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EVALUATION OF STRESS BETWEEN COATED AND NON COATED IMPLANT SURFACE

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ABSTRACT

The implants are said to be successful once it integrate with the surrounding hard tissue prior to prosthetic rehabilitation. Finite element analysis is an effective tool used to assess the biomechanical characteristics of different types of dental implants. This study was to arrive at a qualitative comparison in the stress concentration and distribution between the surface coated and non surface coated implant by using computer simulations to examine clinical situations.

INTRODUCTION

The implants are said to be successful once it integrate with the surrounding hard tissue prior to prosthetic rehabilitation [1-3]. Variety of factors control osseo-integration, these factors can be categorized as surgical, implantological and biomechanical optimization is an important objective in the design of dental implants. Most efforts have been directed at optimizing implant geometry in order to maintain a beneficial stress level at the bone implant interface. Finite element analysis is an effective tool used to evaluate biomechanical characteristics of different types of dental implants. The literature reflects that it has been widely used to model to design and functionality of dental implants and predict fractures of design optimization. A key factor for the success or failure of a dental implant is the manner in which stresses are transferred to the surrounding bone. Vertical and transverse loads from mastication induce axial forces and bending moments and result in stress gradients in the implant as well as in the bone [4].

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Aims and Objectives

This study was to arrive at a qualitative comparison in the stress concentration and distribution between coated and non-coated implant surface using Finite element analysis.

MATERIALS AND METHODS

In the present study 3 dimensional finite element study was carried out at the first molar site with 8 different commercially available implants, (out of which 4 were surface coated and other 4 were non surface coated implants) to determine the stress distribution patterns.
The implants used in the study are Surface coated implants are
1. Noble Biocare Replace select tapered Ti U 4.5mm D 12 mm L and 4.5mm D 15mm L.
2. Zimmer tapered screw-vent 4.3mm D 12mmL and 4.3mm D 15mm L

3. Non surface coated Implants as Adin tapered 4.4mm D 10mmL, 4.2mm D 13mL, and
4. uniti tapered 4.4mm D 12mmL and 4.4mm D 15mmL

Loads and boundary conditions

For all the cases the bottom portion of the cortical bone and cross-sectional faces on either side of the bone is fixed. A vertical (35 N), horizontal (15 N) and oblique (75 N), emulating the masticatory load, periodontal force and the muscle force respectively were in turn applied to each of the above models.

Software detail; CT scan of the bone and crown is taken into mimics 8.13 software,Surface data of the implant, abutment and inscrew is generated using Solid edge 2012 software, Finite element model is generated using Hypermesh 11 software,analysis was carried out using Analysis 12.6 software

Hardware details; Intel core 4 duo processor,8GB ram,600gb hard disk,Color Coding For Von-Mises Stress. *Color coding for displacement.* Blue is minimum and red is the maximum in between shades is the variation of displacement from minimum to maximum.

METHODOLOGY

The geometric models of the implant, inner screw, and abutment for all 8 designs were modeled solid edge software by using reverse engineering technique The geometric model of the bone and crown was obtained from the CT scan..The geometric models into Hypermesh software for meshing..The process of converting geometric model into finite element model is called meshing. Finite element model consist of nodes and elements. Assembled finite element model of the implants crown and bone is then imported into Ansys software for analysis. The loads and boundary conditions mentioned above are applied in the solution stage solving stage: solving each load case separately. Post processing the results and capturing the displacement and Von-misses stress contours of each individual parts in the system. Preprocessing, solving and post processing are three stages in Ansys.

RESULTS

Plate 1. Pictures of full component o f Noble Biocare 12mm and 15mm length on vertical load of 35 N, lateral load of 15N and oblique load 75 N

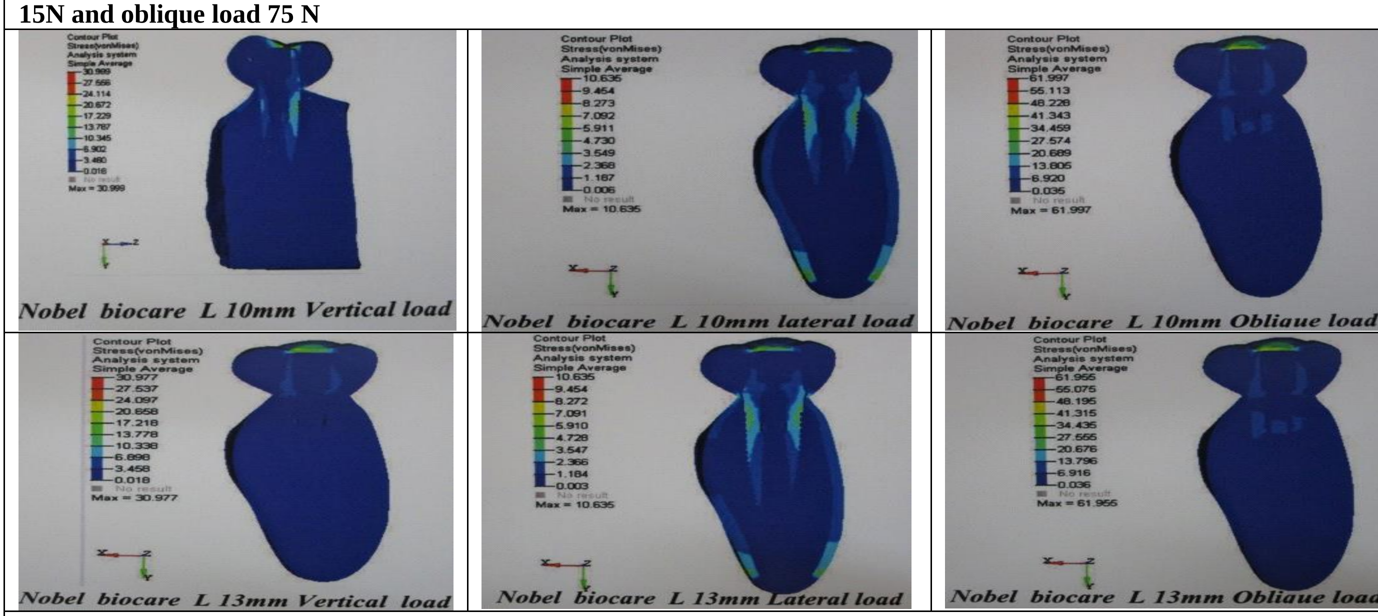
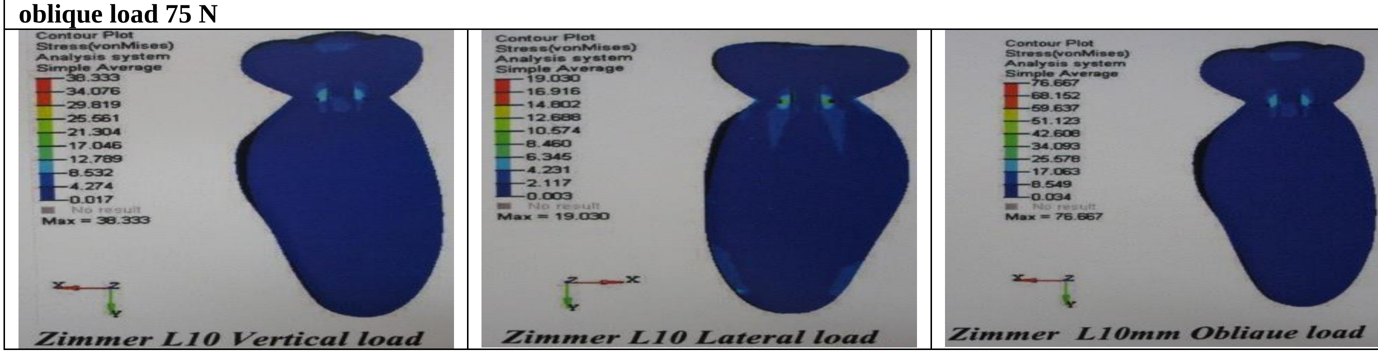


Plate 2. Pictures of full component of Zimmer 12mm and 15mm length on vertical load of 35 N, lateral load of 15N and oblique load 75 N



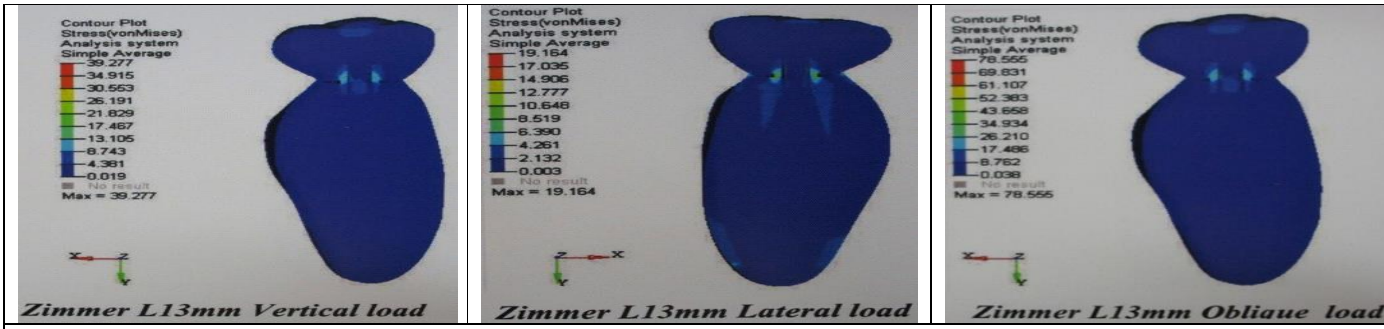


Plate 3. Pictures of full component of ADIN 12mm and 15mm length on vertical load of 35N, lateral load of 15N and oblique load of 75N

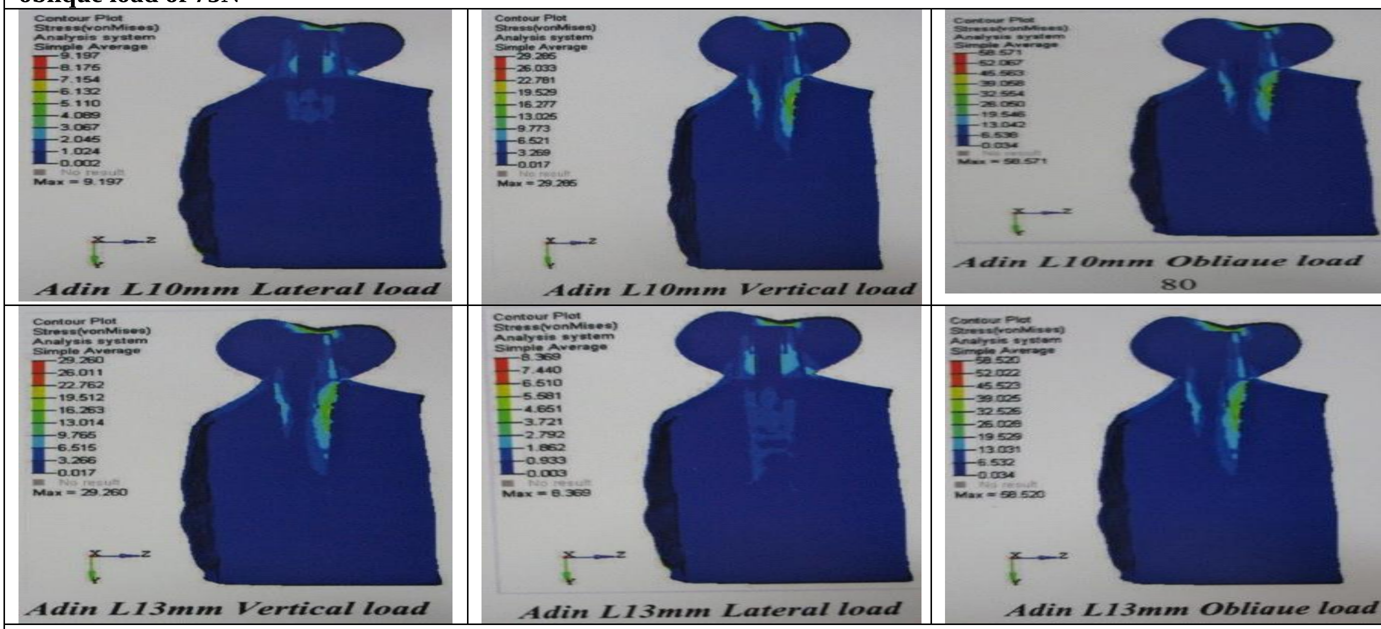


Plate 4. Pictures of full component of UNITI 12mm and 15mm. Length on vertical load on 30 N, lateral load of 15N and oblique load of 75 N.

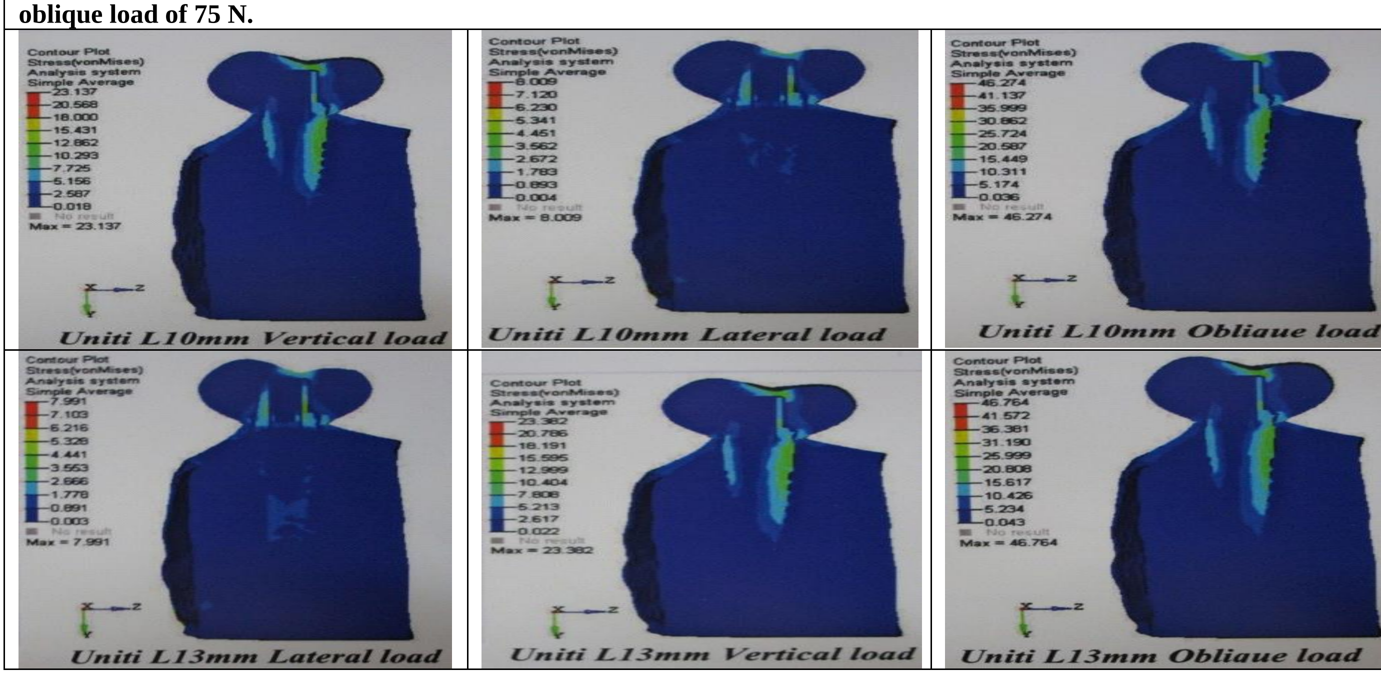


Table 1. Turkey HSD multiple comparisons

Variables		Crown	Abutment	Inscrew	Implant	Soft bone	Hard bone	FUL
Vertical	Lateral	0.89	0.78	0.16	0.57	0.00	0.00	0.63
	Oblique	0.22	0.92	0.27	0.71	0.82	0.83	0.61
Lateral	Vertical	0.90	0.78	0.16	0.57	0.00	0.00	0.63
	Oblique	0.42	0.54	0.007	0.19	0.00	0.00	0.17
Oblique	Vertical	0.22	0.92	0.27	0.72	0.82	0.83	0.61
	Lateral	0.48	0.54	0.006	0.19	0.00	0.00	0.17

Stress distribution pattern between vertical lateral and oblique forces among all the samples used were analyzed using ANOVA and Turkey HSD test with a total sample size of 24 with 8 in each group.

The mean standard deviation significance and percentage of significance for the three loading condition in all the components are given in the above table the results showed that in the soft bone and hard bone there was 99.9% significance and 99% significance in inscrew using ANOVA.

The stress distribution patterns between surface coated and non-surface coated implants were analyzed using independent sample tests in vertical, oblique and lateral load with a sample size of four in each group.

Table 2. Vertical Load

Model	Group	N	Mean	Standard Deviation	Significance	%
Crown	S	4	81.3	25.20	0.66	NS
	NS	4	87.5	11.57	0.67	
Abutment	S	4	84.69	51.56	0.23	NS
	NS	4	50.64	3.59	0.27	
Inscrew	S	4	29.74	2.90	0.037	95%
	NS	4	23.96	3.23	0.038	
Impant	S	4	71.11	30.07	0.54	NS
	NS	4	60.86	11.54	0.56	
Soft Bone	S	4	7.62	4.518	0.18	NS
	NS	4	4.13	1.056	0.22	
Hard Bone	S	4	42.88	25.21	0.14	NS
	NS	4	21.51	2.015	0.18	
Full	S	4	116.24	15.19	0.02	95%
	NS	4	87.55	11.57	0.02	

The mean, standard deviation, significance and percentage of significance for all the components between the surface coated implants (represented as S) and non surface coated implants (represented as NS) are given in the above table the results showed that in the INSCREW and the full component there was 95% significance. There was a significance of 0.037 and 0.038 when equal variance was assumed and not respectively for an INSCREW and in full components the significance values were 0.024 and 0.026 respectively.

Table 3. Lateral Load

Model	Group	N	Mean	Std. Deviation	Significance	%
Crown	S	4	88.42	20.72	0.24	NS
	NS		72.60	12.83	0.25	
Abutment	S	4	115.34	87.16	0.19	NS
	NS		52.37	3.54	0.24	
Inscrew	S	4	36.82	1.55	0.05	95%
	NS		26.17	3.75	0.06	
Implant	S	4	84.69	41.75	0.59	NS
	NS		71.7	14.83	0.59	
Soft Bone	S	4	12.57	1.52	0.16	NS
	NS		13.87	0.34	0.19	
Hard Bone	S	4	82.37	4.09	0.35	NS
	NS		80.28	0.33	0.39	
Full	S	4	148.58	48.77	0.039	95%
	NS		83.92	5.65	0.075	

The mean, standard deviation, significance and percentage of significance for all the components between the surface coated implants (represented as S) and non-surface coated implants (represented as NS) are given in the above table the results showed that in the INSCREW and the full component there was 95% significance. There was a significance of 0.037 and 0.038 when equal variances was assumed and not respectively for an INSCREW and in full components the significance values were 0.031 and 0.034 respectively.

DISCUSSION

Aims of this study was to evaluate the stress patterns generated in the crown, abutment, in screw, and bone to evaluate the stress distribution patterns among the different lengths of the same implant, among vertical, lateral, and oblique forces of all the 8 implants and finally to find out stress distribution patterns among surface coated and non-surface coated implants [5-16].

As the length of an implant increased for a vertical load there was an increase in stress concentration at in screw for both the surface coated and non-surface coated implants. As the length of an implant increased for a vertical load stress concentration varied among crown, abutment, implant, and hard bone in between surface coated and non-surface coated implants. Among non-surface coated implants there was a decrease in overall stress concentration when the lengths of the implants have increased.

Among the surface coated implants there was an increase in stress concentration at the abutment, in screw, and soft bone. At the soft bone the stress concentration always increased except in uniti implants as the length of the implants have increased. Among surface coated and non-surface coated implants the pattern of stress distribution was almost similar except at the in screw and full component.

CONCLUSION

The site of maximum stress concentration at the implant was always at the neck of the implant for all the 3 forces and all the 8 implants. As the length of the implant increased stress concentration had a tendency to increase at the abutment and inscrew on all the 3 forces. The stress distribution patterns between vertical, lateral, and oblique forces showed similarity in all components except in soft bone, hard bone, The pattern of stress distribution was almost similar between vertical and oblique loading except in crown but varied with lateral load between surface coated implants.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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