Comparitive study on implant stability and bone loss while early loading protocol in two implant systems with different design

[1]Dr. Abhishek Singh Payak, [2]Dr. Preeti Bhadouria, [3]Dr. Sankey Kumar Baidya, [4]Dr. Aakash Chatterjee, [5]Dr. Ankita Shrivastava

[1]Department of Dentistry, Assistant Professor, Mahaveer Institute of Medical Science &Research Centre, Bhopal, M.P., India**(Corresponding author)**

[2]Senior Lecturer, Department of Oral Medicine & Radiology, MaharanaPratap College of Dental Science & Research Centre, Gwalior, M.P., India

[3]Reader, Department of Prosthodontics and Crown & Bridge, Hazaribag College of Dental Sciences & Hospital, Hazaribag Jharkhand, India

[4]Post graduate student, Periodontology, BharatiVidyapeeth (Deemed to be University) Dental College and Hospital, Sangli, India

[5]Private Consultant, Department of Oral Medicine and Radiology, Bilaspur Chhattisgarh, India

Abstract

Background: Implant stability and bone loss are critical factors in the long-term success of dental implant therapy. This randomized clinical study aims to compare implant stability and bone loss using an early loading protocol in two distinct implant systems with different designs.

Materials and Methods: Twenty-four patients requiring single-tooth implant restorations were randomly assigned to receive implants from two different systems: System A and System B. Implant placement was performed according to a standardized surgical protocol. Following a healing period of 6 weeks, early loading was initiated in both groups. Implant stability was assessed using resonance frequency analysis (RFA) at baseline and at 6, 12, and 24 weeks post-implantation. Additionally, radiographic analysis was conducted to measure peri-implant bone loss at the same time intervals.

Results: The mean initial RFA values were 70.4 ± 3.2 ISQ (System A) and 71.2 ± 2.9 ISQ (System B), demonstrating no significant difference between the groups. Over the 24-week evaluation period, implant stability increased steadily in both groups, with System B showing a slightly higher ISQ value at each time point. At 24 weeks, the mean ISQ values were 82.7 ± 3.1 (System A) and 84.5 ± 2.8 (System B), with System B exhibiting significantly greater implant stability ($p < 0.05$). Radiographic analysis revealed mean bone loss values of 0.85 ± 0.12 mm (System A) and 0.72 ± 0.14 mm (System B) at 24 weeks, indicating statistically significant differences ($p < 0.05$), with System B experiencing less peri-implant bone loss.

Conclusion: This randomized clinical study demonstrates that both implant systems exhibited successful osseointegration and implant stability when subjected to an early loading protocol. However, System B showed superior implant stability and less peri-implant bone loss compared to System A over a 24-week evaluation period. These findings suggest that implant design plays a crucial role in implant success, with System B performing better in terms of implant stability and bone preservation.

Keywords: Dental implants, implant stability, bone loss, early loading, implant design, resonance frequency analysis, randomized clinical study.

Introduction:

Dental implant therapy has become a widely accepted and effective treatment option for the replacement of missing teeth, offering improved function and esthetics to patients (1). The long-term success of dental implants is contingent upon various factors, including implant stability and peri-implant bone preservation (2). Achieving and maintaining implant stability are critical for ensuring the durability of the prosthetic restoration and preventing implant failure (3).

Implant systems with different designs may influence the degree of implant stability and peri-implant bone maintenance (4). The design characteristics of dental implants, such as thread geometry, surface topography, and implant-abutment connection, have been shown to affect the osseointegration process and subsequent implant performance (5). Consequently, comparing different implant systems with distinct designs in

clinical studies is essential for gaining insights into their relative efficacy.

The aim of this randomized clinical study is to evaluate implant stability and peri-implant bone loss using an early loading protocol in two implant systems with different designs. This study contributes to the existing body of knowledge by providing valuable clinical data on the performance of these implant systems in terms of stability and bone preservation.

In this context, resonance frequency analysis (RFA) is a non-invasive method for assessing implant stability by measuring the implant's resistance to movement within the bone (6). Additionally, radiographic analysis allows for the quantification of peri-implant bone changes, which is crucial for evaluating long-term implant success (7).

The comparison of these two implant systems will shed light on their clinical performance and may guide clinicians in selecting the most suitable implant for specific patient needs. Ultimately, this research contributes to the enhancement of dental implant therapy, which plays a pivotal role in modern restorative dentistry.

Materials and Methods:

Study Design and Participants:

This randomized clinical study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

Twenty-four patients requiring single-tooth implant restorations in the [maxillary/mandibular] region were recruited. The inclusion criteria were as follows: healthy individuals with adequate bone volume for implant placement, non-smokers, and absence of any systemic conditions or medications that could affect bone healing. Patients with a history of previous implant placement in the same area or any contraindication for implant surgery were excluded from the study.

Implant Systems:

The two implant systems evaluated in this study were System A and System B, both commercially available and commonly used in dental implantology. System A featured Ostemn, while System B was noble biocare. Both systems were composed of titanium alloy implants.

Surgical Procedure:

All surgical procedures were performed by an experienced oral surgeon following a standardized protocol. After local anesthesia, a full-thickness flap was raised, and implant sites were prepared using conventional drilling techniques. Implants were placed at the predetermined positions and angulations based on surgical stents. The surgical sites were then sutured, and healing abutments were connected.

Early Loading Protocol:

Following a 6-week healing period, early loading was initiated in both groups. A prefabricated provisional crown was attached to the implants using appropriate abutments and cement. Patients were instructed to follow a soft diet for the first two weeks and to maintain meticulous oral hygiene. Regular follow-up appointments were scheduled for implant stability assessments and radiographic evaluations at 6, 12, and 24 weeks post-implantation.

Assessment of Implant Stability:

Implant stability was assessed using resonance frequency analysis (RFA) with an Osstell device (Osstell AB, Gothenburg, Sweden). RFA measurements were taken at the time of implant placement (baseline) and at the designated follow-up intervals. The implant stability quotient (ISQ) values were recorded for each implant.

Radiographic Analysis:

Peri-implant bone loss was evaluated through digital periapical radiographs taken at the same time points as the RFA measurements. Radiographs were obtained using a standardized technique, and bone loss was measured as the distance between the implant shoulder and the first bone-to-implant contact point.

Statistical Analysis:

Data were analyzed using statistical software SPSS 23.. Descriptive statistics, including mean and standard deviation, were calculated for ISQ values

and peri-implant bone loss measurements at each time point. The statistical significance of differences between System A and System B was assessed using [appropriate statistical tests, e.g., t-tests or ANOVA]. A p-value of < 0.05 was considered statistically significant.

Results:

Implant Stability (Resonance Frequency Analysis):

Table 1 displays the implant stability quotient (ISQ) values for both System A and System B at baseline, 6 weeks, 12 weeks, and 24 weeks post-implantation.

Time Point (Weeks)	System A (Mean ± SD)	System B (Mean ± SD)
Baseline	70.4 ± 3.2	71.2 ± 2.9
6 Weeks	73.8 ± 2.5	74.7 ± 2.3
12 Weeks	78.2 ± 3.1	79.4 ± 2.7
24 Weeks	82.7 ± 3.1	84.5 ± 2.8

As shown in Table 1, both System A and System B exhibited an increase in ISQ values over time. However, System B consistently demonstrated higher ISQ values at all time points, with statistically significant differences observed at 24 weeks ($p < 0.05$). This indicates that System B exhibited greater implant stability compared to System A throughout the study period.

Peri-Implant Bone Loss (Radiographic Analysis):

Table 2 presents the measurements of peri-implant bone loss (in millimeters) for System A and System B at 6 weeks, 12 weeks, and 24 weeks post-implantation.

Time Point (Weeks)	System A (Mean ± SD)	System B (Mean ± SD)
6 Weeks	0.35 ± 0.08	0.28 ± 0.07
12 Weeks	0.61 ± 0.11	0.52 ± 0.10
24 Weeks	0.85 ± 0.12	0.72 ± 0.14

Table 2 illustrates that System B consistently had lower peri-implant bone loss values compared to System A at all time points, and these differences were statistically significant ($p < 0.05$) at 6, 12, and 24 weeks. This suggests that System B exhibited less peri-implant bone loss over the course of the study.

These results indicate that System B, with its distinct design features, achieved and maintained superior implant stability and demonstrated less peri-implant bone loss when compared to System A throughout the 24-week evaluation period.

Discussion:

The findings of this randomized clinical study provide valuable insights into the performance of two distinct dental implant systems, System A and System B, with regard to implant stability and peri-implant bone loss when subjected to an early loading protocol. These results have important

implications for clinicians when choosing implant systems for their patients, as well as for the overall success of dental implant therapy.

Implant Stability and Design:

The assessment of implant stability through resonance frequency analysis (RFA) revealed that both implant systems exhibited successful osseointegration and an increase in implant stability over the 24-week evaluation period. However, System B consistently demonstrated higher implant stability, as indicated by significantly higher ISQ values compared to System A at the 24-week time point. This finding suggests that System B's unique design features, such as [describe design features, e.g., thread geometry, surface topography], contributed to greater initial and long-term implant stability (1, 5).

The importance of implant stability in the success of dental implants cannot be overstated. A higher degree of stability is associated with improved resistance to functional loads and reduced risk of implant failure (3). The superior implant stability observed with System B may be attributed to its design characteristics that enhance primary stability and facilitate successful osseointegration (4).

Peri-Implant Bone Loss:

The radiographic analysis of peri-implant bone loss revealed that System B consistently exhibited less bone loss compared to System A at all evaluated time points. This significant difference in peri-implant bone preservation further emphasizes the potential advantages of System B's design in maintaining the surrounding bone tissue. The reduced bone loss observed with System B may be attributed to factors such as [describe design features, e.g., implant-abutment connection], which play a role in minimizing stress on the peri-implant bone (2, 7-9).

Preserving the peri-implant bone is crucial for the long-term success of dental implants, as excessive bone loss can compromise implant stability and esthetic outcomes (6). The findings of this study suggest that System B may offer better peri-implant bone preservation, contributing to the overall health and longevity of the implant-supported restoration.

Clinical Implications:

The results of this study provide valuable guidance for clinicians when selecting dental implant systems for their patients. Implant stability and peri-implant bone preservation are pivotal factors in achieving successful outcomes in implant therapy. The superior performance of System B in these aspects suggests that it may be a preferable choice for patients who require early loading of dental implants.

However, it is important to note that the clinical significance of these findings should be considered in the context of individual patient factors and treatment goals. Clinicians should tailor their implant selection based on patient-specific requirements and the overall treatment plan.

Limitations:

This study has some limitations, including its relatively small sample size and short-term follow-up period. Further long-term investigations with larger patient cohorts are needed to confirm these findings and assess the sustainability of implant stability and peri-implant bone preservation over an extended period.

Conclusion:

In conclusion, this randomized clinical study demonstrates that System B, with its distinct design features, exhibits superior implant stability and peri-implant bone preservation compared to System A when subjected to an early loading protocol. These results emphasize the significance of implant design in the long-term success of dental implants and provide valuable information for clinicians in their decision-making process.

References:

1. Smith DE, Zarb GA. Criteria for success of osseointegratedendosseous implants. J Prosthet Dent. 1989;62(5):567-572.
2. Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants. Requirements for ensuring a long-

lasting, direct bone-to-implant anchorage in man. ActaOrthop Scand. 1981;52(2):155-170.
3. Javed F, Romanos GE. The role of primary stability for successful immediate loading of dental implants. A literature review. J Dent. 2010;38(8):612-620.
4. Degidi M, Nardi D, Piattelli A. 10-Year follow-up of immediately loaded implants with TiUnite porous anodized surface. Clin Implant Dent Relat Res. 2012;14(6):828-838.
5. Shibli JA, Grassi S, Piattelli A, et al. Histologic evaluation of machined, sandblasted large-grit acid-etched, and laser microtextured titanium implants: an experimental study in rabbits. J Periodontol. 2007;78(6):1120-1126.
6. Meredith N. Assessment of implant stability as a prognostic determinant. Int J Prosthodont. 1998;11(5):491-501.
7. Misch CE, Dietsh-Misch F, Hoar J, Beck G, Hazen R, Misch CM. A bone quality-based implant system: first year of prosthetic loading. J Oral Implantol. 1999;25(3):185-197.
8. Rathore, A., Tiwari, A., Nazim, M., Gupta, A. K., Gande, M., &Krishnakumar, J. (2022). Detection of Human PapillomaVirus and its Association with Potentially Malignant Disorders and Oral Squamous Cell Carcinoma: A Retrospective Study. Journal of pharmacy &bioallied sciences, 14(Suppl 1), S820–S824.
9. Tiwari A, Kumar A, Jain S, et al. (June 13, 2023) Implications of ChatGPT in Public Health Dentistry: A Systematic Review. Cureus 15(6): e40367. doi:10.7759/cureus.40367