ORIGINAL RESEARCH

Comprehensive Assessment of Effect of Different Types of Implant Abutment with Varying Loading Stresses On Early Screw Loosening: An (In-Vitro) Original Research Study

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ABSTRACT
Background and Aim: Screw loosening is one of the most common clinical dilemmas seen in the post operative phases of implant therapy. Screw loosening can lead to ultimate failure of the prosthesis thus entire treatment. Several factors are discussed by different researchers which are responsible for screw loosening. Therefore, this in vitro study was conducted to comprehensively assess the effect of different types of implant abutment with varying loading stresses on early screw loosening.
Materials & Methods: This study was conducted in the department of Prosthodontics wherein total sixty implant abutment samples were included. Group 1 consisted of twenty standard types abutment. Group 2 consisted castable abutment. Group 3 consisted of CAD-CAM assisted implant abutment. A customized rectangular metal jig was fabricated in which implant fixture fits comfortably. Abutments were tightened over the implants with maximum of 30 Ncm. Dynamic stresses were applied independently on each sample assembly and unscrewing torques was noted carefully. P value less than 0.05 was considered significant (p< 0.05).
Statistical Analysis and Results: Statistical analysis was completed by using statistical software Mean torque value (Unscrewing Torques before Cyclic Loading) for group 1, 2 and 3 was 19.37, 17.82 and 17.43 respectively. Mean torque value (Unscrewing Torques after Cyclic Loading) for group 1, 2 and 3 was 18.17, 16.92 and 16.55 respectively. The measured standard deviation was 0.381, 0.637 and 0.032 for group 1, 2 and 3 respectively. P value was highly significant for group 1. The comparison among the 3 study groups using one-way ANOVA showed highly significant level of significance. Two sample t- test assessments of mean score and standard deviation in three groups showed highly imperative values.
Conclusion: Within the limitations of the study authors confirmed that there was not any significant different in the initial screw loosening stresses with various abutment systems. All the three experienced implant abutment systems showed insignificant change in screw loosening stresses after undergoing cyclic loading.

Key words: Screw Loosening, Implant, Abutment, Loading, Stress, Prosthodontics

INTRODUCTION

Dental implants to restore missing teeth have become a conventional treatment modality for partially and completely edentulous patients. An implant abutment connection has a immense impact on screw loosening. Screw loosening happens on the joint of the external hex in the external connection type by vibration and micro-movement during practical loading. Screw loosening is the major cause of failure of implant therapy. This can be initiated or accelerated by several factors. Forces and specially angulated forces are one of the prime reasons of this unwanted event.[1,2,3] Masticatory forces are mostly combination of differently angulated forces which act directly and indirectly on the implant abutment assembly. For simulation of these stresses, many researchers have artificially experimented similar conditions to assess outcomes.[4,5,6] Different ranges of force at different angulations have been tried in the past for investigation. With the advancements in the prosthodontic techniques, newer abutments are now available worldwide. Manufacturer claim that they are barely affected by the dynamic and cyclic loading forces.[7,8] They also believe that these abutments pose minimal lessening incidences. Cast able abutments have their own limitations and disadvantages. Therefore cast able abutments are more likely to be loose after loading in the mouth.[9,10] Hence, this in vitro study was conducted to comprehensively assess the effect of different types of implant abutment with varying loading stresses on early screw loosening.

MATERIALS & METHODS

This study was planned and performed in the department of Prosthodontics of the institute in which various implant abutments have been assessed for different study objectives. The basic ideology was prospective in-vitro design. Total sixty implant abutment samples were included in the study those belonging to different categories. The study was conducted after segregating the sampled in to three different study groups. Group 1 consisted of twenty implant abutment samples of standard types which were supplied by manufacturer along with the implants. Group 2 consisted of implant abutment samples those fabricated in the laboratory of the institute by casting. They were termed as castable or custom made implant abutment. Group 3 consisted of implant abutments those fabricated by computer aided designing and associated software. They were termed as CAD-CAM assisted implant abutment. For evaluation of the forces and loosening, a customized rectangular metal jig was fabricated by brass metal. The dimension was 2X4 inches with 1 inch height. Metallic slot was prepared in the jig in which implant fixture fits snugly. Jig also allows application of 45^0 angulated stress on the abutments. All test implants were placed in the jig individually and abutments were evaluated for various stresses. Abutments were tightened over the implants with maximum of 30 Ncm. This was standardized in all sixty studied samples. Varying stresses were applied individually on each sample assembly for 95 cycles between 30 to 190 N at 20 hertz frequency. All sample assemblies were then unscrewed (loosened) before and after cyclic loading and unscrewing torques were noted carefully. This procedure was attempted for all three studied groups. Details hence received was entered in table and sent for basic statistical analysis. P value less than 0.05 was considered significant ($p< 0.05$).

STATISTICAL ANALYSIS AND RESULTS

Statistical analysis was conducted by using statistical software Statistical Package for the Social Sciences version 21 (IBM Inc., Armonk, New York, United States of America). The principal endeavor was to estimate and obtain p values, mean, standard deviation, chi- square test, standard error and 95% CI. Table 1 show about abutment & group wise allocation of Samples. All three groups have 20 Implant Abutments each (Standard Implant Abutment,

Table 1: Abutment & Group wise allocation of Samples

Sr. No	Group 1	Group 2	Group 3
1	Standard Implant Abutment	Castable or Custom Made Implant Abutment	CAD-CAM Assisted Implant Abutment
2	n=20	n=20	n=20
3	Implant=Standard	Implant=Standard	Implant=Standard
4	Evaluation Methodology: Jig Assisted	Evaluation Methodology: Jig Assisted	Evaluation Methodology: Jig Assisted

Castable or Custom Made Implant Abutment, CAD-CAM Assisted Implant Abutment). Table 2 show about essential statistical explanation with level of significance evaluation using pears on chi-square test [before cyclic loading].

Table 2: Essential statistical explanation with level of significance evaluation using pears on chi-square test [Before Cyclic Loading]

Sides of Implant	Mean Torque Value	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Unscrewing Torques Before Cyclic Loading							
Group 1	19.37	0.837	0.831	1.33	2.124	1.0	0.01*
Group 2	17.82	0.848	0.202	1.12	2.746	2.0	0.70
Group 3	17.43	0.264	0.324	1.02	1.212	1.0	0.20
***p<0.05 significant**							

Mean torque value (Unscrewing Torques before Cyclic Loading) for group 1, 2 and 3 was 19.37, 17.82 and 17.43 respectively. The measured standard deviation was 0.837, 0.848 and 0.264 for group 1, 2 and 3 respectively. P value was highly significant for group 1. It was 0.01. Table 3 show about essential statistical explanation with level of significance evaluation using pears on chi-square test [After cyclic loading].

Table 3: Essential statistical explanation with level of significance evaluation using pears on chi-square test [After Cyclic Loading]

Sides of Implant	Mean Torque Value	Std. Deviation	Std. Error	95% CI	Pearson Chi-Square Value	df	Level of Significance (p value)
Unscrewing Torques After Cyclic Loading							
Group 1	18.17	0.381	0.035	1.45	2.537	1.0	0.01*
Group 2	16.92	0.637	0.251	1.94	2.947	2.0	0.20
Group 3	16.55	0.032	0.644	1.54	1.234	1.0	0.80
***p<0.05 significant**							

Mean torque value (Unscrewing Torques after Cyclic Loading) for group 1, 2 and 3 was 18.17, 16.92 and 16.55 respectively. The measured standard deviation was 0.381, 0.637 and 0.032 for group 1, 2 and 3 respectively. P value was highly significant for group 1. It was 0.01. The measured standard error for group 1, 2 and 3 was 0.035, 0.251 and 0.644 respectively. Table 4 illustrates the comparison among the 3 study groups using one-way ANOVA [for group 1,2,3].

Table 4: Comparison among the 3 study groups using one-way ANOVA [for group 1,2,3]

Variables	Degree of Freedom	Sum of Squares ∑	Mean Sum of Squares m∑	F	Level of Significance (p)
Between	2	2.049	1.029	4.2	0.001*

Groups					
Within Groups	21	8.939	0.239	-	
Cumulative	122.43	13.521	***p<0.05 significant**		

The comparison was attempted for calculation made between groups, calculations made within groups and calculations made cumulative. The level of significance was 0.001 (highly significant). Table 5 illustrates two sample t- test assessments of mean score and standard deviation in three study groups. Measured p value for before cyclic loading was 0.005 highly significant (for all three studied groups). Measured p value for after cyclic loading was 0.841 non-significant (for all three studied groups).

Table 5: Two sample t- test assessment of mean score and standard deviation in three study groups

Two sample t- test	**Before Cyclic Loading**		**After Cyclic Loading**	
	Mean Score	**SD**	**Mean Score**	**SD**
Group 1	19.37	0.837	18.17	0.381
Group 2	17.82	0.848	16.92	0.637
Group 3	17.43	0.264	16.55	0.032
P-value	0.005 (Significant)		0.841(Non-Significant)	
***p<0.05 significant**				

DISCUSSION

Albrekts son and coworkers had searched the efficiency features for successful implant therapy. They studied these factors in terms of associated longevity. Literature has well shown that different types of implant abutment show varying loading stresses on early screw loosening.[11,12,13] Many of the studies had simulated the intraoral chewing conditions by creating angulated and cyclic load on implant abutment assembly. Different loading patterns and various stress frequencies have also shown miscellaneous outcomes and results.[14] Priest studied about virtually planned and computer-milled implant abutments. He also stressed on the superior outcomes and performances of computer-milled implant abutments.[15] Ortorp and associates have compared precision of fit between cast and CNC-milled titanium implant frameworks for the edentulous mandible. Their results were highly comparable with our outcomes.[16] Al-Fadda and colleagues have also explored about the accuracy of fit of 2 methods for fabricating implant-prosthodontic frameworks. Their results were very striking since they have found imperative inferences.[17] Oh and other researchers have studied about effect of types of abutment and dynamic loading on microgap between implant fixture and abutment. Like our results, they had also found insignificant differences between tested groups. The apparent similarly can be explained on th basis of similarity in methodology and specifications.[18] Kapos and others had studied Computer-aided design and computer-assisted manufacturing in prosthetic implant dentistry. They have recommended about the usage of Computer-aided design and computer-assisted manufacturing in implant dentistry.[19] Kim and colleagues have explored the Influence of the implant abutment types and the dynamic loading on initial screw loosening. Their research was one of the pioneer studies in its field. Their results were highly comparable with our outcomes and inferences.[20] Sammour and others have checked the effect of implant abutment connection designs, and implant diameters on screw loosening before and after cyclic loading.[21] They also found the changes in the loosening forces after cyclic loading of stresses. Paek and other coworkers analyzed screw loosening with prefabricated abutments and customized CAD/CAM abutments.[22] Other workers have also presented highly useful and critical recommendations about loosening stresses before and after cyclic loading of forces.[23,24]

CONCLUSION

Within the limitations of the study authors confirmed that there was not any significant different on initial screw loosening stresses with various abutment systems. All the three tested implant abutment systems showed nominal change in screw loosening stresses after undergoing cyclic loading. Maximum screw loosening stress was noticed in Standard Implant Abutments while minimum screw loosening stress was noticed in CAD-CAM Assisted Implant Abutments. Our study results must be taken as indicative for estimating prognosis for similar clinical circumstances. However, authors expect few other large scale studies to be conducted to establish concrete and reliable norms.

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