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In Vitro Assessment of Primary Stability of Dental Implants Placed Under Cyclic Loading with Different Parameters: An Original Research Study

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KEYWORDS
Primary Stability, Cyclic Loading, Implant, Abutment, Fixture

ABSTRACT:
Background and Aim: Implant primary stability is one of the greatest criteria of its success. Primary stability is frequently affected even by little alteration in microbial flora or mechanical parameters. Implant primary stability also depends on loading patterns and type of abutment used. Therefore this study was designed and conducted to assess the primary stability of dental implants placed under cyclic loading with different parameters.
Materials & Methods: Total 24 implant fixtures were used with two different types of implant abutment (angulated abutment of 200 Group 1 & 250 Group 2 respectively). For force application, a metallic jig was prepared for holding the implant abutment fixture in a predetermined position. Firstly, pre loading primary stability was noted (removal torque). Dynamic force was then applied and post loading primary stability or removal torque was noted. Any inaccurate data step was reattempted. Authors also ensured to lessen the data error by making consistency in procedures. Intra-observer variations were also taken care of for preciseness of data quality. P value less than 0.05 was considered as significant.
Statistical Analysis and Results: Statistical analysis was done by statistical software Statistical Package for the Social Sciences. For pre dynamic loading, group 1 samples have mean removal torque of 17.23 and standard deviation of 0.859. The level of significance (p value) was non significant (0.232). Similarly, group 2 samples have mean removal torque of 18.10 and standard deviation of 2.839. The level of significance (p value) was non significant (0.121). For post dynamic loading, group 1 samples have mean removal torque of 16.93 and standard deviation of 0.349. ANOVA Analysis showed that overall measured

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level of significance (p value) was highly significant (0.002).
Conclusion: Within the limitations of the study, authors stated that cyclic loading has clear and demonstrable effect on the primary stability of implants. Also, there was insignificance difference in between two tested abutment angulations. Authors also anticipate other future long term studies with wider parameters.

Introduction

Dental implant prosthesis is highly recommended for rehabilitation missing teeth particularly in anterior region. Implant prosthesis offer predictable acceptance and response from patients point of view. Primary stability is most important clinical criteria for implant success.[1-2] Primary stability of implants depends on various factors including microbial physio-mechanical factors. In the clinical practice, clinicians usually confront failure of implant prosthesis due to poor initial primary stability.[3-4] Researchers have been conducted and showed that primary implant stability is primarily based on microbial activity. These deleterious micro-pathological events induce alveolar ridge resorption and peri-implantitis or peri-implantmucositis. Many of the pioneer workers in the literature have confirmed that osseointegration completes in 6 month and 3 months in maxillary and mandibular arches respectively.[5-8] Soon after successful osseointegration of implant, prosthetic loading is initiated. Implant prosthesis show variable alveolar bone loss after prosthetic loading. Intraoral masticatory forces are not constant instead variable. Intraoral forces are ranging from slight to heavy torque and that too in different directions and angulations. Many researchers have been conducted to check and evaluate the effect of dynamic forces on primary stability however we have noticed very few studies on angulated abutments in these regards. Therefore this study was planned, outlined and performed to assess the primary stability of dental implants placed under cyclic loading with different parameters.

Materials & Methods

This study was executed on in-vitro model in which total 24 implant fixtures were used. Two different types of implant abutment were employed in the study. Both abutment groups were having angulated abutment of 20^0 & 25^0 respectively. Group 1 abutment had 12 (20^0 angled) abutments and group 2 abutment had 12 (25^0 angled) abutments. All 24 abutments were fixed to their individual respective implants of identical dimensions and specificity. Simple random sampling procedure was followed for selection of all abutments and implants. To simulate the intraoral condition of force application, a metallic jig was prepared. The sole aim of this jig was to hold the implant abutment fixture in a desired way of testing. All implant abutment fixtures were positioned on this jig and tested further. Since intraoral masticatory forces are mostly dynamic and highly varying, authors planned to put different sets of forces on each implant abutment sample set. Initially, pre loading primary stability was noted accordingly (removal torque). A controlled measured and calculated dynamic force was applied on all fixtures one by one individually. Authors utilized controlled torque of range 30Ncm-200Ncm for 100 cycles at the rate of 12 Hz. Post loading primary stability (removal torque) was noted accordingly for all samples. Care was taken to record the readings accurately. Any error in data or procedure was immediately discarded and the procedure was reattempted on fresh samples. Inclusion criteria included angled abutment fixed over osseointegrated threaded implants, screw retained fixtures, identical positioning on jig. Authors also ensured to minimize the data error by making uniformity in procedures. Intra-observer variations were also taken care of for maintaining data quality. P value less than 0.05 was considered as significant.

Statistical Analysis and Results

All the relevant data and findings were compiled and sent for statistical evaluation using statistical software Statistical Package for the Social Sciences version 22.0 (IBM Inc., Armonk, New York, USA). The processed data was sent for suitable statistical tests to estimate p values, mean, standard deviation, standard error an 95% CI. Table 1 and graph 1 expressed about the distribution of types and number of various abutments used in the study. Total 24 abutments were used and studied under two groups as per their angles (20^0 & 25^0). Table 2 demonstrated about the pre dynamic loading statistical analysis and description for group 1 and group 2 implants with angled abutment fixtures: Fundamental statistical description with level of significance evaluation using "Pearson Chi-Square" test. Here, group 1 samples have mean removal torque of 17.23 and standard deviation of 0.859. The level of significance (p value) was non significant (0.232). Similarly, group 2 samples have mean removal torque of 18.10 and standard deviation of 2.839. The level of significance (p value) was non significant (0.121). Table 3 demonstrated about the post dynamic loading statistical analysis and description for group 1 and group 2 implants with angled abutment fixtures:

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Fundamental statistical description with level of significance evaluation using "Pearson Chi-Square" test. Here, group 1 samples have mean removal torque of 16.93 and standard deviation of 0.349. The level of significance (p value) was non significant (0.342). Similarly, group 2 samples have mean removal torque of 17.48 and standard deviation of 2.129. The level of significance (p value) was non significant (0.161). Table 4 showed about the basic statistical interpretations of; between groups, within groups and cumulative [ANOVA Analysis]. Data and related analysis was performed for between group, within group and cumulative. The overall measured level of significance (p value) was highly significant (0.002).

Table 1: Distribution of types and number of various abutments used in the study

Abutment	**n**	**Angle**
Group 1	12	20^0
Group 2	12	25^0
Total	24	-

Table 2: Pre dynamic loading statistical analysis and description for group 1 and group 2 implants with angled abutment fixtures: Fundamental statistical description with level of significance evaluation using "Pearson Chi-Square" test

Abutment	**Mean of Removal Torque**	**Std. Deviation**	**95% Coefficient interval**	**Std. Error**	**Pearson Chi-Square Value**	**df**	**Level of Significance (P value)**
Group 1	17.23	0.859	0.309	2.052	0.859	1.0	0.232
Group 2	18.10	2.839	1.480	2.065	2.839	2.0	0.121
							***p<0.05 significant**

Table 3: Post dynamic loading statistical analysis and description for group 1 and group 2 implants with angled abutment fixtures: Fundamental statistical description with level of significance evaluation using "Pearson Chi-Square" test

Abutment	**Mean of Removal Torque**	**Std. Deviation**	**95% Coefficient interval**	**Std. Error**	**Pearson Chi-Square Value**	**df**	**Level of Significance (P value)**
Group 1	16.93	0.349	0.484	2.858	0.129	1.0	0.342
Group 2	17.48	2.129	1.323	2.023	2.239	2.0	0.161
							***p<0.05 significant**

Table 4: Basic statistical interpretations of; between groups, within groups and cumulative [ANOVA Analysis]

ANOVA					
Parameters	**Degree of Freedom**	**Sum of Squares ∑**	**Mean Sum of Squares m∑**	**F**	**Level of Significance**
Between groups	2	1.056	1.507	1.2	0.002*****
Within groups	11	1.203	0.342	-	
Cumulative	194.10	2.303			***p<0.05 significant**

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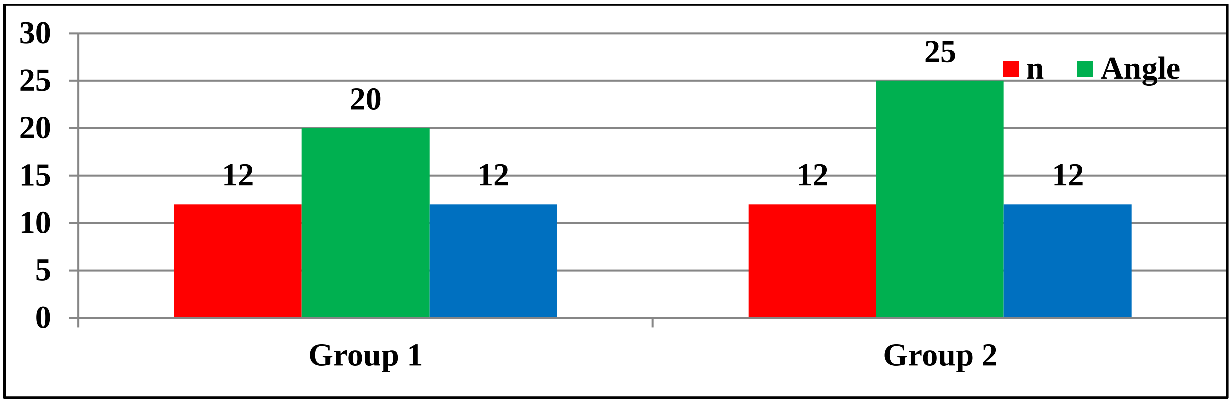
Graph 1: Distribution of types and number of various abutments used in the study



Discussion

Dental implant is most common type of dental treatment for replacing missing natural teeth. In the past, implants have been extensively experimented for its longevity and technicalities. Recently clinicians have started using other implants also like zygomatic implants, basal implants, mini implants and other extraoral implants.[9-12] Nevertheless, with the increased practice and demands, implants poses associated clinical problems also. The most common clinical issue confronted by implant therapy is failure of implant because of peri-implantmucositis and nearby bone losses.[13-16] This mobility of implant ultimately leads to the critical failure of prosthesis. All such clinical difficulties and events have been extensively studied and tried by various researchers across the globe. Many concepts and methods have been discussed and recommended by different researchers for minimizing the harmful effects on primary implant stability.[17-20] Brann and other workers studied about the various factors influencing nerve damage during lower third molar surgery including the implant placement. They stressed that implant stability is directly related to the angle of abutment and extent of direct bony union between implant and bone surfaces.[20] Jörnéus and other researchers experimented about the loads and designs of screw joints for single crowns supported by osseo-integrated implants. Their results were highly comparable with our outcomes.[21] Burguete studied in detail about tightening characteristics for screwed joints in osseointegrated dental implants. They conclude that implant primary stability solely depends on the applied loads like forces of mastication.[22] Their inferences were highly predictable and imperative. Similar assumptions have also been noticed in other pioneer studies.[23-25]

Conclusion

Within the limitations of the study, authors highlighted extremely significant and clinically relevant postulations. They stated that cyclic loading has clear and demonstrable effect on the primary stability of implants. Results of the study also confirm that primary stability declines after cyclic loadings. However these noted declines in stability was not sharp. Additionally, there was insignificance difference in between two tested abutment angulations. All findings and recommendations of this study must be reviewed carefully before utilizing in similar conditions. Authors also expect other future long term studies with larger samples and testing parameters.

References

1. Schwarz MS. Mechanical complications of dental implants. Clin Oral Implants Res 2000;11:156-8.
2. Binon PP. Evaluation of machining accuracy and consistency of selected implants, standard abutments, and laboratory analogs. Int J Prosthodont 1995;8:162-78.
3. Merz BR, Hunenbart S, Belser UC. Mechanics of the implant-abutment connection: an 8-degree taper compared to a butt joint connection. Int J Oral Maxillofac Implants 2000;15:519-26.
4. Norton MR. An in vitro evaluation of the strength of an internal conical interface compared to a butt joint interface in implant design. Clin Oral Implants Res 1997;8:290-8.

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5. Kumar P. Osteopromotion to enhance bone volume in implant rehabilitative therapies: An insight. Eur J Prosthodont 2013;1(3);71.
6. Kumar P. Imperative role of surgical templates in accurate implant positioning: A key to success. Eur J Prosthodont 2013;1(3);69-70.
7. Kumar P. Current interpretations and scientific rationale of the implant- supported dental prostheses: A clinical perspective. Eur J Prosthodont 2013;1(3);72.
8. Kumar P, Kumar P, Yadav S, Tyagi S. Immediate over delayed implant placement philosophy as a novel approach in oral implantology. Int J Health Allied Sci 2013;2(2):138.
9. Sahoo S, Kumar P, Sethi K, Goel M. Trends and attitude of edentate patients towards conventional and implant rehabilitative therapies: An Indian outlook. Int J Medicine Public Health 2013;3(2):126-7.
10. Kumar P. Infectious risks for dental implants: An insight. Eur J Prosthodont 2013;1(1):27.
11. Sahoo S, Suvarna SR, Sethi K, Kumar P. Awareness and need of dental implant therapy as pertinent to Indian situation: An overview. Int J Med Public Health 2013;3(2):124-5.
12. Kumar P, Goel R, Jain C, Kumar A, Parashar A, Gond AR. An overview of biomedical literature search on the World Wide Web in the third millennium. Oral Health Dent Manag 2012;11(2):83-9.
13. Weiss EI, Kozak D, Gross MD. Effect of repeated closures on opening torque values in seven abutment-implant systems. J Prosthet Dent 2000;84:194-9.
14. Norton MR. Assessment of cold welding properties of the internal conical interface of two commercially available implant systems. J Prosthet Dent 1999;81:159-66.
15. Balfour A, O’Brien GR. Comparative study of antirotational single tooth abutments. J Prosthet Dent 1995;73:36-43.
16. Theoharidou A, Petridis HP, Tzannas K, Garefis P. Abutment screw loosening in single-implant restorations: a systematic review. Int J Oral Maxillofac Implants 2008;23: 681-90.
17. Kumar P, Khattar A, Goel R, Kumar A. Role of Botox in Efficient Muscle Relaxation and Treatment Outcome: An Overview. Ann Med Health Sci Res 2013;3(1):131.
18. Kumar P. Dental implant complications as an increasing annoyance in prosthodontics: An overview. Euro J Prosthodont 2013;1(1):27.
19. Kumar P. Recommendations and Guidelines to Diminish Clinical Implant Failure: A Clinical Note. J Adv Med Dent Sci Res 2014;2(2):1-2.
20. Brann CR, Brickley MR, Shepherd JP. Factors influencing nerve damage during lower third molar surgery. Br Dent J 1999;186:514–16.
21. Jörnéus L, Jemt T, Carlsson L. Loads and designs of screw joints for single crowns supported by osseo-integrated implants. Int J Oral Maxillofac Implants 1992;7:353-9.
22. Burguete RL, Johns RB, King T, Patterson EA. Tightening characteristics for screwed joints in osseo-integrated dental implants. J Prosthet Dent 1994;71:592-9.
23. Haack JE, Sakaguchi RL, Sun T, Coffey JP. Elongation and preload stress in dental implant abutment screws. Int J Oral Maxillofac Implants 1995;10:529-36.
24. Kim ES, Shin SY. Influence of the implant abutment types and the dynamic loading on initial screw loosening. The journal of advanced prosthodontics. 2013 Feb 1;5(1):21-8.
25. Martin WC, Woody RD, Miller BH, Miller AW. Implant abutment screw rotations and preloads for four different screw materials and surfaces. J Prosthet Dent 2001;86:24- 32.