFA method was also used the day of the surgery (Osstell 1) and at restoration placement (Osstell 2). Survival rates were stratified according to the clinical classification categories using life table analysis. The association between Osstell 1 and 2 and the clinical classification was tested with ANOVA.

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Conclusion:

Only secondary stability RFA values were able to significantly predict implant outcomes, but not primary stability values. There was a good correlation between RFA and the proposed clinical classification of primary stability.

3. Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications.

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PERIODONTOLOGY 2000

Implant stability measurements using resonance frequency analysis: biological and biomechanical aspects and clinical implications

LARS SENNERBY & NEIL MEREDITH

Osseointegrated implants for prosthetic rehabilitation of the edentulous patient show high success rates if certain preconditions are fulfilled. Implant stability plays a critical role for a successful critical outcome since short implants and implants placed in soft bone are more prone to failure (13, 49). In the original protocols for implant placement, primary implant stability was ensured by new bone formation and remodelling, termed osseointegration, which was accomplished during an initial healing period in which implants remained non-loaded to secure undisturbed bone formation onto the implant surface. The process of osseointegration increases the stiffness of the bone around the implant, and the bony interlock with the implant surface prevents micro-movement and the formation of fibrous scar tissue at the time of implant loading. However, the development of new implant surfaces and clinical techniques has enabled a marked reduction of the initial healing period, even to the point of an immediate/early loading of implants that show high primary stability (7, 37). Thus, the success of immediate/early loading implant techniques is dependent on the ability of the clinician to determine the degree of primary implant stability and changes in stability along with new bone formation and remodelling.

The clinical perception of primary implant stability is frequently based on the cutting resistance of the implant during its insertion. The feeling of 'good' stability may be accentuated if there is the sense of an abrupt stop at the seating of the implant. Root forms of tapered implants often have a geometry that will provide a firm stop and perhaps a false perception of high stability. A percussion test has also been used to assess implant stability. The percussion test may involve the tapping of a mirror handle against the implant carrier and is designed to elicit a ringing sound from the implant as an indication of good stability or osseointegration. Percussion tests probably provide more information about the tapping instrument, and will at best only yield poor qualitative information. Insertion torque measurements are sometimes used to determine primary implant stability (6). Application of a reverse or unscrewing torque has also been proposed for the assessment of implant stability at the time of abutment connection (53). Implants that rotate under the applied torque are considered failures and are then removed. However, an implant surface in the process of osseointegrating, albeit slowly, may fracture under the applied torque stress. Moreover, as animal experiments have demonstrated the re-integration of loosened and rotationally mobile implants (26), the reverse torque testing has fallen into disrepute. Other techniques, such as the Periotest and resonance frequency analysis, aim to provide an objective measure of implant stability and osseointegration that is noninvasive and does not damage the implant–tissue interface (6, 28). The resonance frequency analysis technique has been extensively used in experimental and clinical research for the last 10 years. The purpose of this

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4. Resonance frequency analysis: Agreement and correlation of implant stability quotients between three commercially available instruments.

Abstract

Purpose:

Purpose: The purpose of this study was to analyze the implant stability quotient (ISQ) values recorded by three commercially available resonance frequency analysis (RFA) instruments from a large cohort of implants in order to determine their accuracy and agreement with one another both for static measurements of ISQ at a given time and for change in ISQ over time.

Material and methods:

Materials and Methods: A cohort of n = 210 implants had their primary stability, secondary stability, or both evaluated in both the mesiodistal (MD) and buccolingual (BL) directions by means of ISQ using three different RFA instruments: Osstell ISQ (O_{ISQ}), Osstell IDx (O_{IDX}), and the Penguin (PG). ISQ values were recorded both at the time of implant placement and at 3 months postinsertion prior to definitive restoration. All values were tabulated for a blinded statistical analysis using Bland-Altman plots to determine if the outcome values were in agreement both for primary and secondary stability. In addition, a subgroup was evaluated to determine if change in ISQ was also in agreement. An intraclass correlation (ICC) was used to measure the reliability of the measurements for each instrument.

Results:

Results: Bland-Altman plots confirmed that there was a high agreement for MD values between O_{ISQ} and O_{IDX}, with 72.7% of readings being within one ISQ unit and 94.7% within four units. Comparing PG to OISQ, the respective values at one and four units were 15.3% and 82.3%, and comparing PG to O_{IDX}, the respective values were 16.3% and 85.2%. In general, there was a greater uncertainty in the BL values having wider variability and demonstrating less agreement between instruments, with the percentage of readings falling within four units reducing to 85.9% (O_{ISQ} vs O_{IDX}), 72.3% (PG vs O_{ISQ}), and 74.3% (PG vs O_{IDX}). For change in ISQ over time, 92.3% of values were in agreement to within four units between instruments O_{ISQ} and O_{IDX} in the MD direction and 73% in the BL direction. The respective percentage changes of values in agreement within four units for PG vs O_{ISQ} were 76.9% and 60.3% and for PG vs O_{IDX} were 80% and 53.8%. The paired t test from mixed effects revealed that there was a significant difference for mean MD values between PG vs O_{ISQ}; P = .015 with a mean 0.823 units higher was recorded for PG. Similarly for PG vs O_{IDX}, P = .008 with a mean 0.871 units higher was recorded for PG. For mean BL values between PG vs O_{IDX}, P = .000 with a mean 1.161 units higher was recorded for PG, and finally, for O_{ISQ} vs O_{IDX}, P = .005 with a mean 0.597 units higher was recorded for O_{ISQ}. However, the maximum upper and lower bound estimated bias between any two instruments was only 1.86 units and 0.46 units both for PG vs O_{IDX} in the BL direction, and it is doubtful that this is of clinical relevance even if statistically significant. ICC revealed that for static MD measurements, there was an 85% reliability between all three instruments (range: 79% to 97%). For BL measurements, the reliability value was 66% (range: 69% to 71%). When considering ICC for changes in ISQ values over time in the MD direction, there was a 70% reliability between all three instruments (range: 58% to 94%). For BL measurements, the reliability value was 58% (range: 46% to 91%).

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Conclusion:

Conclusion: Differences exist between instruments to some extent, most notably between the Penguin and the two instruments from Osstell, which showed good agreement to each other. While differences in evaluating ISQ with the PG were statistically significant, they were less than 1.86 units at the upper bound limit, and it is doubtful that this is of clinical relevance. Increased variability and reduced reliability for BL values render these less clinically sound when trying to assess primary stability.

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5. Initial stability measurements of implants using a new magnetic resonance frequency analyzer with titanium transducers: an ex vivo study.

Abstract

The establishment of dental implant stability is mandatory for successful osseointegration. Resonance frequency analysis (RFA) is the most frequently used method for the clinical measurement of implant stability. The purpose of the present study was to evaluate the reliability of the recently developed RF analyzer Penguin RFA and to compare it with the traditional RF analyzer Osstell ISQ. Sixty implants were inserted into fresh steer vertebrae and pelvis. Implant stability was measured using Penguin RFA by its transducers (multipegs) and Osstell ISQ by its transducers (smartpegs). Additionally, stability was measured by multipegs with Osstell ISQ and by smartpegs with Penguin RFA. The intraobserver and interobserver reliability of Penguin RFA were estimated by the intraclass coefficient (ICC). Mean implant stability quotients (ISQs) measured with Osstell ISQ were higher than the ISQs measured with Penguin RFA ($P < .05$). The intra- and interobserver reliability of Penguin RFA were considered as excellent (ICC > 0.7). For Osstell ISQ, no significance in ISQs was detected between the readings by smartpegs and multipegs ($P > .05$), while for Penguin RFA ISQs by smartpegs were significantly higher than the ISQs by multipegs ($P <.05$). The recently developed Penguin RFA is reliable and can be used in clinical practice for the measurement of dental implant stability regardless of the bone type. The multipegs originally manufactured for the Penguin RFA is also compatible with Osstell ISQ.

6. In vitro comparative analysis of two resonance frequency measurement devices: Osstell implant stability coefficient and Penguin resonance frequency analysis.

Abstract

Adequate implant stability is an essential requirement. The introduction of the Penguin resonance frequency analysis raises some questions regarding its reliability, reproducibility, and repeatability as well as how it compares to the older Osstell device.

Purpose:

To assess the newer Penguin implant stability coefficient (ISQ) device (vs the Osstell device).

Material and methods:

A total of 120 implants were used, divided into four groups (A, B, C, and D) (according to design) and placed in fresh bovine bone. Consecutive measurements were made with both devices (Penguin/Osstell) with their respective transducers. Then, the ISQ values were measured with the Penguin device using the Osstell transducer, and vice-versa.

Results:

The mean insertion torque (N/cm) values for the implants were as follows: Group A = 24.7 ± 9.4; Group B = 25.6 ± 9.7; Group C = 28.7 ± 7.9; Group D = 19.1 ± 5.5. The mean ISQ values for the entire sample were as follows: Penguin 67.7 ± 6.1 and Osstell 68.5 ± 9.6. The ISQ value measured with the Penguin device using a SmartPeg transducer was 67.0 ± 8.0, and that for the Osstell device using a MultiPeg transducer was 68.3 ± 7.5. The intraclass correlation coefficient (ICC) was calculated for the ISQ values obtained from both devices and was >0.90 for all transducers. When the ICC transducers were interchanged, the values were <0.77.

Conclusion:

Both ISQ devices allow for reliable and repeatable measurement of implant stability; however, the use of each device-specific transducer is recommended.

7. In vitro comparison of resonance frequency analysis devices to evaluate implant stability of narrow diameter implants at varying drilling speeds in dense artificial bone blocks.

Abstract

Background:

There are no studies that have assessed the implant stability quotient (ISQ) values of narrow diameter implants placed in artificial dense bone blocks at varying drilling speeds (DSs).

Purpose:

The aim of the present in vitro experiment was to compare the performance of OSSTELL and Penguin devices to evaluate implant stability at DSs of 800 and 2000 rpm.

Material and methods:

A total of 360 osteotomies were created in dense artificial bone blocks at DSs of 800 and 2000 rpm. Dental implants from three manufacturers (group-1: NobelActive implants, Nobel Biocare, Yorba Linda, California; group-2: Zimmer, Eztetic-Zimmer implants, Zimmer Biomet Dental, Palm Beach Gardens, Florida; and group-3: Astra Tech implant system, Dentsply Sirona, York, Pennsylvania) were randomly placed in these osteotomies using an insertion torque of 15 Ncm (60 implants/group). Implant stability in all bone blocks immediately following implant placement was evaluated using the OSSTELL and Penguin devices. ISQ values were presented as means ± SD. Statistical significance was set at $P < .05$.

Results:

There was no significant difference in the ISQ values obtained from the OSSTELL and Penguin devices for implants in groups 1, 2, and 3. There was no significant difference when ISQ values obtained from the OSSTELL device were compared with the Penguin device for narrow diameter dental implants placed in dense bone blocks with osteotomies performed at 800 and 2000 rpm. ISQ values showed statistically significant higher values for OSSTELL compared to Penguin device.

Conclusion:

The OSSTELL and Penguin devices are reliable for the assessment of implant stability in dense artificial bone. Implant design and site-DS does not seem to have a significant impact of implant stability in artificial dense bone blocks.

8. Can resonance frequency analysis detect narrow marginal bone defects around dental implants? An ex vivo animal pilot study.

Abstract

Background:

Resonance frequency analysis (RFA) is applied to assess implant stability, as expressed by the implant stability quotient (ISQ). This study aimed to investigate the potential of RFA devices to identify narrow marginal bone defects around implants.

Methods:

Twenty-eight Straumann bone level (BL) implants and 28 bone level tapered (BLT) implants were placed ex vivo in porcine ribs. Implants in the control group (A) were fully submerged in the bone. In three experimental groups, implants were placed with a 0.9-mm circumferential marginal bone defect extending 2 mm (B), 4 mm (C) and 6 mm (D) apically. Two RFA devices were used to measure implant stability.

Results:

ISQ values decreased as the defects' depth increased, with the greatest reduction observed between full bone (A) and 2-mm defects (B) ($P < 0.001$). No significant differences were found in the ISQ values recorded from BL and BLT implants.

Conclusions:

ISQ values can effectively detect narrow, intrabony marginal bone defects, in particular when involving the first coronal 2 mm. This finding could have implications for the early diagnosis of conditions affecting the marginal bone, such as peri-implantitis. Further research is required to investigate if such findings can be replicated after osseointegration is achieved.

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Penguin RFA is non-invasive

1. **The predictive value of resonance frequency analysis measurements in the surgical placement and loading of endosseous implants.**

Abstract

Purpose:

The purpose of this study was to investigate the predictive value of resonance frequency analysis in assessing implant survival. This was accomplished by determining the correlation between implant stability quotients (ISQs) and implant survival following different placement staging (1-stage vs 2-stage) and loading (early vs traditional) protocols.

Material and methods:

A retrospective study was performed on implant patient data collected over a 5-year period. Patients ranged in age from 16 to 91 years. We analyzed 703 implants during placement and 1,254 implants before loading. All implants were placed with respective ISQs recorded by 1 oral and maxillofacial surgeon. Receiver operating characteristic (ROC) statistical analysis was used to calculate sensitivity and specificity values corresponding to various ISQ cutoff points for different placement staging and loading protocols; $\chi(2)$ tests were used to identify significant differences.

Results:

In predicting implant failure, sensitivity progressively increased and specificity decreased as ISQ cutoff values increased. All failures occurred at an ISQ less than 66 for the placement staging protocol and an ISQ less than 67 for the loading protocol. When ISQ values were below 60, higher survival rates were observed when implants were placed using a 2-stage rather than a 1-stage placement staging protocol ($P < .05$). The area under the ROC curve for placement staging was 0.80, and the area under the ROC curve for loading was 0.89. An implant survival rate of over 98% was achieved.

Conclusion:

Resonance frequency analysis is a noninvasive technique used to measure the stability of implants and to help guide placement staging and loading protocols. This study showed that increasing ISQ values correlated with increased sensitivity in detecting implant failure. Given the high survival rates of dental implants, additional studies can further elucidate the relationship between ISQ values and survival rates.