



Comprehensive Clinical Estimation and Comparison of Primary Stabilities in Photoactivated and Conventionally Surface Treated Implants: An Original Research Study

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ABSTRACT:

Background and Aim: Optimal osseointegration and clinical nonexistence of peri-implant diseases are the two most critical success criteria for dental implants. Nevertheless in many of the clinical circumstances, operators fail to achieve optimal osseointegration with complete lack of peri-implant diseases. Therefore this study was proposed, abstracted and conducted to estimate and compare the primary stabilities in photoactivated and conventionally surface treated dental implants.

Materials and Methods: Total 22 (both male and female) patients were included in the study in the age range of 30 years to 45 years. Presence of adequate osseointegration was tested by using new innovative system Penguin RFA. Group 1 included 11 implants those with conventional surface treatment. Group 2 included 11 implants those photoactivated by ultraviolet therapy as surface treatment. Both of the intended groups of implants were checked after 6 month of osteotomy procedure. Osseointegration/primary stability was noted as satisfactory or non-satisfactory. Informed consent was obtained from all participating patients. Statistical analysis was conducted to outline the inferences and results. P value less than 0.05 was taken as significant.

Statistical Analysis and Results: All the recorded data was subjected to basic statistical analysis with SPSS statistical package for the Social Sciences. P-value was highly significant for age group 30-33 years wherein it was 0.01. In group 1, total 8 implants/patients showed satisfactory response whereas 2 patients showed non satisfactory responses related to their primary stabilities. 1 patient was chosen questionable category. P value was highly significant for non satisfactory group. It was 0.01. In group 2, total 7 implants/patients showed satisfactory response whereas 3 patients showed non satisfactory responses related to their primary stabilities. P value was highly significant for non satisfactory group. It was 0.01. Moreover, level of significance (p value) was highly significant (0.004) for ANOVA test conducted between groups.

Conclusion: Within the limitations of the study, the authors concluded that primary stability was slightly superior in the implants treated by conventional method over photoactivated method. The results were significant in both estimations. Furthermore, other future long term studies are anticipated to substantiate and confirm our results.



Introduction

Now days, dental implant treatment is a common clinical procedure for rehabilitation of missing teeth. Clinicians have experimented various methods to increase the extent of osseointegration since osseointegration is crucial for successful implant treatment.^{1,2,3} As we all are aware that the osseointegration is the key aspect for long term success of endosseous dental implants. Literature has well evidenced that implant success also depends upon several other factors including Implant surface properties like roughness, topography, energy and metallic composition. All these factors directly and indirectly impart in optimal osseointegration.^{4,5} Over the years, researchers had tried various methods to maximize implant surface by increasing its roughness. Increasing the surface roughness leads to the increase of surface area thereby enhancing the progression of osseointegration.^{6,7,8} These surface alterations methods are primarily categorized as additive and subtractive methods. One of the recent advancement in this field is photofunctionalization (PhF), which is defined as the modification of titanium surfaces after ultraviolet treatment.^{9,10,11} Photofunctionalization is also known as photoactivation procedure. In photofunctionalization/photoactivation, researcher aims to modify the physicochemical behaviors and thereby surface wettability of implant.^{12,13} Albrektsson *et al.* firstly noticed and stated that implant design and surface texture two elementary factors involved directly in the development of osseointegration.¹⁴ Implant surface alteration mostly aims to change surface texture as well as surface energy to enhance the cellular propagation and expansion in the local milieu. Therefore this study was proposed, abstracted and conducted to estimate and compare the primary stabilities in photoactivated and conventionally surface treated dental implants.

Materials and Methods

This study was conducted in the department of Prosthodontics of the institute with the intention of comparing primary stabilities in two different scenarios. Total 22 implants those requiring rehabilitation of their single lower posterior teeth, were selected. Implant based rehabilitation of missing Mandibular first molar (of either side) was included professionally in the study. The study process step by step was explained in details to all participating patients. Simple random sampling procedure was applied for bias free sample selection. Prefixed exclusion criteria were; 1) Patients with underlying/ongoing systemic disease 2) Absence of any ongoing profound medication 3) presence of any post operative follow up problem 4) very young/old patients out of the young age range of 30-45 years 5) all uncooperative patients. Standard osteotomy procedure

was used by similar team and identical armamentarium and operator. Both male and female patients were included in the study in the age range of 30 years to 45 years. Presence of adequate osseointegration was tested for individual implant site. This was attempted by using new innovative system Penguin RFA® (Aseptico Inc., Woodinville, WA, USA). Authors noticed that this method of assessing osseointegration is novel and opted by several clinicians and researchers worldwide. Penguin RFA is a hand held electronic device which is cordless, light weight and compatible with most of the popular implant systems/brands. Penguin RFA exhibits precise results by reusable calibrated MulTiPegs. Group 1 included 11 implants those with conventional surface treatment. They were basically machined implant which is milled, or polished. Mostly, the surface area roughness is kept in the range of 0.3–1.0 [(Sa) value] by most of the commercial manufacturers. Group 2 included 11 implants those photoactivated by ultraviolet therapy as surface treatment. Many of the researchers have termed it as Photo-functionalization. Photo-functionalization/activation acts by promoting interactions of cells and proteins on a molecular level. All these are somewhat similar to the process of osteoconductivity. Both of the studied groups of implants were checked after 6 month of osteotomy procedure. Osseointegration/primary stability was noted as satisfactory or non-satisfactory. Informed consent was obtained from all participating patients. Statistical analysis was conducted to outline the inferences and results. P value less than 0.05 was taken as significant.

Statistical Analysis and Results

All the recorded data were scrutinized at starting levels for presence of any evident incorporated confounders. Post hoc analysis was avoided so as to ensure data quality with minimal errors. Thereafter data was subjected to basic statistical analysis with SPSS statistical package for the Social Sciences version 22 for Windows. Nonparametric test, namely, chi-square test, was used for further data analysis; p-value. Out of 22 studied patients, 14 were males and 8 were females [Table 1, Graph 1]. P-value was highly significant for age group 30-33 years wherein it was 0.01. Age group other than first showed non significant p values for their statistics. Table 2 depicts about the basic statistical description with level of significance evaluation using “Pearson Chi-Square” test. This was for exclusively Group 1 (n=11) where conventional surface treatment was used and thereafter Primary stability assessed by Penguin RFA. Responses were noted under the categories as satisfactory or non-satisfactory during 6 month post-osteotomy phases. Total 8 implants/patients showed satisfactory response whereas 2 patients showed non satisfactory responses related to their



primary stabilities. 1 patient was chosen questionable category. P value was highly significant for non satisfactory group. It was 0.01. Table 3 depicts about the basic statistical description with level of significance evaluation using “Pearson Chi-Square” test. This was for exclusively Group 2 (n=11) where photoactivated surface treatment was used and thereafter Primary stability assessed by Penguin RFA. Responses were noted under the categories as satisfactory or non-satisfactory during 6 month post-osteotomy phases. Total 7 implants/patients showed

satisfactory response whereas 3 patients showed non satisfactory responses related to their primary stabilities. 1 patient was chosen questionable category. P value was highly significant for non satisfactory group. It was 0.01. Table 4 illustrated about the basic evaluation conducted amongst all studied groups using one-way ANOVA test. The inferences revealed that level of significance (p value) was highly significant for ANOVA test conducted between groups. It was appreciably 0.004.

Table 1: Age & Gender based statistical explanation of contributing patients

Age Group (Yrs)	Male	Female	Total	P value
30-33	5	3	8	0.01*
34-37	6	2	8	0.50
38-41	2	1	3	0.20
42-45	1	2	3	0.80
Total	14	8	22	*p<0.05 Significant

Graph 1: Patients demographic allocation and related details

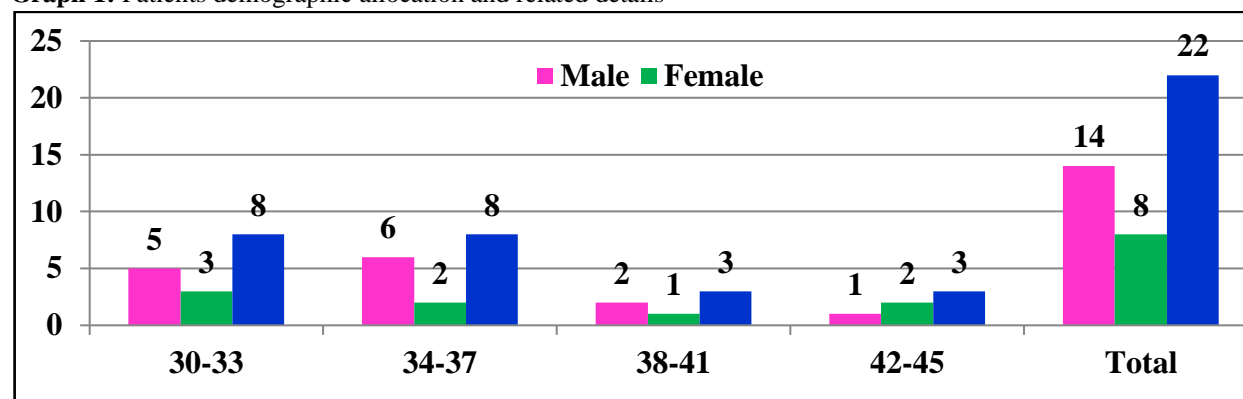


Table 2: Basic statistical description with level of significance evaluation using “Pearson Chi-Square” test (Group 1, n=11 conventional surface treatment: Primary stability assessed by Penguin RFA and interpreted as satisfactory or non-satisfactory during 6 month post-osteotomy phases)

Status	n	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square	df	p value
Satisfactory	08	1.94	0.940	0.376	1.96	1.549	1.0	0.08
Non-satisfactory	02	1.21	0.364	0.358	1.12	1.947	2.0	0.01*
Questionable	01	1.01	0.695	0.942	1.43	1.153	1.0	0.40
*p<0.05 significant								

Table 3: Basic statistical description with level of significance evaluation using “Pearson Chi-Square” test (Group 2, n=11 photoactivated surface treatment: Primary stability assessed by Penguin RFA and interpreted as satisfactory or non-satisfactory during 6 month post-osteotomy phases)

Status	N	Stat. Mean	Std. Dev.	Std. Error	95% CI	Pearson Chi-Square	df	p value
Satisfactory	07	1.75	0.041	0.645	1.96	1.659	1.0	0.06



Non-satisfactory	03	1.35	0.059	0.738	1.54	1.237	2.0	0.01*
Questionable	01	1.01	0.747	0.042	1.52	1.323	1.0	0.50
*p<0.05 significant								

Table 4: Evaluation amongst all studied Groups using one-way ANOVA

Variables	Degree of Freedom	Sum of Squares Σ	Mean Sum of Squares $m\Sigma$	F	Level of Sig. (p)
Between Groups	3	2.257	1.938	1.1	0.004*
Within Groups	17	2.645	0.325	-	-
Cumulative	123.12	11.939	*p<0.05 significant		

Discussion

Osseointegration and its extent is solely depends upon the host response and other biological/ microbial activities in the implant surroundings. The external surface of dental implant is the region which is direct contact with the tissues. Tingn and Jeong also researched similar aspects and stated critical outcomes.^{15,16} All expected beneficial or deleterious activates are happening over these surfaces only. Therefore, the nature and texture of the surface of the implant is highly significant. Researchers including Alhomsi, Kumar, Giner have shown that textured implants surfaces possess large surface area as compared to smooth surfaced implants.^{17,18,19} It was also illustrated that large surface area is required for implant fixation with bone through osseointegration procedure. Lee, Sean confirmed that the focal implant fixation and long-term mechanical strength may be increased by a suitably introduced by macro-roughness.^{20,21} Many experiments showed that micro-roughness is usually fall in the range of 1-10 μm . There are several methods for increasing the dental implant surface roughness so as to increase the Osseointegration as stated by Kaluderovi, Irastoza.^{22,23} Mechanical methods are involving physical alteration and it usually result in rough or smooth surfaces. These interventions are attempted to improve the union, propagation and segregation of cells. Popular methods are grinding, blasting, machining and polishing. Chemical way of surface atraaction of dental implants is also very popular. This was further authenticated by Pelegrine and Buxadera-Palomero et al.^{24,25} Titanium and its alloys of implants are chemically modified by chemicals and their reactions at the titanium surfaces. Ultimately they lead to the production of surface roughness with optimal wettability. Common materials used for this purpose are acids or alkali, hydrogen peroxide treatment, chemical vapor deposition and anodization. Physical methods of implant surface alteration are plasma splattering, sputtering and ion deposition. This was also illustrated in the studies of Takekawa and Jar.^{26,27} Sandblasting is

air blasting of different sized oxides like titanium dioxide, aluminum oxide, zirconium dioxide and silicon carbide. Acid Etched is primarily used to eliminate oxide and contamination to achieve fresh and standardized surface finishes. Semenzin and Albeshri demonstrated that Laser Etching is a contactless approach wherein the implant surface is not splashed with blasting media.^{28,29} Their recommendations are widely used these days in applicable situations for enhanced results. Additionally, laser etching is highly uncomplicated method for managing the surface details/texture of the implant surface.

Conclusion

Within the limitations of the study authors outlined highly significant presumptions. Authors estimated and compared the primary stabilities in photoactivated and conventionally surface treated implants and noticed that primary stability was slightly superior in the implants treated by conventional method over photoactivated method. The results were significant in both estimations. Additionally, both of the tested surface treatment methods have their own advantages and disadvantages with prefixed indications and contraindications. Therefore, selection of the accurate type of surface treatment is highly imperative and crucial in clinical setups. Authors also anticipate some other future studies to be conducted to authenticate and validate our results.

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