ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

A Study on Stress Distribution of Different Preformed Crowns in Deciduous Mandibular Second Molar Using Finite Element Analysis

Received: 19 October 2022, **Revised:** 24 November 2022, **Accepted:** 26 December 2022

1. Anil T. Patil., Professor and Head, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

2. Srigiri Surath., Postgraduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

3. Sandhyarani B., Associate Professor, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University) Dental College and Hospital, Sangli, Maharashtra, India.

4. Prathamesh P. Nikam., Postgraduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

5. Tanaya R. Kulkarni., Postgraduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

6. Vriti Pursnani., Postgraduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

Department(s) and institution(s):
Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli, Maharashtra, India.

Corresponding Author:
Name: **Dr.Srigiri Surath**
Address: Postgraduate Student, Department of Pediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed to be University), Dental College and Hospital, Sangli- 416416, Maharashtra, India.
Phone numbers: +91 7758012833
E-mail address: surathsrigiri56@gmail.com

Keywords
Aesthetic crowns, Deciduous mandibular second molar, Finite element analysis, Preformed, Stress distribution

Abstract
Background: This study compared the stress distribution of different preformed crowns in deciduous mandibular second molar by using finite element analysis.
Materials & Methods: The study included 3D scan of sound deciduous mandibular second molar and its supporting tissues, which were converted from CBCT DICOM to STL by using MIMICS for generating 3D geometric model. A pulpectomy treated tooth obturated with zinc oxide eugenol and restored with GIC type II cement was modelled. Crown preparation was modelled to reduce all the enamel and 70% of the dentin. Then, the tooth preparation model was restored with the different crowns

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

luted using GIC type I cement; (Group 1: Pulpectomy treated restored tooth without crown, Group 2: Stainless steel crown, Group 3: Kids-e-Bioflx crown, Group 4: NuSmile zirconia crown, Group 5: Kids-e-zirconia crown). Hypermesh was used to generate the finite element meshed models, which were imported to ANSYS software and subjected to 245 N bite force at 00, 450, 900 load. Results were obtained in the form of von Mises stress distributions.
Results: Preformed aesthetic crowns shown less stresses along the underlying structures compared to preformed stainless steel crown. The stress patterns were within the safe range for crown models compared to model without crown.
Conclusion: Pulpectomy treated tooth when restored with appropriate crown can increase the life of tooth. FEA analysis can be used as guide to motivate parents about the importance of crown in children.

Introduction

The deciduous teeth are the best space maintainers for maintaining the length of the dental arch. Because of the rising prevalence of dental caries in today's scenario, executing numerous restorative treatments to maintain the functional integrity of the primary dentition has become necessary. All the restorative procedures, however, require the removal of decayed tooth structure. [1,2] The weakened tooth is then reinforced to withstand the better masticatory stresses with restorative materials such as amalgam, resin modified glass ionomer cement, resin filled composites, stainless-steel crowns.[3]
Preformed stainless steel crowns (SSC) are the most effective, long-lasting, and reasonably priced restorative material.[4] But, their use in clinical practice is still limited due to the poor aesthetics offered.[3] Prefabricated zirconia crowns which are more translucent, anatomically contoured, aesthetically pleasing, bio-inert, and having good wear resistance are employed as an excellent aesthetic restorative material. Recently, Bioflx crowns (Kids-e-dental, LLP, India) made up of resin polymer which do not require subgingival preparation are introduced. Hence, preformed aesthetics crowns are gaining popularity as an alternative to preformed stainless-steel crowns. [4,5]
Biting and chewing results in the transmission of masticatory forces mediated along the crown structure to the teeth. Biomechanical evaluation of extracted tooth and restorative materials in vitro utilize destructive mechanical tests for analysing the tooth behaviour and provide limited information about the internal behaviour of the structures being studied. [6,7] Researchers routinely utilise three-dimensional Finite Element Analysis (3-D FEA) to observe the stress distribution following dental restoration or prosthesis using various 3D models, and it is now widely regarded as a non-invasive and outstanding method for complex stress analysis of overlaying structures.[8,9] However, very few studies have been undertaken to evaluate the efficacy of preformed stainless-steel crowns with that of preformed aesthetic paediatric crowns as full coverage paediatric restorations using finite element analysis. But there are some lacunae in comparing finite element analysis stress distribution between different preformed aesthetic crowns with preformed stainless-steel crowns as most of these studies did not consider the surrounding structures of the tooth. Hence, the goal of this study was to examine the

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

stress distribution of various prefabricated crowns used in children on supporting tooth structure and the periodontium by using a 3D finite element model.

Materials And Methods

Materials:

- Cone beam computed tomography (CBCT) in a Digital Imaging and Communication in Medicine (DICOM) format
- Materialise Interactive Medical Image Control System (MIMICS)
- Hypermesh (version 11; Altair system Inc.,)
- Analysis of Systems (version 18., ANSYS Inc., Canonsburg, Pennsylvania) to generate desired finite element analysis models and analysis.

Groups:

Group 1 - Pulpectomy treated restored tooth without crown

Group 2 - Stainless-steel crown (3M ESPE, USA)

Group 3 - Kids-e-Bioflx crown (Kids-e-dental, LLP, India)

Group 4 - NuSmile zirconia crown (light shade) (NuSmile ZR Primary Crowns, Houston, TX, USA)

Group 5 - Kids-e-zirconia crown (Kids-e-dental, LLP, India)

Methodology:

Inclusion Criteria:

- Non- carious, sound deciduous mandibular second molar.
- Healthy children of 6-7 years age.

Exclusion Criteria:

- Medically compromised and special children.
- Considerable curvature of roots or other anomalies of tooth.

Source of Data:

- The study was carried out after obtaining the written consent from the patient's guardian and by using a CBCT scan (DICOM format at 0.5 mm intervals) of a 6-year-old child with sound non-carious deciduous mandibular second molar which was taken for anterior tooth trauma evaluation during last year. Single sample per group (total five groups) were selected according to prior studies for finite element analysis of stress distribution considering crowns.

Method of data collection:

Development of the tooth model:

The 3D scan of the tooth was transformed from CBCT DICOM to stereolithographic (STL) formatted file, by using MIMICS for generating 3D geometric models. [8,10] The tooth was modelled with its basic parts consisted of enamel, dentin and a pulp chamber with its corresponding pulp. [8,10] A periodontal ligament zone with a 0.25 mm thickness was constructed to surround the outer portion of the two roots. [8] Cortical (2 mm thick) and spongy bone models were prepared with the inner part representing the spongy bone with 14 mm diameter and 22 mm height, which was covered by cortical bone (diameter of 16 mm and height of 24 mm). [11] A pulpectomy treated tooth obturated with zinc oxide eugenol and restored with glass ionomer cement (GIC), [GC Fuji type II, Gold Label, GC Corporation, Tokyo, Japan] was reconstructed using MIMICS. Then, on the same model crown preparation is modelled such that, only 30% of the dentine was left behind to imitate a grossly destructed tooth and was crowned with respective crowns over it using GIC luting cement (GC Fuji Type I, GC Corporation, Tokyo, Japan). [2,10] The tooth geometry was exported to the finite element program in the STL file format [Figure 1]. [11]

Mesh generation:

Finite element analysis uses nodes which make a grid called mesh. Hypermesh [9] was utilized here to generate the finite element model by processing geometric models [Table 1]. The Poisson's ratio, modulus of elasticity values of the materials was attributed to the model after the importation into the software [Table 2]. The materials were assumed to be homogeneous, isotropic, and linearly elastic. The meshed models were imported to ANSYS for analysis [Figure 2]. [2,10]

Boundary conditions

The models received occlusal load at a constant intensity of 245 N to simulate a mastication load. The load was applied on the teeth at three points on the outer inclines of the buccal cusps and two points on the inner inclines of the lingual cusps. The analysis was carried out in three directions 0^0 (vertical), 45^0 (oblique), 90^0 (lateral) along the long axis of the tooth [Figure 2].[11]

The stress patterns and values on application of load was calculated based on the von Mises dimensional criterion. [2]

Results

The von Mises stresses were visualized in color coding ranging from dark blue (minimum stress) to red (maximum stress). In all the model's maximal stresses are restricted to the crown with major stress areas being the dentin structure with very little penetrating to the underlying periodontal ligament and bone [Table 3]. [1]

On vertical load (0^0):

The maximum von Mises stress on dentin with vertical load were greater with group 4 (306.545 MPa) followed by group 3 (283.189 MPa) and least vertical stress were seen on group 5 (178.255 MPa) with majority of stresses concentrated at middle 3rd of inner surface of the root dentin. At 0^0 load the group 3 (26.4625, 198.374, 33.9046 MPa) and group 4 (26.4578, 198.351, 33.8989 MPa) shown to exhibit more or less similar stress distribution on periodontal ligament, cortical bone and cancellous bone respectively, while the group 2 (10.7907, 86.9439, 14.5222 MPa), group 5 (10.7936, 86.8793, 14.5264 MPa) and group 1 (10.6879, 88.1736, 14.4972 MPa) has shown to exhibit analogous stress distribution pattern [Figure 3].

On oblique load (45^0):

The maximum stress on dentin with oblique load were greater for group 2 (221.14 MPa) and group 4 (216.458 MPa) followed by group 5 (200.7 MPa). Least vertical stresses concentrated at cervical 3rd of the external surface of the crown dentin seen with group 1 (196.926 MPa) followed by group 3 (199.966 MPa). At 45^0 load all the crowns shown to transmit more or less similar amount of stress on the underlying periodontal ligament, cortical and cancellous bone [Figure 4].

On lateral load (90^0):

Stress patterns changed with load directions. Considering all the structures of the tooth and different models involved, the higher von Mises stresses were noted on lateral loading followed by vertical load and comparatively less with oblique load. The higher stress on the dentin structure at the lateral loading were observed with group 2 (337.867 MPa) and group 4 (334.463 MPa) followed by group 1 (300.596 MPa) and lower stress on the dentin at lateral loading were observed with group 3 (281.048 MPa) [Figure 5].

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

Discussion

Pulpectomy treated teeth exhibit decreased flexibility, increased brittleness, and a higher susceptibility to fracture, therefore, preformed crown placement following the pulpectomy procedure has demonstrated to have a high success rate. Atieh M et al. (2008) stated that, the British Society of Paediatric Dentistry authorised the placement of crown following pulpotomy or pulpectomy procedures. [3]

Preformed stainless-steel crowns have long been considered as the gold standard, yet they are also regarded as aesthetically unappealing crowns. Currently there is wide concern among the parents of the children regarding the aesthetic appearance of their child's teeth. Alrashdi M et al. (2021) mentioned that prefabricated zirconia crowns appear to be a good alternative to preformed metal crowns in term of esthetics, parental satisfaction, gingival health, retention, and resistance to fracture. [4,5] Important clinical steps for zirconia crown retention include tooth preparation and the bond strength of the luting cement between the tooth and the crown. Zirconia crowns are more time consuming, cannot be trimmed and are not flexible. So, these crowns are usually not recommended in anxious and uncooperative patients. Another concern for zirconia crowns is that, when contaminated with blood or saliva they tend to have lesser adhesion to the cement, to address this issue NuSmile developed the try-in pink crown. [5] But with the latest innovations and recent advancements, crown manufacturers are trying to minimize these factors. Recently a relatively newer alternative prefabricated aesthetic crowns like Kids-e-Bioflx crowns are introduced, which are tooth colored new age crowns made up of high strength hybrid resin polymer material that are semiflexible, semi-adjustable, do not require subgingival preparation, and are easy to place with less enamel or dentin removal as their tooth preparation is similar to that of preformed stainless-steel crowns. Hence, they can be considered a good aesthetic crown option for children who are afraid or unable to cooperate.[5]

The advent of finite element analysis has made researchers to use a 3D FEA model to simulate the oral cavity and to evaluate the stress distribution on various tooth structures and restorative materials. In a study conducted by Gurbuz et al. in 2008 stated that, the von Mises criteria used in finite element analysis, provide a way to analyse the effect of forces on restoration, to convert normal and shear stress into single stress to obtain significant results.[12] However, very few studies have been conducted till date using finite element analysis to evaluate stress distribution of preformed aesthetic crowns on underlying tooth, periodontal ligament and bone. Hence, present study aimed to evaluate stress distribution of different preformed crowns on deciduous mandibular second molar and its surrounding structures by using finite element analysis. The von Mises stresses are calculated based on a combination of all principal stresses in order to provide more general information about stress distribution. [13,14] Because the variables may be manipulated with computer precision, chance variation resulting from sampling error is eliminated. The same finite element analysis repeated 100 times will produce equivalent results every time. Thus, it is certain that the results are always caused by the manipulation of the variables and not by chance. For this reason, sample size selection and statistical analysis are not applicable to an FEM study. Instead, the data were interpreted using visual, qualitative and quantitative comparisons similar to the previous studies conducted (Holmes D C et al. 1996; Demirel A et al. 2019). [15,16]

According to Sachdeva A et al. (2015) and Waly AS et al. (2021) the mandibular teeth especially the second primary molar are more prone to caries than the maxillary teeth amongst both males and females; hence, it is the most common molar that receives the crown. Therefore, in this study primary second mandibular molar was selected. [11, 17] Rentes AM et al. (2002) and Prabhakar AR et al (2015) in their study mentioned that in the primary dentition the biting forces range between 161-330N and considered 245N as an average force. Hence, in our study a force of 245N was allocated to each model in order to mimic the various physiologic masticatory settings. [13,18]

In the present study, the results showed that on the application of force, maximum von Mises stress was taken up by the dentin and minimal stress was transmitted to the underlying periodontal ligament, cortical and cancellous bone. For all the models, the maximum stresses were found to be concentrated mainly on the middle third of the internal root surfaces and to a lesser extent on the external root surfaces. These results were in accordance with the Demirel A et al. (2019) who conducted a study on primary mandibular second molars without permanent successors to analyse whether or not the increase in masticatory forces from childhood to adulthood provoke stresses in the tooth and the supporting tissues that can lead to pathological root resorption, ankylosis and infraocclusion in tooth and periodontal tissue. In this study he found that in both the models (simulating child and adult masticatory conditions), the stress values raised with age with compressive stresses seen on internal root surfaces, while the tensile stresses focused on the furcation area and external root surfaces. [15]

In the current study, the results demonstrated that lateral forces applied at 90° generated the highest von Mises stresses in the dentin structure of preformed stainless-steel crown than that of the preformed aesthetic crowns, while lower stress on the dentin was observed with Kids-e-Bioflx crown (281.048 MPa). Overall, lesser von Mises stresses were delivered to the underlying periodontal ligament, cortical and cancellous bone in all the models. These results were in accordance with Prabhakar AR et al. (2017), who conducted an invitro study utilizing two finite element models of primary maxillary second molar both with the analogous amount of tooth structure, one restored with preformed stainless steel crown and the other with preformed zirconia crown and then the finite element models were exported to ANSYS software and subjected to an average simulated bite force of 245N. The results displayed that preformed zirconia crowns and their underlying dentin were subjected to lesser von Mises stresses and they concluded that a grossly destructed tooth restored with a preformed zirconia crown can withstand stress effectively than a tooth restored with a preformed stainless-steel crown. [2]

Alamoudi RA et al. (2022) conducted a 3 year (2014 to 2017) interventional study on

232 pulpectomy treated primary teeth. Researchers investigated the potential clinical outcome of NuSmile primary zirconia crowns (172 primary incisors and 60 primary molars) with 2 years follow up and concluded that NuSmile zirconia crowns preserve and maintain gingival health and have long-term survival rates with good retention and marginal integrity, indirectly preventing secondary caries.[19] In our study, NuSmile zirconia crowns exhibited overall greater stress distribution at 0^0, 45^0 and 90^0 on the dentin, periodontal ligament, cortical and cancellous bone compared to other preformed crowns.

Nischal M et al. in 2020 conducted an invivo study to assess the anatomical form, surface texture, marginal discoloration, marginal integrity, and secondary caries of three different types of crowns in 45 deciduous anterior teeth which were randomly selected and divided into three groups of 15 each: group I—Pedoform strip crowns, group II—Kids-e-crown, and group III—Luxa crown at different time intervals of 3, 6, and 9 months. Authors concluded that performed Kids-e-zirconia crown was the best among the three coronal restorations and are having high flexure strength with good ability to resist crack propagation. [20] In the present study Kids-e-zirconia crown has shown to exhibit overall less stress distribution at 0^0, 45^0 and 90^0 on the dentin, periodontal ligament, cortical and cancellous bone compared to other preformed crowns.

The finite element method is sometimes viewed as a less time-consuming process than experimental research, and therefore could minimize laboratory testing requirements. Due to the complexity of shape, properties, and boundary conditions of dental structures, comprehensive modelling can also quickly become very complex and time-consuming. Finite element analysis can provide information that would be impossible or difficult to acquire with experimental observations, but at the same time, finite element analysis cannot be performed without experimental input and validation. Although certain differences may remain between reality and the analyses, using the finite element method, as the numerical approach can approximate, otherwise inaccessible stress distributions within a tooth-restoration complex. Furthermore, the facility to visualize many of the consequences from finite element analyses has also undoubtedly helped researchers to more clearly convey their data, and helped to expand the discussion and dissemination of research findings that have contributed to improve oral health. [6]

Conclusion

When compared to investigations on the real models, using a finite element analysis the trials can be repeated, there are no ethical concerns, and it provides detailed insight into complex mechanical behaviour of restored teeth influenced by stress fields which are difficult to measure otherwise. FEA research should be supplemented with invitro experimental studies and clinical evaluation. [9, 21] The results of this study could be used as a tool to educate and motivate patients in clinical practice. The use of appropriate crown helps to provide an ideal occlusal scheme that allows proper physiologic contact points and prevents traumatic load, that may jeopardize the periodontal health of the pulpectomy treated tooth. [8]

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

References

[1] Hasan I, Frentzen M, Utz KH, Hoyer D, Langenbach A, Bourauel C. Finite element analysis of adhesive endo-crowns of molars at different height levels of buccally applied load. Journal of Dental Biomechanics. 2012;3.

[2] Prabhakar AR, Chakraborty A, Nadig B, Yavagal C. Finite element stress analysis of restored primary teeth: A comparative evaluation between stainless steel crowns and preformed zirconia crowns. International Journal of Oral Health Sciences. 2017 Jan 1;7(1):10.

[3] Atieh M. Stainless steel crown versus modified open-sandwich restorations for primary molars: a 2-year randomized clinical trial. International Journal of Paediatric Dentistry. 2008 Sep;18(5):325-32.

[4] Alrashdi M, Ardoin J, Liu JA. Zirconia crowns for children: A systematic review. International Journal of Paediatric Dentistry. 2022 Jan;32(1):66-81.

[5] Khatri A. Esthetic zirconia crown in pedodontics. International Journal of Pedodontic Rehabilitation. 2017 Jan 1;2(1):31.

[6] Soares CJ, Versluis A, Valdivia AD, Bicalho AA, Veríssimo C, Barreto BD. et al., Finite element analysis in dentistry-improving the quality of oral health care. Finite Element Analysis-From Biomedical Applications to Industrial Developments, Intech. 2012 Mar 30; 2:25-56.

[7] Desai Shrikar R, Shinde Harshada H. Finite Element Analysis: Basics and Its Applications in Dentistry. Indian Journal of Dental Sciences. 2012 Mar 1;4(1).

[8] Abuelenain DA, Ajaj R, El-Bab EI, Hammouda MM. Comparison of Stresses Generated within the Supporting Structures of Mandibular Second Molars Restored with Different Crown Materials: 3-D Finite Element Analysis (FEA). Journal of Prosthodontics. 2015 Aug;24(6):484-93.

[9] Saxena A, Chandak M. Finite Element Analysis (FEA) as a Decisive Tool for Study of Force Distribution in Dentistry. Scholars Journal of Dental Sciences. 2016; 3(10):278-283

[10] Hegde K, Suvarna R, Bhat S. Stress analysis in endodontically treated primary molar with and without stainless steel crown: A comparative finite element model study. Journal of Natural Science, Biology and Medicine. 2019 Jul 1;10(2):202.

[11] Waly AS, Souror YR, Yousief SA, Alqahtani WM, El-Anwar MI. Pediatric stainless-steel crown cementation finite element study. European Journal of Dentistry. 2021 Feb;15(01):077-83.

[12] Gurbuz T, Sengul F, Altun C. Finite element stress analysis of short-post core and over restorations prepared with different restorative materials. Dental Materials Journal. 2008;27(4):499-507.

[13] Rentes AM, Gavião MB, Amaral JR. Bite force determination in children with primary dentition. Journal of Oral Rehabilitation. 2002 Dec;29(12):1174-80.

[14] Gultekin BA, Gultekin P, Yalcin S. Application of finite element analysis in implant dentistry. Finite Element Analysis - New Trends and

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

Developments. Open Access Publisher 2012 Oct; 2:21-54.

[15] Demirel A, Sarı Ş. Are Increased Masticatory Forces Risk for Primary 2nd Molars without Successors? A 3D FEA Study. Journal of Clinical Pediatric Dentistry. 2019;43(1):64-8.

[16] Holmes DC, Diaz-Arnold AM, Leary JM. Influence of post dimension on stress distribution in dentin. The Journal of Prosthetic Dentistry. 1996 Feb 1;75(2):140-7.

[17] Sachdeva A, Punhani N, Bala M, Arora S, Gill GS, Dewan N. The prevalence and pattern of cavitated carious lesions in primary dentition among children under 5 years age in Sirsa, Haryana (India). Journal of International Society of Preventive & Community Dentistry. 2015 Nov;5(6):494.

[18] Prabhakar AR, Yavagal CM, Chakraborty A, Sugandhan S. Finite element stress analysis of stainless steel crowns. Journal of Indian Society of Pedodontics and Preventive Dentistry. 2015 Jul 1;33(3):183

[19] Alamoudi RA, Walia T, Debaybo D. Evaluation of the Clinical Performance of NuSmile Pedodontics Zirconia Crowns in Pulp-Treated Primary Teeth—2 Years Follow-Up Study. European Journal of Dentistry. 2022 Feb 23.

[20] Nischal M, Gupta T, Mehra M, Sadana G. Clinical Comparison of Three Tooth-colored Full-coronal Restorations in Primary Maxillary Incisors. International Journal of Clinical Pediatric Dentistry. 2020 Nov;13(6):622.

[21] Musani I, Prabhakar AR. Biomechanical stress analysis of mandibular first permanent molar; restored with amalgam and composite resin: a computerized finite element study. International Journal of Clinical Pediatric dentistry. 2010 Jan;3(1):5.

Table 1: Number of nodes and elements of each finite element mesh model

Zone	Nodes	Elements
Group 1	581351	397592
Group 2	578273	394273
Group 3	579237	395298
Group 4	578623	394892
Group 5	583026	399276

Table 2: Elastic modulus and Poisson's ratio of materials used in the model

Material	Elastic modulus (Gpa)	Poisson's ratio
Enamel [22]	80.35	0.33
Dentin [22]	19.89	0.31
Periodontal ligament [22]	0.069	0.45
Cancellous bone [22]	0.490	0.30
Cortical bone [22]	14.700	0.30

Zinc oxide eugenol cement [17]	5.4	0.35
GIC Type II cement [17]	12	0.3
GIC Type I cement [2]	10.8	0.3
Stainless-steel crown [2]	200	0.33
Kids-e-Bioflx crown	5.03	0.39
NuSmile zirconia crown	198	0.32
Kids-e-zirconia crown	250	0.28

Gpa - Gigapascal

Table 3: Showing maximum von Mises stress on different parts of tooth and its supporting tissues of pulpectomy treated restored deciduous mandibular second molar models

Structure	Group 1	Group 2	Group 3	Group 4	Group 5
Load: Vertical (0^0)					
Dentin stress	221.211	200.654	283.189	306.545	178.255
Periodontal ligament stress	10.6879	10.7907	26.4625	26.4578	10.7936
Cortical stress	88.1736	86.9439	198.374	198.351	86.8793
Cancellous stress	14.4972	14.5222	33.9046	33.8989	14.5264
Load: Oblique (45^0)					
Dentin stress	196.926	221.14	199.966	216.458	200.7
Periodontal ligament stress	18.5994	18.6839	18.6858	18.6825	18.7037
Cortical stress	140.205	140.07	140.076	140.06	140.413
Cancellous stress	23.8466	23.9386	23.9408	23.9368	23.9684
Load: Lateral (90^0)					
Dentin stress	300.596	337.867	281.048	334.463	290.912
Periodontal ligament stress	22.0356	21.8795	21.8804	21.8773	21.9274

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

Cortical stress	160.965	160.641	160.646	160.629	161.195
Cancellous stress	28.5226	28.315	28.3168	28.3122	23.3852

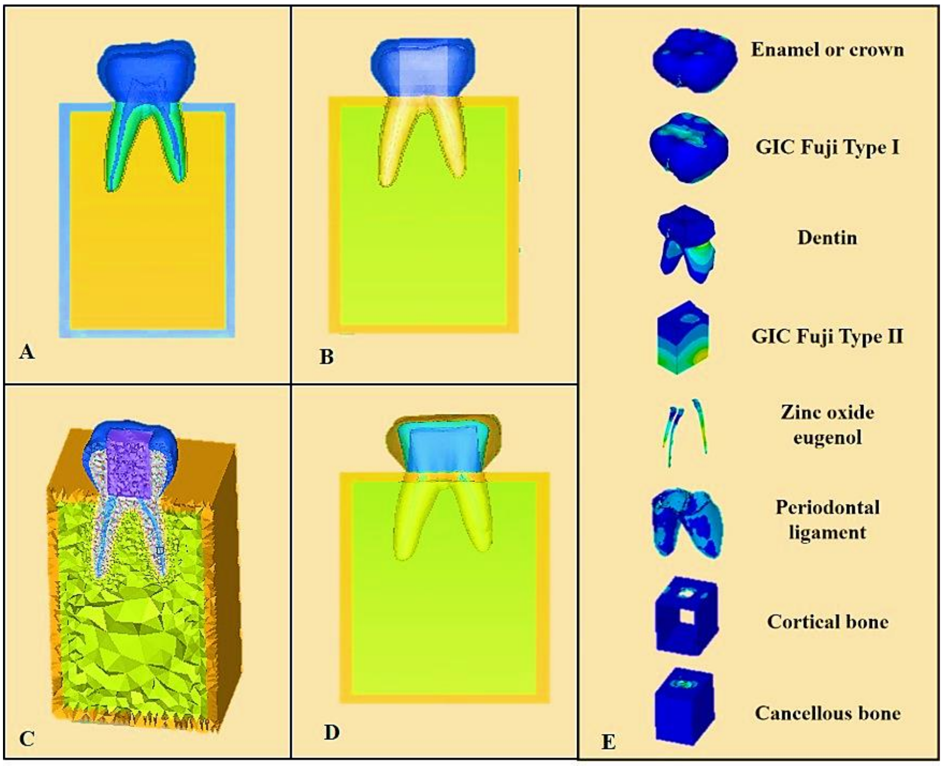

Figure 1: Showing 3D model reconstructed using MIMICS (A) Healthy tooth and its surrounding structures, (B) Pulpectomy treated restored tooth without crown, (C) Cross sectional view of pulpectomy treated restored tooth without crown, (D) Pulpectomy treated restored tooth with crown, and (E) Various components of pulpectomy treated restored tooth with crown

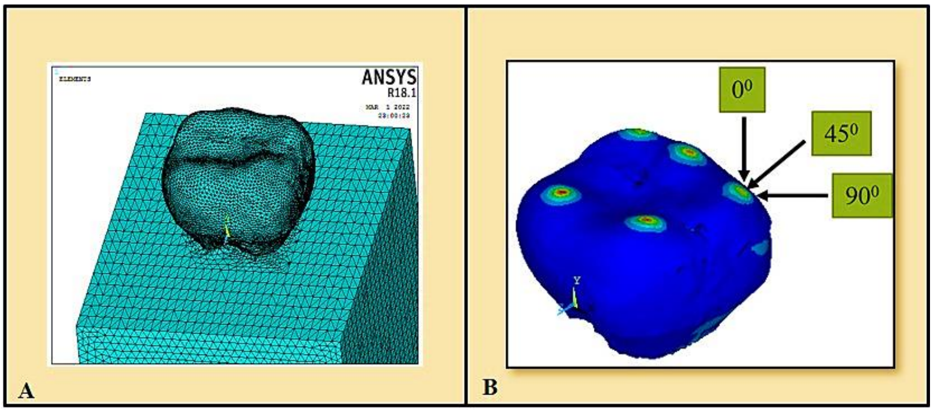

Figure 2: (A) Showing meshing of tooth model using Hypermesh, and (B) Showing loading points and direction simulating masticatory forces

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

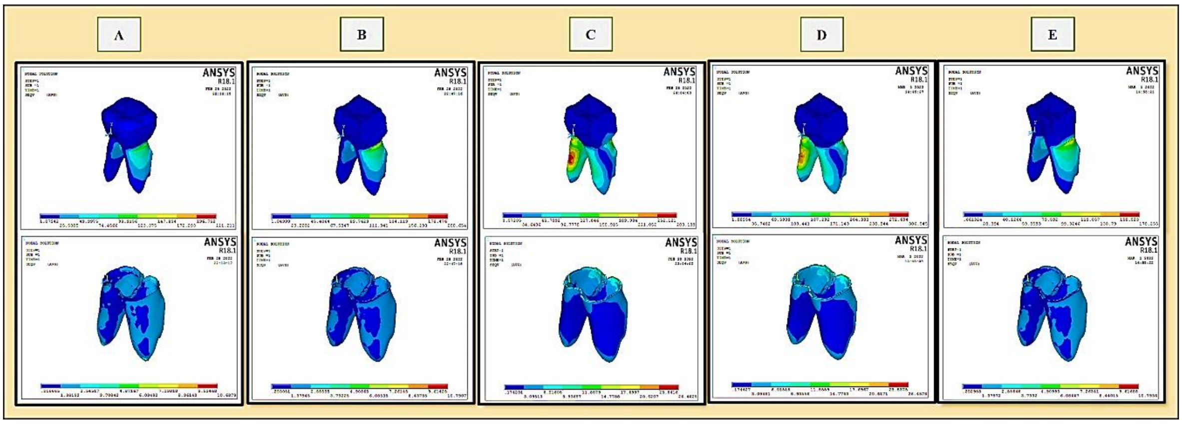

Figure 3: von Mises stress observed on vertical loading (0^0) on dentin, periodontal ligament, cortical and cancellous bone: Restored pulpectomy treated deciduous mandibular second molar (A) Group 1, (B) Group 2, (C) Group 3, (D) Group 4, and (E) Group 5

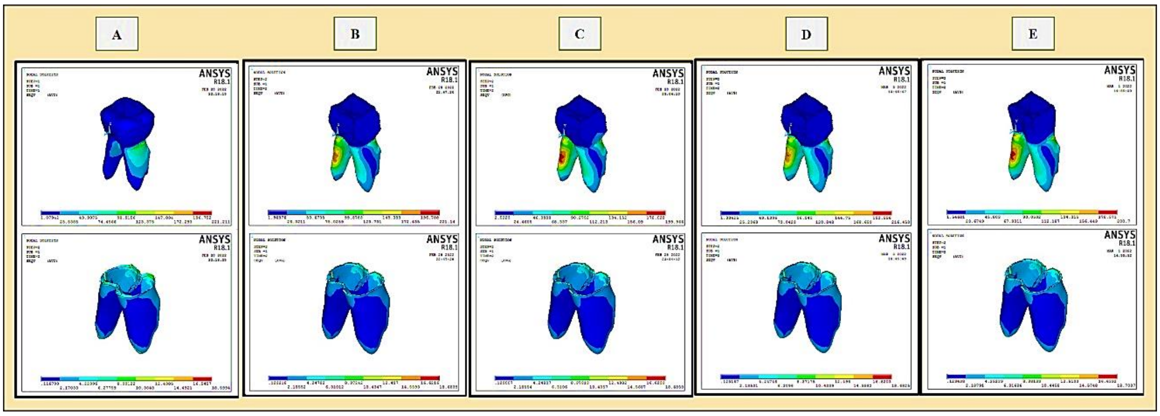

Figure 4: von Mises stress observed on oblique loading (45^0) on dentin, periodontal ligament, cortical and cancellous bone: Restored pulpectomy treated deciduous mandibular second molar (A) Group 1, (B) Group 2, (C) Group 3, (D) Group 4, and (E) Group 5

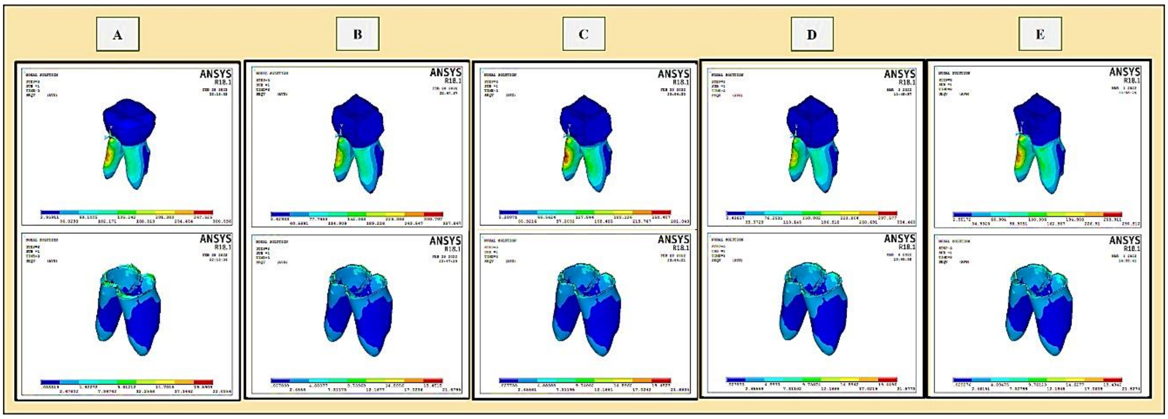

Figure 5: von Mises stress observed on lateral loading (90^0) on dentin, periodontal ligament, cortical and cancellous bone: Restored pulpectomy treated deciduous mandibular second molar (A) Group 1, (B) Group 2, (C) Group 3, (D) Group 4, and (E) Group 5