Effect of Masticatory Load on Abutment Screw Loosening of Three Different Types of Metal Ceramic Implant Crowns - A 3 Dimensional Fea Study

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Abstract: ***Purpose**: To evaluate and compare masticatory load on abutment screw loosening of three types of implant prosthesis- screw, cement and screw cement retained prosthesis and effect of prosthesis on stress distribution in peri - implant area. **Material & Methods**: A Three Dimensional (3D) finite element model of edentulous mandibular molar region, geometric model of the implants, abutments, screws and crowns were modelled by using reverse engineering technique. Three models cement retained, screw-cement retained, screw retained implant prosthesis models were simulated for the study. A solid 4mm tapered, screw type implant 13mm long (CMI II) was selected for the study. Three straight abutments, (Nobel Biocare) were modeled through reverse engineering and were used for the implant. A titanium abutment screw was also modeled to fit in the abutment. The loads applied were static and were uniformly applied throughout the occlusal surface of the superstructure. A masticatory load at the rate of 100 N at 20,000 cycles for 1 second followed by 1 second of no loading will applied[3] and will be repeated till the screw loosens. **Results**: Maximum Von Mises stress values on vertical loading were observed on the abutment screw of all the three implant prosthesis. The abutment screw of cement-screw prosthesis showed fatique earlier than the cement and screw retained prosthesis. With respect to bone structure, the maximum Von Mises stress values were observed in the cement retained implant prosthesis, followed by screw retained implant prosthesis and in Screw- Cement retained implant prosthesis. **Conclusion**: Within the limitations of the study, the study showed that Screw- Cement retained prosthesis showed early screw loosening followed by cement retained and then screw retained implant prosthesis.***

Keywords: Abutment Screw Loosening, Cement retained implant prosthesis, Screw retained implant prosthesis, Screw- cement retained implant prosthesis, Metal Ceramic implant crowns

1. Introduction

One of the most commonly encountered post loading complications in dental implant is abutment screw loosening resulting in microgaps between the abutment and the implant thus leading to gingivitis, angular bone loss and eventually implant failure. Knowledge of possibility of abutment screw loosening in different types of implant retained prosthesis can provide an insight on prosthetic success to the dentist[1].

The very common problem encountered with single implant is abutment screw loosening. Reasons for screw loosening include screw stretch, individual finger strength, less than ideal implant position, inappropriate occlusal scheme or crown anatomy, variations in hex dimension coupled with equal variations in the abutment counterparts, slight differences in fit and accuracy and tension on abutment and cylinder from ill-fitting restorations[2].

Numerous studies show that abutment loosening constitutes one of the marked implant post-surgical complications requiring clinical intervention in both screw retained and cement retained prosthesis. The cement retained prosthesis is very difficult to retrieve and retained cement in the peri-implant area could cause peri-implantitis leading to implant failure[3].

Prostheses may be attached to implants or implant abutments by screw retention or cementation. Some authors suggest that the screw-retained prosthesis, established by Branemark, offers reversibility and more stability and security at the implant/ abutment interface[4]. Other studies emphasize the advantages of the cement-retained prosthesis, including more versatile esthetics, passive placement, and the simplicity of the technique[4].

Screw retention in implant-supported prostheses was developed in response to the need for retrievability even though occlusion and esthetics were sacrificed. Screw retained prosthesis is more prone for fracture and loosening of abutment screw over cement retained prosthesis,as a poor interface fit between implant components will increase initial displacement and cause wear of the contact area with an increase of the gap in the screw joint[5].

The screw joint is also the weakest link between the implant components, easily it could loosen or fracture[2]. Therefore, the screw cement retained prosthetic abutment has been developed that has the combined advantage of better esthetics and retrievability over the conventional screw and cement retained prosthesis respectively.

Moreover, metal ceramic posterior crowns are the most commonly used restorative material today[3] and the dynamics of force distribution can be understood by using a finite element analysis.

While the options in abutments for the operator has increased, there is a need to know the screw loosening potential of each as well as the pattern of stress distribution in peri-implant bone area with respective prosthesis. As invitro Finite Element Analysis will enable us to simulate masticatory loads on the various abutment options, thereby studying the potential for screw loosening as well as peri implant stress patterns.

The favorable clinical outcomes in many retrospective and prospective analysis imply, that screw loosening does have a negative effect on the outcome of implant therapy. The mechanics of implant screw loosening or fracture are well understood in the field of engineering. They have not been as widely explored in dentistry. Also, finite element analysis (FEA) indirectly addresses the issue of abutment screw loosening, a mechanical complication.

FEA is a powerful computer simulation tool in solving stress-strain problems in the mechanics of solids and structures in engineering. The use of finite element modeling (FEM), a designing tool well suited for analysis of complex stress and strain fields in and around dental implants, is becoming more widespread. The finite element method has been applied to dental field to predict stress distribution patterns in the implant- bone interface not only for comparison of various root-form implant designs, but also by modeling various clinical scenarios and prosthetic designs. This method offers the advantage of solving complex structural problems by dividing them into smaller and simpler interrelated sections by using mathematical techniques.

The purpose of the study is to evaluate and compare masticatory load on abutment screw loosening of three types of implant prosthesis- screw, cement and screw cement retained prosthesis and its stress distribution in peri- implant area.

2. Material and methodology

The finite element method (FEM) is a numerical analysis technique for obtaining approximate solutions to a wide variety of engineering problems. FEM, divides a structure into several elements (pieces of the structure), then reconnects elements at “Nodes”. This process results in a set of simultaneous algebraic equations.

The term finite element was first coined by Mr. Clough in 1960. In the early 1960s, engineers used the method for approximate solutions of problems in stress analysis, fluid flow, heat transfer, and other areas. In 1976, Weinstein et al were the first to use FEA in implant dentistry[32].

Finite element analysis is a method which involves three stages:

1) **Pre processing:** Creation of Finite element model from the geometric model, application of material properties are the major tasks in this step.
2) **Solving stage :** Applying loads and boundary conditions and then conducting the numerical analysis
3) **Post processing:** Plotting the results like deformations and stresses.

Pre- processing Stage: Data acquisition:

Materials required were:

1) CT scan of edentulous mandibular first molar region.
2) Implant- 4.0×13mm

Figure 1

1) Abutments – Three straight Abutments, from Neo Biotech

Figure 2

2) Mandibular First Molar Implant Crowns :

Figure 3 (A) **Figure 3 (B)** **Figure 3 (C)**

3) Assembled Prosthesis- Screw Retained, Cement Retained and Screw Cement Retained Metal Ceramic Prosthesis.


Figure 4 (A)


Figure 4 (B)


Figure 4 (C)

A three-dimensional (3D) finite element model of edentulous mandibular first molar was made using tetrahedral elements with the help of Hyper mesh Software.

A computerized tomography (CT scan) in DICOM format of edentulous mandibular first molar was used to get the finite element model of bone. Initially a 3D model was built with the help of software like Mimics (http://biomedical.materialise.com/mimics) and processed to convert it into STL (stereolithiography) format files.

To further fine tune the 3d model we used modelling software like CATIA V5. Then these STL files were imported into rapid form software, here the wireframe model is converted to geometric model and is exported as IGES (Initial graphics exchange specification) format, This is the final geometric model which is taken into hypermesh software, pre-processor software, for meshing and applying boundary, load conditions and to convert or to create a finite element model.

The three-dimensional (3D) geometric model of the implants, abutments, screws and the three prosthesis- Screw retained, Cement retained and Screw Cement retained metal ceramic prosthesis framework were modeled using Solid Edge (2004) software by using reverse engineering technique. Reverse engineering is a technique in which we extract the dimensional details, like width, height, thickness, diameter etc, of a physical component (screw, implant, etc.) by using precision measuring instruments. All materials used in the models were considered to be isotropic, homogeneous and linearly elastic. The corresponding material property was taken from the literature[28,29,30,31,32].

Material properties of the materials used in the model: [28,29,30,31,32]

Table I

Material	Young modulous (Pa)	Poisons ratio
Titanium (Ti-6Al-4V)	110×10^{3}	0.35
Titanium Abutment and Screw	110×10^{3}	0.28
Cortical bone	1.37×10^{4}	0.3
Cobalt-Chromium alloy	218×10^{3}	0.33
Feldspathic Porcelein	8.28×10^{3}	0.35
Resin	2.7×10^{2}	0.35

Models:

Bone: One model was created for the study. The model simulated has an implant of 4×13mm implant placed parallel (Fig 5).

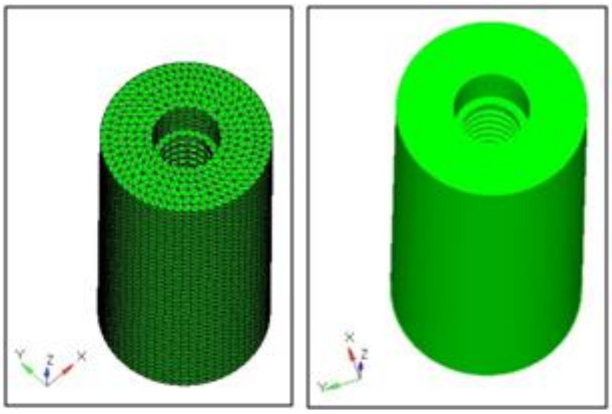


Figure 5

Implants

A solid 4mm tapered, screw type implant 13mm long (Neo CMI implant, Neo Biotech) was selected for the study. The implant had a threaded helix structure. The implant was placed in the bone. (Fig 6)

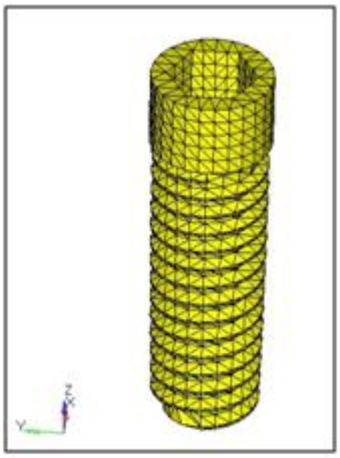


Figure 6

Abutments

A straight abutment, (Neo Biotech) was modeled through reverse engineering and was used for straight implant. (Fig 7).

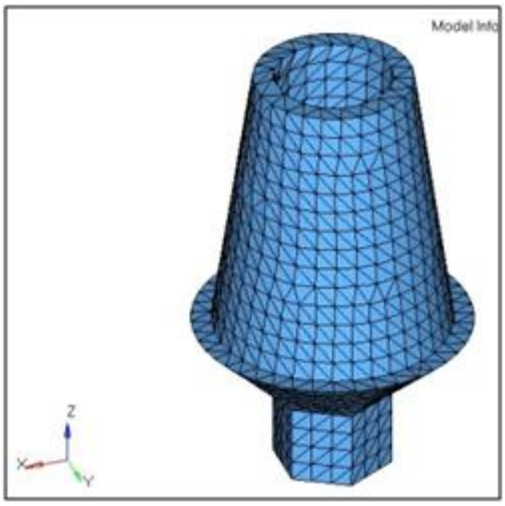


Figure 7

Abutment Screw

A titanium abutment screw was also modeled to fit in the abutment. (Fig 8)

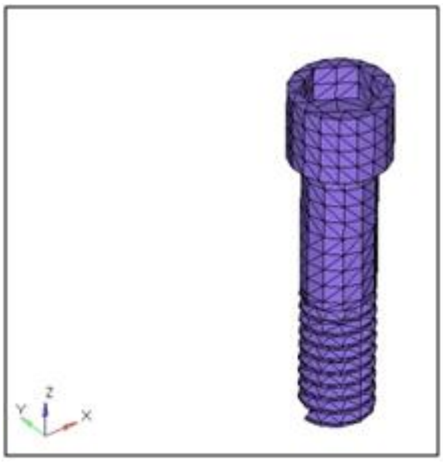


Figure 8

Mandibular first molar Crowns

Three mandibular first crowns were modelled.

Screw retained prosthesis had a cobalt chromium framework of thickness 0.5mm and the veneer material had 2mm thickness. An access hole was made with a ring of thickness 0.5mm on occlusal surface (Fig 9a and Fig 9b).

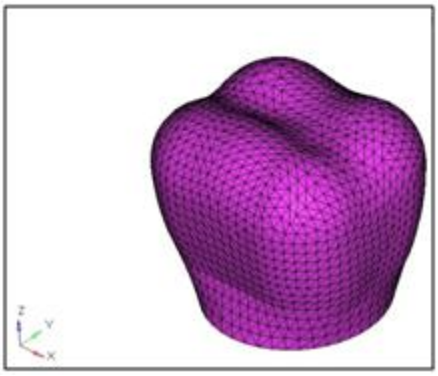


Figure 9 (A)

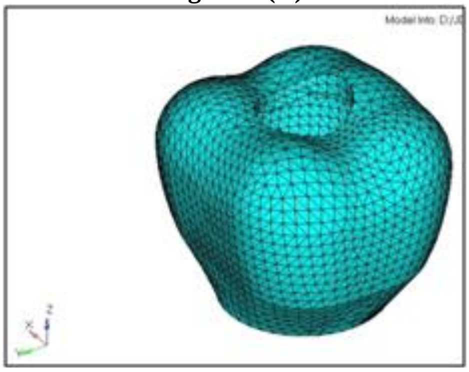


Figure 9 (B)

Assembly:

The individual units were then assembled and then therequired prosthesis design was achieved. Cement retained prosthesis (Fig 10b) and Screw Cement retained prosthesis (Fig 10c) had a cobalt chromium framework of thickness 0.5mm and the veneer material had 2mm thickness. An access hole was made with a ring of thickness 0.5mm on occlusal surface on Screw Retained prosthesis (Fig 10a) and Screw Cement Retained Prosthesis (Fig 10a).

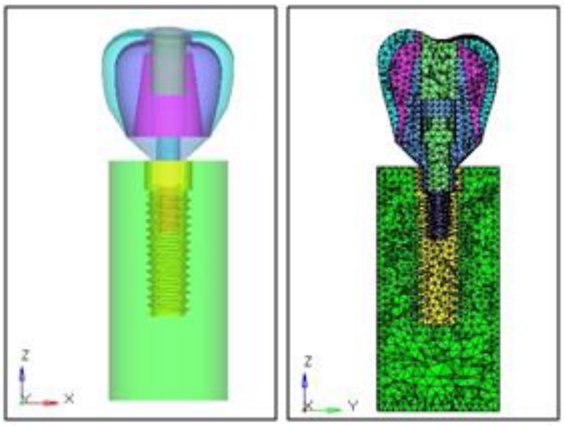


Figure 10 (A)

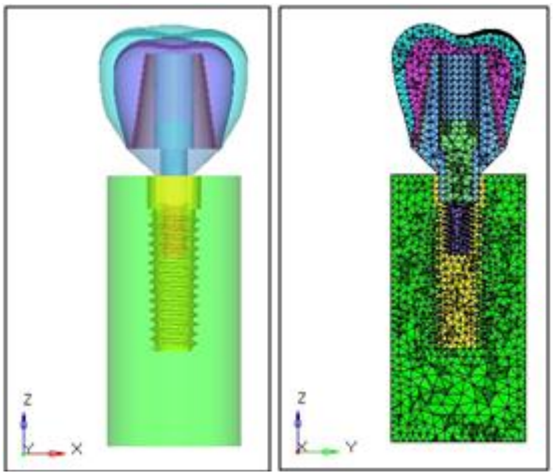


Figure 10 (B)

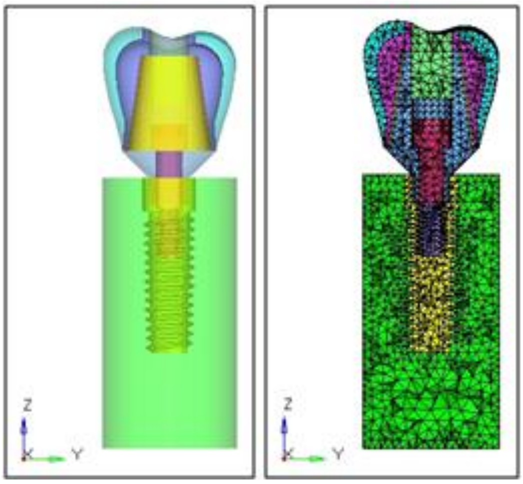


Figure 10 (C)

There have been various veneering material which have been widely studied like porcelain, acrylic resin and composite resins. It has been shown by research that composite resins or glass modified composite resins produced in recent years lead to the formation of low stress levels in the bone around the implants and Prosthesis. And hence we used 2mm thick Resin as our veneering material to study stress pattern.

For FEA analysis we require two things, load and boundary conditions, apart from model and materials.

Load

Alternate Static and Dynamic loads was applied uniformly applied throughout the occlusal surface of the mandibular first molar crowns.

A masticatory load at the rate of 100 N at 20,000 cycles for 1 second followed by 1 second of no loading was applied

Boundary Condition

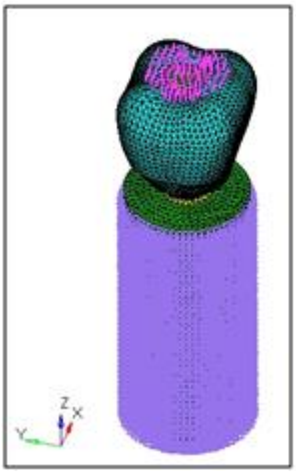


Figure 11 (A)

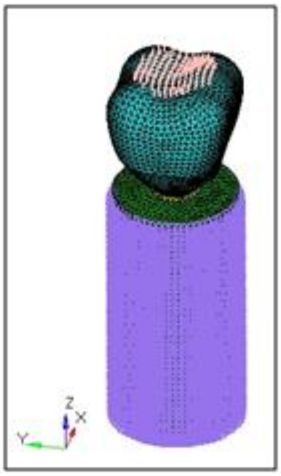


Figure 11 (B)

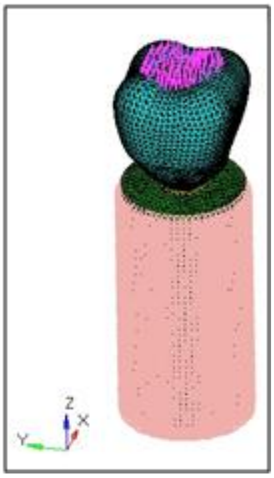


Figure 11 (C)

Comparative Groups

MODEL 1 – Screw retained mandibular first molar implant prosthesis model

MODEL 2 – Cement retained mandibular first molar implant prosthesis model

MODEL 3 – Screw-Cement retained mandibular first molar implant prosthesismodel

Solving Stage

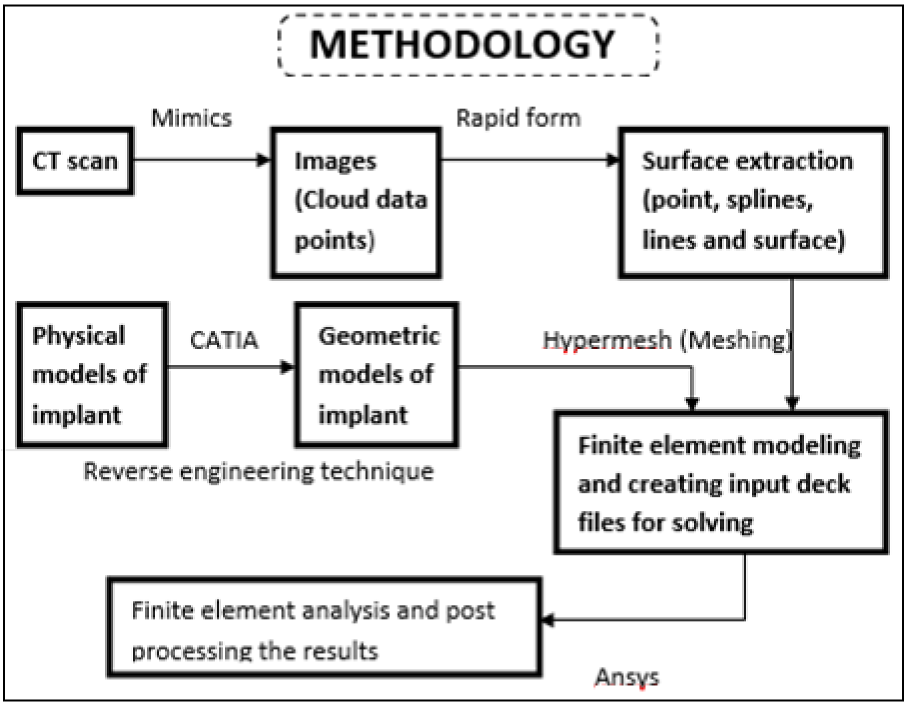
Assembled finite element models of the mandibular first molar region with implants, abutments, screws and crowns was then imported into Ansys (Ansys 12.1) software for analysis. The loads and boundary conditions were applied in the solution stage.

Post Processing

Is a stage in which we capture the displacement and Von-Mises stress contours of each individual parts in the system and assess the critical regions in the model.

Table II: Number of Elements and Nodes in Different Models

Model	Number of Elements	Number of Nodes
Model 1	85148	16907
Model 2	84698	17215
Model 3	85801	17343



3. Results

DMX- Maximum Displacement
SMX- Maximum Stress
SMN- Minimum Stress

Table III
Stresses on Assembled Prosthesis
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.001871	0.001148	0.002036
SMX	20.138	21.252	21.34
SMN	0	0	0

Table IV
Stresses on Implant
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.545E-03	0.549E-03	0.562E-03
SMX	11.919	12.004	13.163
SMN	0.797622	0.797073	0.799812

Table V
Stresses on Abutment
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.953E-03	0.001071	0.001166
SMX	20.138	21.252	21.34
SMN	0.695015	2.691	2.705

Table VI
Stresses on Abutment Screw
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.690E-03	0.698E-03	0.725E-03
SMX	7.816	7.836	8.211
SMN	0.16318	0.155671	0.15625

Table VII
Stresses on Crown
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.998E-03	0.01148	0.001307
SMX	2.795-5.962	2.722-5.277	2.99-5.999
SMN	0.45042-0.523476	0.36676-0.569921	0.068006-0.568781

Table VIII
Stresses on Bone
On Vertical Loading of 100 N in MPa

Stress	Model 1	Model 2	Model 3
DMX	0.447E-03	0.449E-03	0.458E-03
SMX	2.141	2.119	2.27
SMN	0	0	0

Model 1:

Screw Retained Mandibular First Molar Implant Prosthesis

On Vertical Loading of 100 N

Stress on Assembled Prosthesis:

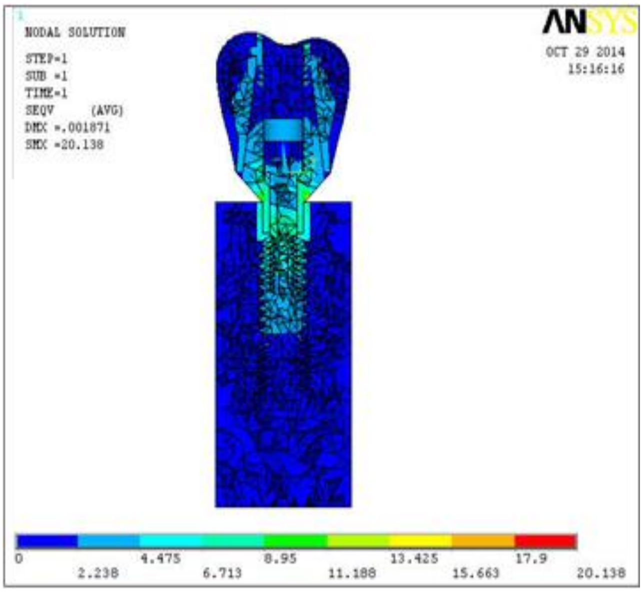


Figure 12

The assembly showed maximum stress in the region of implant abutment interface of 20.138 MPa. And uniform stress of 8.95-11.188 MPa throughout the Prosthesis.

On Implant:

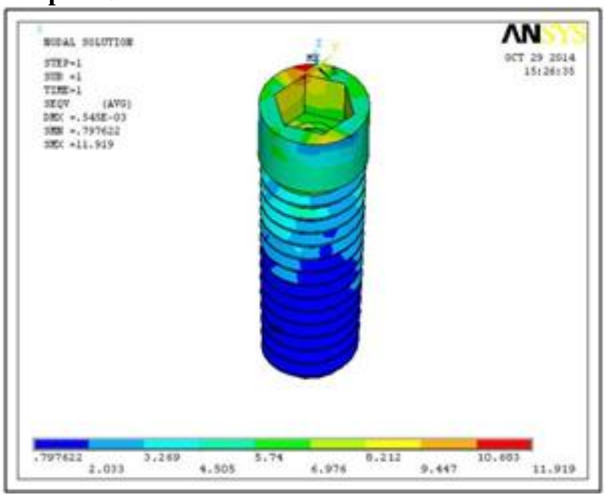


Figure 13

The Implant showed maximum stress in the region of implant- abutment interface of 11.919 MPa. And uniform stress of 5.74-9.447 MPa throughout the implant.

On Abutment:

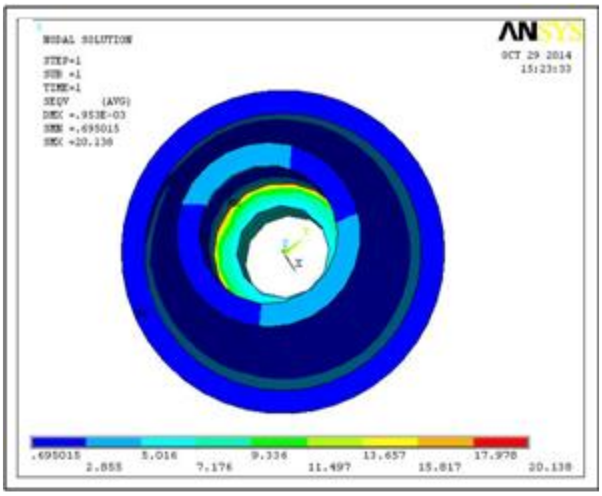


Figure 14

The abutment showed maximum stress in the region of abutment- screw interface of 20.138 MPa. And uniform stress of 5.016-15.817 MPa throughout the abutment.

On Abutment Screw:

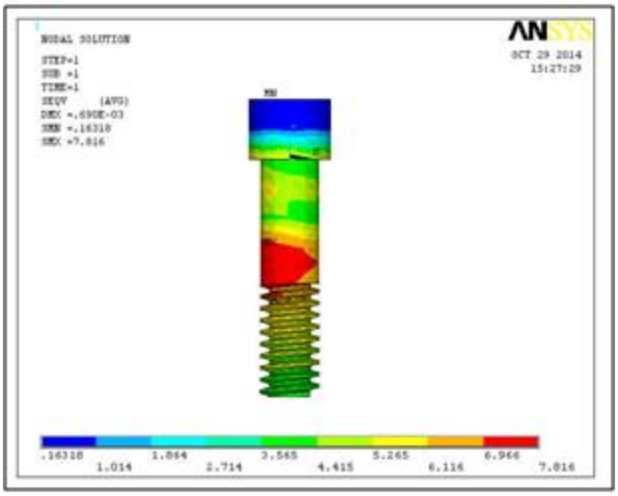


Figure 15

The abutment screw showed maximum stress in the region of screw threads of 7.816 MPa. And uniform stress of 3.565-6.966 MPa throughout the screw.

On Prosthesis:

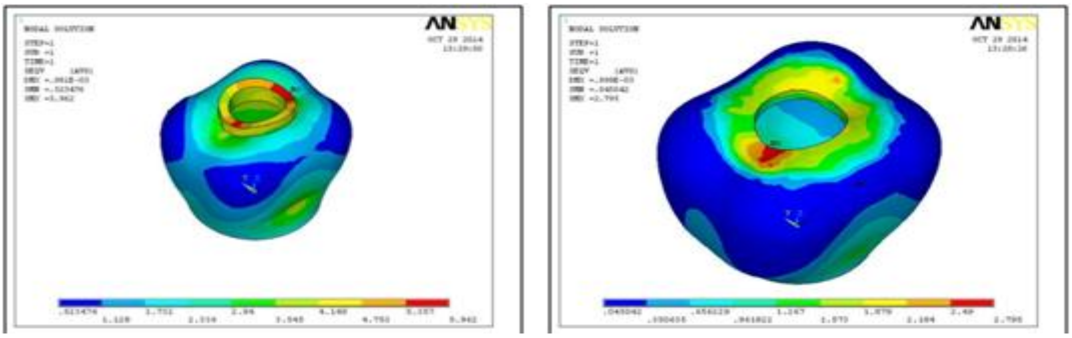


Figure 16

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The crown showed maximum stress in the region of access hole interface of 2.795 MPa. And uniform stress of 1.267-2.49 MPa throughout the Prosthesis.

On Bone:

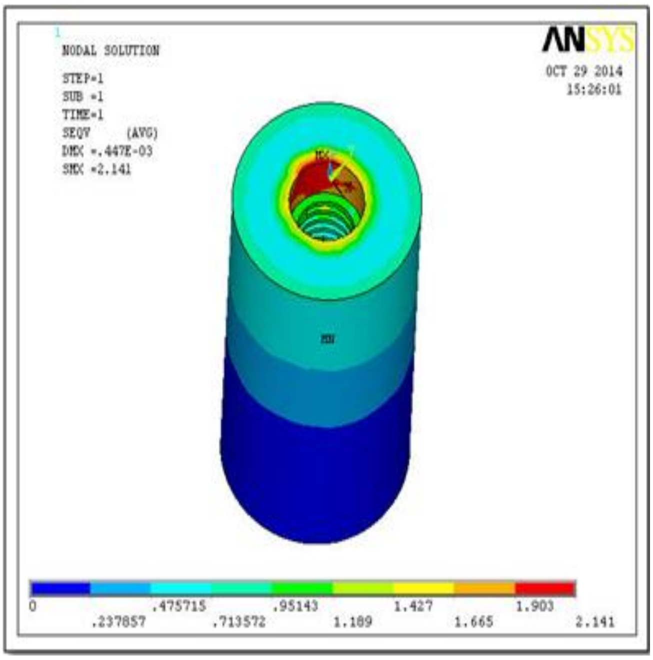


Figure 17

There was a maximum stress seen at the abutment implant interface of 2.141 Mpa and 0.95- 1.66 Mpa throught the bone.

Model 2
Cement Retained Mandibular First Molar Implant Prosthesis

<u>On Vertical Loading of 100 N.</u>
Stress on Assembly:

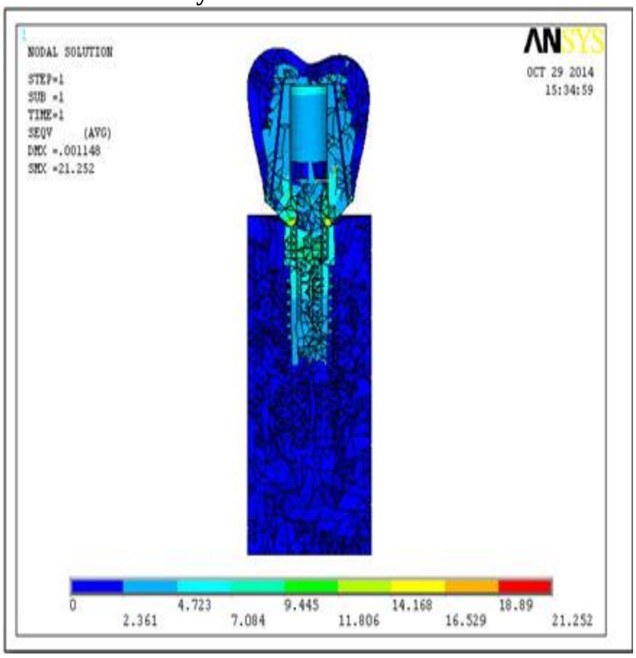


Figure 18

The assembly showed maximum stress in the region of implant abutment interface of 21.252 MPa. And uniform stress of 9.445-16.529 MPa throughout the Prosthesis.

On Implant:

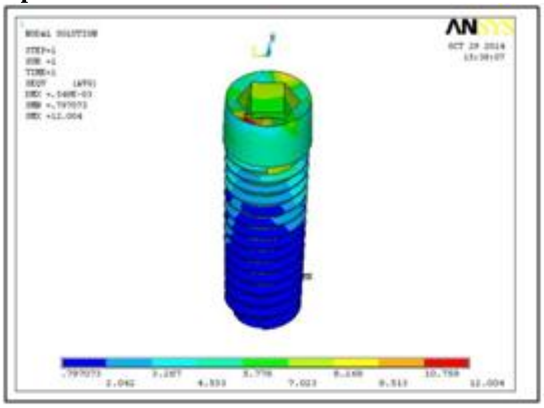


Figure 19

The Implant showed maximum stress in the region of implant- abutment interface of 12.004 MPa. And uniform stress of 5.778-10.759 MPa throughout the implant.

On Abutment:

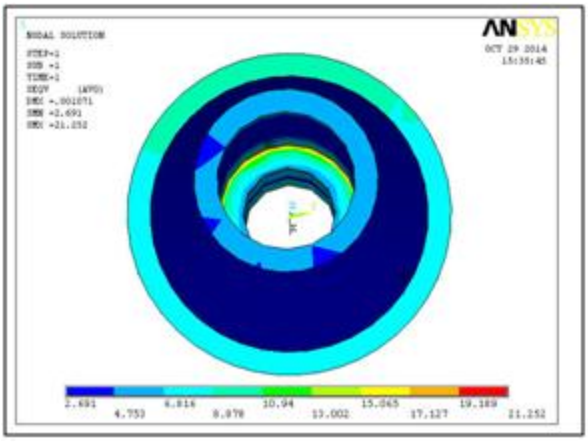


Figure 20

The abutment showed maximum stress in the region of abutment- screw interface of 21.252 MPa. And uniform stress of 15.065-19.189 MPa throughout the abutment.

On abutment screw:

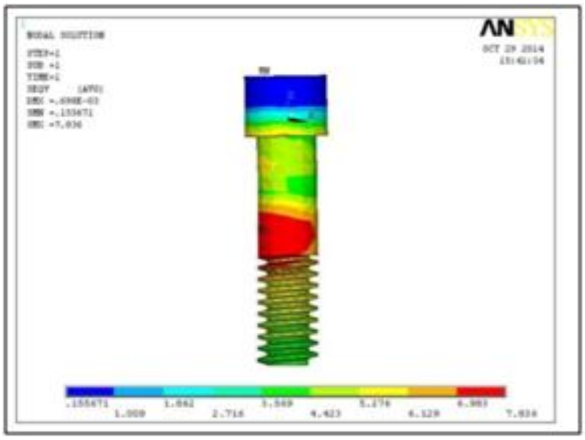


Figure 21

The abutment showed maximum stress in the region of screw threads of 7.836 MPa. And uniform stress of 3.569-6.983 MPa throughout the screw.

On Prosthesis:

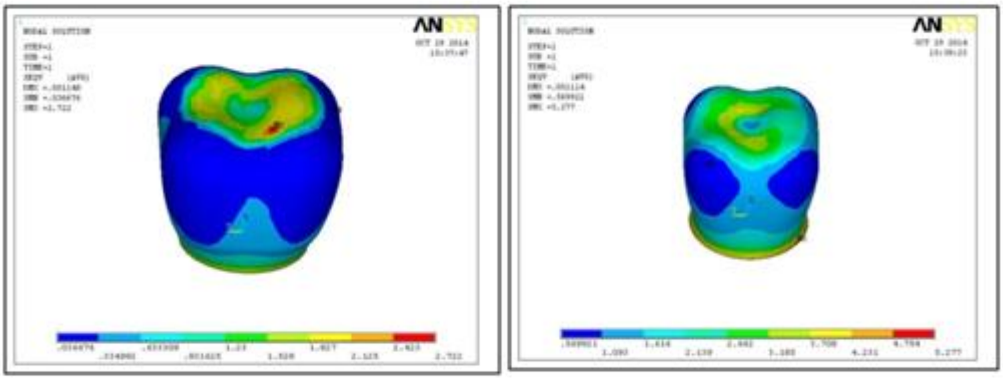


Figure 22

The prosthesis showed maximum stress in the region of occlusal surface of 2.722 MPa. And uniform stress of 1.23-2.423 MPa throughout the Prosthesis.

On Bone:

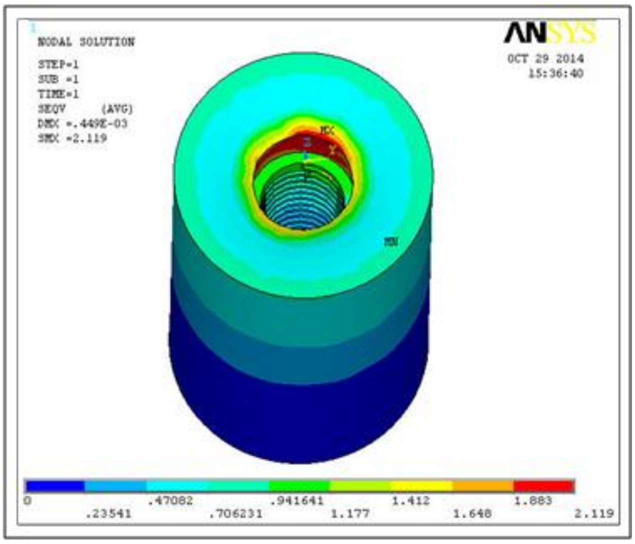


Figure 24

There was a maximum stress seen at the abutment implant interface of 2.119 Mpa and 0.941641-1.883 Mpa throught the bone.

Model 3

3. SCREW CEMENT RETAINED MANDIBULAR FIRST MOLAR IMPLANT PROSTHESIS

<u>On Vertical Loading of 100 N.</u>

Stress on Assembly:

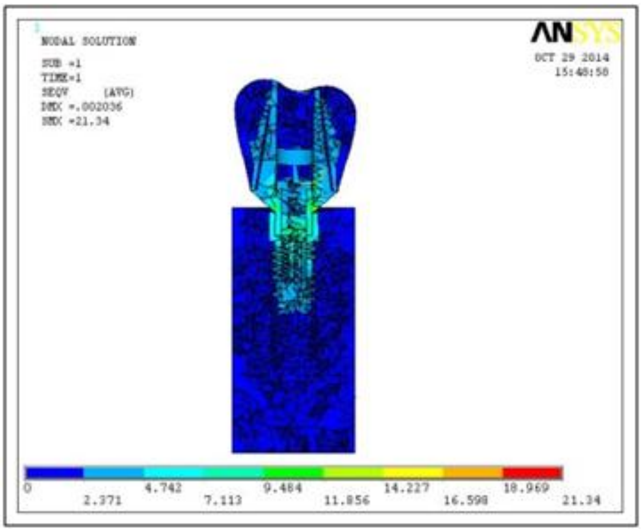


Figure 24

The assembly showed maximum stress in the region of implant abutment interface of 21.34 MPa. And uniform stress of 9.484-16.595 MPa throughout the Prosthesis.

Stress on Implant:

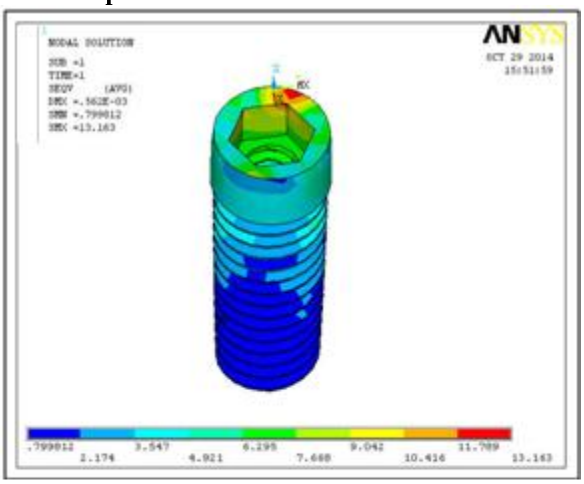


Figure 25

Paper ID: SR221208100416 DOI: 10.21275/SR221208100416

The Implant showed maximum stress in the region of implant- abutment interface of 13.163 MPa. And uniform stress of 7.668-11.789 MPa throughout the implant.

Stress On Abutment:

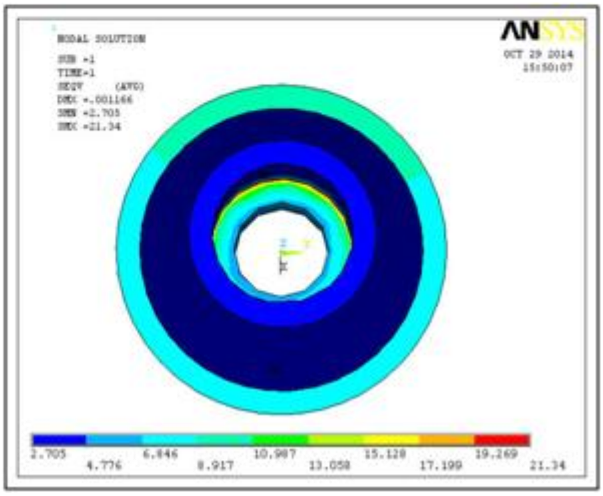


Figure 26

The abutment showed maximum stress in the region of abutment- screw interface of 21.34 MPa. And uniform stress of 15.128-19.269 MPa throughout the abutment.

Stress on Abutment Screw

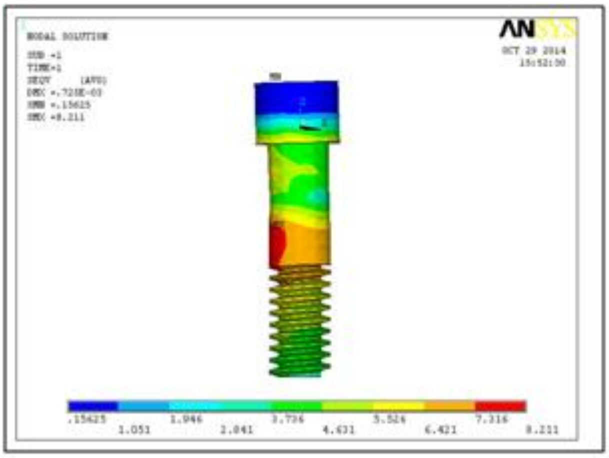


Figure 27

The abutment screw showed maximum stress in the region of screw threads of 8.211 MPa. And uniform stress of 5.526-7316 MPa throughout the screw.

Stress on Prosthesis:

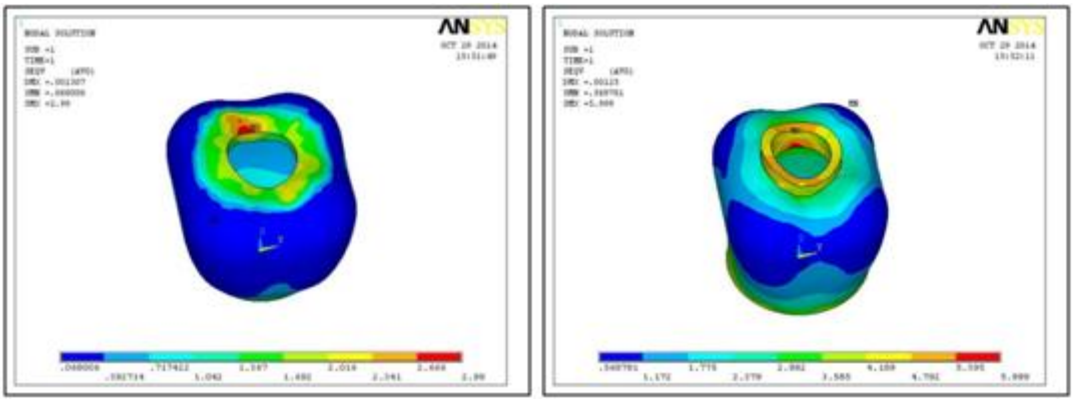


Figure 28

The prosthesis showed maximum stress in the region of access hole interface of 2.99 MPa. And uniform stress of 2.016-2.666 MPa throughout the Prosthesis.

Stress on Bone:

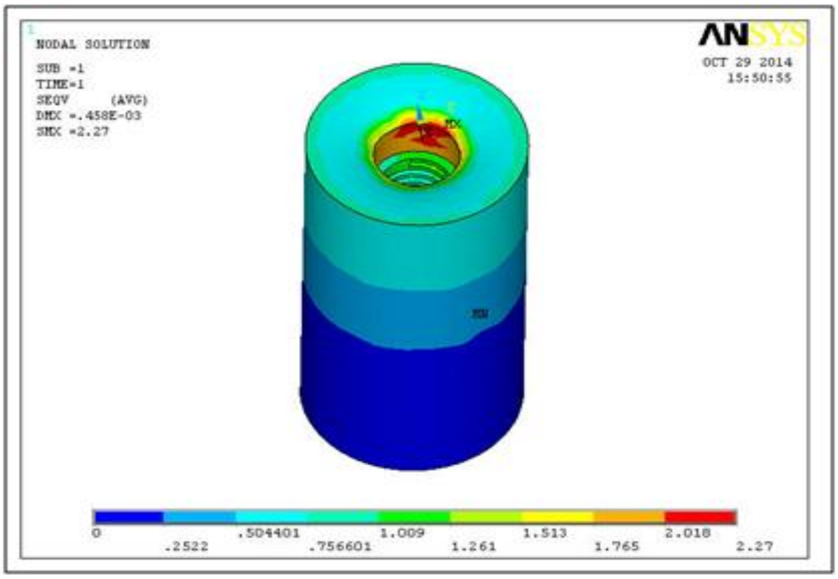
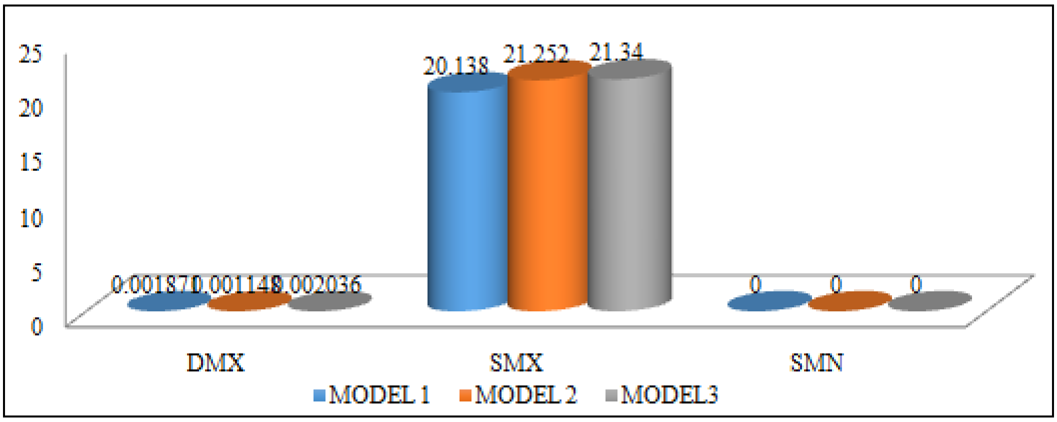


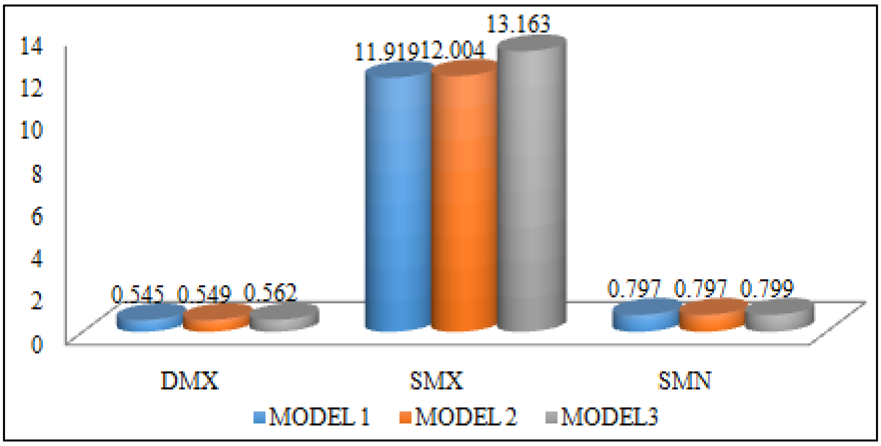
Figure 29

There was a maximum stress seen at the abutment implant interface of 2.27 Mpa and 1.261-2.018 Mpa through out the bone.

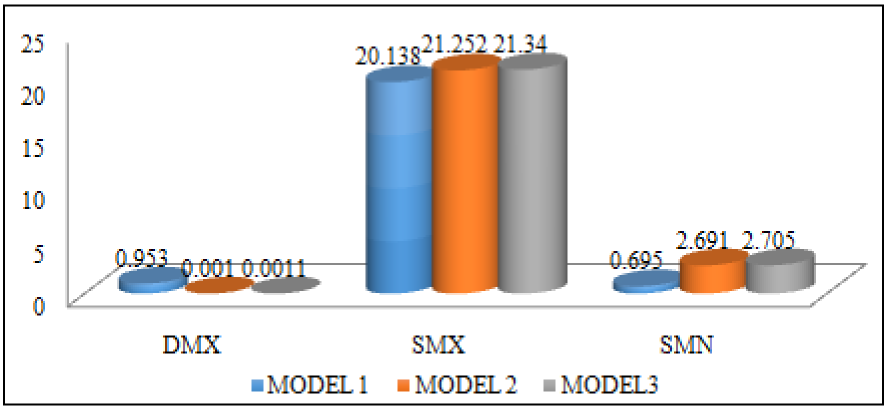
<u>Stress on Assembled Prosthesis</u>
On Vertical Loading of 100 N in MPa



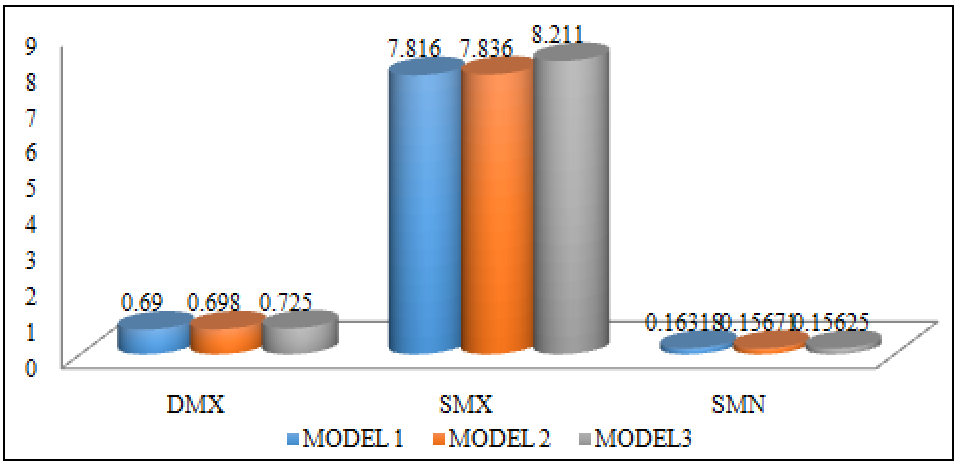
<u>Stress on Implant</u>
On Vertical Loading of 100 N in MPa



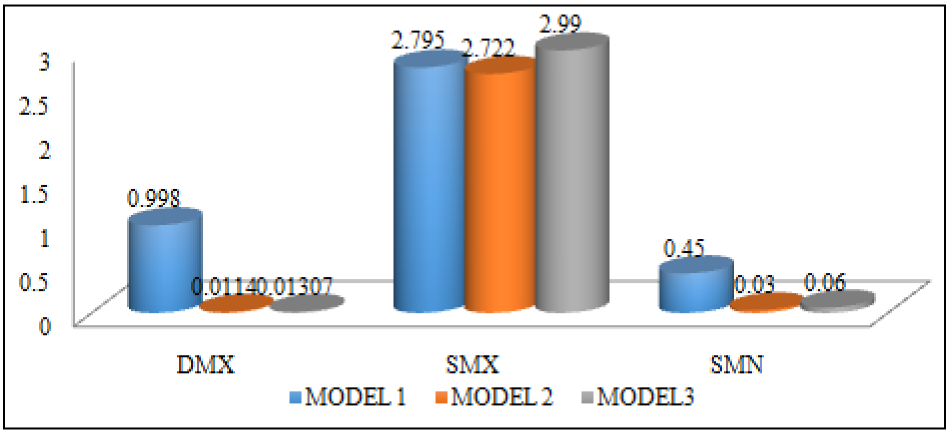
Stress on Abutment
On Vertical Loading of 100 N in MPa



Stress on Abutment Screw
On Vertical Loading of 100 N in MPa

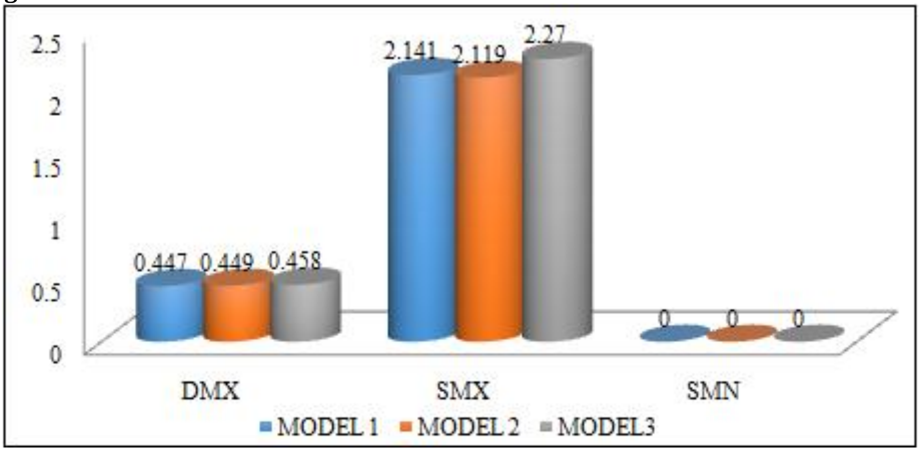


Stress on crowns
On Vertical Loading of 100 N in MPa



Stress on bone

On Vertical Loading of 100 N in MPa



4. Discussion

The success rate of implant therapy has had its impact on prosthodontic treatment considerations. The complications of implant-supported prostheses can be divided into biological and mechanical problems, a significant proportion of which are accounted for by screw loosening[12]

Problems have been observed after a single tooth implant-supported restoration has been inserted. One and three-year follow-up studies on teeth restored with the Branemark system single tooth implant restorations reported that the most common problem encountered was abutment screw loosening[16]

The favorable clinical outcomes in many retrospective and prospective analysis imply that tilting does not negatively affect the outcome of implant therapy. Also, finite element analysis (FEA), indirectly address the issue of implant tilting for single implant restorations. The use of finite element modeling (FEM), a designing tool well suited to the analysis of complex stress and strain fields in and around dental implants, is becoming more widespread. The finite element method has been applied to dental field to predict stress distribution patterns in the implant- bone interface not only for comparison of various root-form implant designs, but also by modeling various clinical scenarios and prosthetic designs. This method offers the advantage of solving complex structural problems by dividing them into smaller and simpler interrelated sections by using mathematical techniques.

Screw-joint stability involves a number of critical factors, with three of the most important being

1) Adequate pre-load
2) The precision of the fit of the mating implant components and
3) The basic antirotational characteristics of the implant-to-abutment interface.
4) Application of the correct torque to an implant screw is translated into a pre-load that holds the components together.[17]

After screws loosen, metal fatigue may result in screw fracture. Although either the prosthetic retaining screw or the abutment screw can fail, it is the abutment screw of the two-stage systems that most frequently fractures. This is because occlusal forces are magnified by the long lever arm to the abutment-fixture interface which is located at the alveolar crest.S[17]

Laboratory tests on models and theoretical calculations have indicated that tightening torque had a significant effect on screw loosening. It would appear that more than 10 Ncm of tightening torque should be recommended for the gold screws in this external hexagon implant system.(3)

As there is no long term data regarding the effect of different prosthesis design on abutment screw loosening, it is imperative for us to study non destructive stress analysis on such biomechanical assemblies so that the long term usage of this protocol is predictable. So this study was taken up.

There have been sufficient clinical data to prove that Screw loosening is one of the most commonly encountered post loading complication is screw loosening. This can lead to microgaps between the abutment and the implant leading to gingivitis and angular bone loss leading to implant failure over a period of time. Knowledge of possibility of abutment screw loosening in different types of implant retained prosthesis can provide an insight on prosthetic success to the dentist.

In this study an edentulous mandibular molar region was modeled to give as precise a picture of the clinical scenario as possible. This also enabled us, to represent a loading situation similar to those in the oral cavity to which the prosthesis is frequently subjected to while masticating and swallowing. The implants used in this study were of 4mm diameter and of 13mm length.

Resin as a veneer material has been proved to be beneficial in reducing impact stresses such as those that occur when the patient inadvertently bites on a hard object. Another advantage of resin is the relative ease with which it can be added to the framework and adjusted when necessary. So resin was the choice of veneer material in this study[27].

The Von Mises yield criterion is based on an internal energy concept. This concept states that “when the internal energy at a specific location in a structure exceeds a certain threshold limit, the structure will yield at this point." The stress component (the direct stresses) was incorporated in the Von Mises stress components. The structure is safe when the Von Mises stress is less than or equal to the absolute value of the yield stress in tension or compression as determined in a uniaxial tension of compression test on a sample of the same material.

The points of interest of stress concentration when individual assembled prosthesis model is loaded can be observed at bone level, implant level, crown level, abutment level and abutment screw level.

The stress in the model 3(Screw cement retained prosthesis) was much higher than the stress seen in the model 1(Screw retained prosthesis) and model 2(Cement retained prosthesis) because of lesser degree of micro movement between the components. The maximum stress was distributed around the implant,abutment and abutment screw interface. Maximum Von Mises stress was seen in the model 3(Table 2) on vertical loading which was around 21.34 MPa, in contrast to model 1 and model 2 and which was approximately around 20.138 and 21.252 MPa respectively. There was no much statistical significant difference between Model 1, 2 and 3.

Screw retained implant prosthesis, in all the three models showed very minimal stress. This could be because of the lesser components in the prosthesis, the absence of micromovement of crown due to absence of resin layer as compared to cement and screw cement retained implant prosthesis, resulting in greater resistance to deformation.

On vertical loading of 100N, the stresses were concentrated on the implant, abutment and abutment screw interface in all the models. This could be because of mechanism of stress transfer to the bone through the components.

In model 1, The assembly showed maximum stress in the region of implant abutment interface of 20.138 MPa and uniform stress of 8.95-11.188 MPa throughout the Prosthesis. The Implant showed maximum stress in the region of implant- abutment interface of 11.919 MPa and uniform stress of 5.74-9.447 MPa throughout the implant. The abutment showed maximum stress in the region of abutment- screw interface of 20.138 MPa and uniform stress of 5.016-15.817 MPa throughout the abutment. The abutment screw showed maximum stress in the region of screw threads of 7.816 MPa and uniform stress of 3.565-6.966 MPa throughout the screw. The crown showed maximum stress in the region of access hole interface of 2.795 MPa. And uniform stress of 1.267-2.49 MPa throughout the Prosthesis. Om model of bone, there was a maximum stress seen at the abutment implant interface of 2.141 Mpa and 0.95- 1.66 Mpa throught the bone.

In model 2, The assembly showed maximum stress in the region of implant abutment interface of 21.252 MPa. And uniform stress of 9.445-16.529 MPa throughout the Prosthesis. The Implant showed maximum stress in the region of implant- abutment interface of 12.004 MPa. And uniform stress of 5.778-10.759 MPa throughout the implant. The abutment showed maximum stress in the region of abutment- screw interface of 21.252 MPa. And uniform stress of 15.065-19.189 MPa throughout the abutment. The abutment showed maximum stress in the region of screw threads of 7.836 MPa. And uniform stress of 3.569-6.983 MPa throughout the screw. The prosthesis showed maximum stress in the region of occlusal surface of 2.722 MPa. And uniform stress of 1.23-2.423 MPa throughout the Prosthesis. On model of bone, There was a maximum stress seen at the abutment implant interface of 2.119 Mpa and 0.941641-1.883 Mpa through out the bone.

In model 3, The assembly showed maximum stress in the region of implant abutment interface of 21.34 MPa. And uniform stress of 9.484-16.595 MPa throughout the Prosthesis. The Implant showed maximum stress in the region of implant- abutment interface of 13.163 MPa. And uniform stress of 7.668-11.789 MPa throughout the implant. The abutment showed maximum stress in the region of abutment- screw interface of 21.34 MPa. And uniform stress of 15.128-19.269 MPa throughout the abutment. The abutment screw showed maximum stress in the region of screw threads of 8.211 MPa. And uniform stress of 5.526-7316 MPa throughout the screw.

The prosthesis showed maximum stress in the region of access hole interface of 2.99 MPa. And uniform stress of 2.016-2.666 MPa throughout the Prosthesis. There was a maximum stress seen at the abutment implant interface of 2.27 Mpa and 1.261-2.018 Mpa through the bone.

5. Clinical Inference

Within the limitations of the study the following clinical inferences can be obtained.

1) Screw cement retained prosthesis is one of the best option in restoring an implant, but however stresses on the abutment screw component seem to increase the incidence of abutment screw loosening.
2) Since the stress on screw cement prosthesis was seen to be high, there is increased chances of loosening of the abutment screw. So periodic recall and checkup of implant prosthesis and retorquing of screw becomes critical.

6. Future Directions

1) For a better understanding of the anatomy of a single edentulous region surrounded by teeth on either side, vital structure and to have a statistical significance, more number of CT Scans of different patients single edentulous arch should be modeled and the results should be studied upon to find a better clinically favorable situation.
2) The other edentulous area such as premolar and canines can also be studied with different treatment options
3) Newer type of materials like the all ceramic components should be subjected to stress analysis to know their efficacy.

7. Limitations of the Study

Though, the study was conducted in such a way as to try and simulate the clinical scenario as close as possible some limitations do exist when not directly dealing with a clinical case.

- It is an invitro simulation of an invivo situation.
- The data is gathered from an actual case scenario, any anatomic variations should be accounted for.
- Masticatory forces are dynamic in nature, whereas this study was conducted under alternative loads.
- Materials have their own properties when put together markes its characteristics which was not considered while modeling. Only young's modulus and poisons ratio was taken into account.
- Bone is a viscoelastic, anisotropic, and heterogeneous material, whereas, in the model used in the study, all materials were assumed to be linearly elastic, isotropic and homogeneous in nature. The resultant stress values obtained may not be accurate quantitatively though they are generally accepted qualitatively.
- The location and magnitude of stresses generated in response to the load applied in the study are pertaining to the finite element model design in this study. This may vary if there are alterations in model design, elastic properties incorporated and the direction of forces applied.

8. Conclusion

Within the limitations of this three-dimensional (3D) finite element analysis (FEA), the findings provide evidence that Screw Cement retained prosthesis has higher incidence of Screw loosening as compared to cement and screw retained prosthesis. No statistically significant difference was found on stress distribution in peri implant area between the three implant prosthesis.

Screw Cement retained prosthesis is one of a feasible option to be used as implant prosthesis considering its advantages over other implant prosthesis. Easy accessibility to the access hole makes it a better option amongst the three implant prosthesis. But validity and long term success of this treatment protocol has to be clinically evaluated.

9. Summary

A study was done to evaluate and compare masticatory load on abutment screw loosening of three types of implant prosthesis- screw, cement and screw cement retained prosthesis and its stress distribution in peri- implant area.

Within the limitations of the study, the study showed that:

1) In all the three models, vertical loading was not well distributed throughout the assembly.
2) In Model 1, it showed that the stress was well tolerated and distributed to the implant through the assembled prosthesis with stress concentration on border of access hole and abutment screw.
3) Model 2, it showed that the stress was distributed to the implant through the assembled prosthesis with stress concentration on implant and abutment interface.
4) Model 3, it showed that the stress was well tolerated and distributed to the implant through the assembled prosthesis with stress concentration on border of access hole and abutment and abutment screw. The stresses were significantly higher in this model compared to other two.
5) All the components showed maximum Von Mises stresses on the Screw cement retained prosthesis.
6) The maximum stress at the implant abutment and the abutment screw interface caused the bending moments in the abutment screw where stress was concentrated leading to fatigue and failure of components.
7) Model 3 being more rigid than model 1 and 2, stresses were more unevenly distributed throughout the components explains the increases fatigue rate.
8) In the peri implant area, maximum stress was found at the implant abutment interface and evenly distributed till the apex.
9) Screw cement retained having combined advantage of both Screw and Cement retained prosthesis can be used be considered prosthesis of choice as implant prosthesis.

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