Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies ***NLM ID:*** *101716117*

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr Indian Citation Index (ICI) Index Copernicus value = 100

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Comparative Evaluation of the Effect of Different Post and Core Materials on Stress Distribution

[1]Vinay Kumar, [2]Shweta Mittal, [3]Mayank Arora, [4]Arun Kumar, [5]Jitendra Lohar

[1]Associate Professor, [2]Professor, [3]Assistant Professor, Department of Conservative and Endodontics, Postgraduate Institute of Dental Sciences, Rohtak, Haryana, India;
[4]Associate Professor, Department of Pedodontics and Preventive Dentistry, Postgraduate Institute of Dental Sciences, Rohtak, Haryana, India;
[5]Reader, Conservative Dentistry and Endodontics, Pacific Dental College and Research Centre, Udaipur, Rajasthan, India

ABSTRACT:
Background: To study and evaluate different post and core materials on stress distribution in radicular dentin. **Materials & methods:** A total of 4 models were enrolled. The models were divided into groups as Ni-Cr post-and-core restored with metal-ceramic restorations (MCRs). Data was collected and stress distribution was measured. The models were analyzed with regard to the stress distribution in dentin. Results were analysed using SPSS software. **Results:** A total of 4 central incisor models were analysed. Stress was examined. The VMS shows the location of the maximum stress without determining its nature. In all the models, stress concentration was detected at two areas of the root: the junction of the middle and cervical thirds of the root and at the gingival border. **Conclusion:** Cast posts induce lower stresses in dentin. ACRs caused the maximum stresses in dentin.
Keywords: post and core, stress distribution.

Received: 21 September, 2022 Accepted: 24 October, 2022

Corresponding author: Vinay Kumar, Associate Professor, Department of Conservative and Endodontics, Postgraduate Institute of Dental Sciences, Rohtak, Haryana, India

This article may be cited as: Kumar V, Mittal S, Arora M, Kumar A, Lohar J. Comparative Evaluation of the Effect of Different Post and Core Materials on Stress Distribution. J Adv Med Dent Scie Res 2022;10(11):65-67.

INTRODUCTION

An endodontically treated tooth is significantly weaker than a vital tooth and presents challenges in restoring it to form and function. Often, because of the minimal remaining tooth structure, posts are inserted to aid in the retention of the core. There are a number of options available in terms of materials for both the post and core, posts can be prefabricated or custom-made. The characteristics of the post include material elastic modulus, diameter, and height, which contribute greatly to the resistance to fracture of the restored tooth. [1] The selection of specific materials and techniques for the restoration of endodontically treated teeth is influenced by the changes that accompany root canal therapy, which include the amount of remaining tooth structure, physical changes in tooth structure, the anatomic position of the tooth, the occlusal forces on the tooth, the restorative requirements of the tooth, and the aesthetic requirements of the tooth. [2]

Restoration of endodontically treated teeth is challenging. Since the time Pierre Fauchard used gold, silver, or wooden dowels to retain crowns, various types of post-and-core systems have been introduced to dentistry. [3] Endodontic posts may be cast with the core, such as gold and nickel-chromium (Ni-Cr) posts, or they may be prefabricated, such as titanium and stainless steel posts. Recently, non-metallic posts such as fiber-reinforced composite (FRC) and ceramic posts have been introduced as theoretically acceptable alternative materials. [4,5] One of the functions of post-and-core systems is to improve the tooth's resistance by dispersing the functional forces along the root length. The material of a dental post is one of the factors affecting the stress distribution in dentin.[6,7]
Another important factor is the reduced root fracture susceptibility when using these posts, since fracture of the post or cementation interface may occur prior to root fracture, allowing of restoration of the tooth. [8] However, despite all these benefits of glass fiber posts

(GFP), their selection and indication are still not fully understood. [9] Little information exists regarding the selection of glass fiber post diameter for use in flared root canals. [10] For example, it is unclear whether a large- or small-diameter post should be used with large diameter canals. [10,11] Hence, this study was conducted to compare and evaluate different post and core materials on stress distribution in radicular dentin.

MATERIALS & METHODS

A total of 4 models were enrolled. The models were divided into groups as Ni-Cr post-and-core restored with metal-ceramic restorations (MCRs). The second group is glass fiber post with composite cores restored with MCRs. The third group included zirconia post-and-core restored with all-ceramic restorations (ACRs), and zirconia post with composite cores and ACRs. Data was collected and stress distribution was measured. The models were analyzed with regard to the stress distribution in dentin. Results were analysed using SPSS software.

RESULTS

A total of 4 central incisor models were analysed. Stress was examined. The VMS shows the location of the maximum stress without determining its nature. In all the models, stress concentration was detected at two areas of the root: the junction of the middle and cervical thirds of the root and at the gingival border. The Ni-Cr post core has the minimal stress around 18 between the middle and cervical one-third of root. The VMS in models is higher in zirconia post and composite core with ACR was 23.9 at the gingival border.

Table: maximum von mises stress (VMS) in models

Models			Max VMS (MPa)	
Post	Core	Crown	At the gingival border	Between the middle and cervical one-third of root
Ni-Cr	Ni-Cr	MCR	17.8	18
Glass fibre	Composite	MCR	22	19.3
Zirconia	Zirconia	ACR	23.2	19.4
Zirconia	Composite	ACR	23.9	19.2

Ni-Cr: nickel chromium, MCR- metal ceramic restoration, ACR- all ceramic restoration

DISCUSSION

The survival of endodontically treated and restored teeth depends on the amount of remaining coronal structure, restorative procedures, and material selection.[12] In particular, the preservation of at least one residual coronal wall or a circumferential 2-mm ferrule effect may contribute to overall tooth mechanical resistance.[13] Posts can be classified based on the elastic modulus, with metallic posts (prefabricated or cast metal posts), ceramic posts, and carbon fiber posts presenting high values and glass fiber posts presenting low elastic modulus.[14] The time needed for preparation, application, and esthetic performance have become important issues in daily practice, however, the strength and reliability of the system used are even more important.[15] During post and core treatment to restore a compromised endodontically treated tooth, the space is filled with a material that has a definite stiffness, unlike the pulp tissue and this creates an unnatural stress distribution within the tooth. Posts that are stiff materials, unlike pulp tissue, create unnatural stresses on restored teeth. [16]Hence, this study was conducted to compare and evaluate different post and core materials on stress distribution in radicular dentin.

In the present study, a total of 4 central incisor models were analysed. Stress was examined. The VMS shows the location of the maximum stress without determining its nature. In all the models, stress concentration was detected at two areas of the root: the junction of the middle and cervical thirds of the root and at the gingival border. A study by Nokar S et al, studied twelve 3D models of a maxillary central incisor were simulated in the ANSYS 5.4 software program. The models were divided into three groups. Each specimen was subjected to a compressive load at a 45-degree angle relative to its longitudinal axis at a constant intensity of 100 N. The first group showed the lowest stress levels in the cervical region, while the stress levels detected in the second group were higher than those in the first group and lower than those found in the third group. Fiber-reinforced posts induced a higher stress concentration between the middle and cervical thirds of the root compared to other posts. [17]

In the present study, the Ni-Cr post core has the minimal stress around 18 between the middle and cervical one-third of root. The VMS in models is higher in zirconia post and composite core with ACR was 23.9 at the gingival border. Another study by Lazari PC et al, studied six models which were built using micro-CT imaging data and SolidWorks 2007 software, varying the root canal (C) and the glass fiber post (P) diameters. Maximum principal stress (σmax) values were evaluated for the root dentin, cement layer, and glass fiber post. The most evident stress was observed in the glass fiber post at C3P1 (323 MPa), and the maximum stress in the cement layer occurred at C1P1 (43.2 MPa). The stress on the root dentin was almost constant in all models with a peak in tension at C2P1 (64.5 MPa). [18]

CONCLUSION

Cast posts induce lower stresses in dentin. ACRs caused the maximum stresses in dentin.

REFERENCES

1. Evaluation of stress distribution in an endodontically treated tooth restored with four different post systems and two different crowns- a finite element analysis. Nahar R, Mishra SK, Chowdhary R. J Oral BiolCraniofac Res. 2020;10:719–726.
2. A review on post and core. Kalra H, Sukhija H, Roy Rassawet R, Rani V. Sch J Dent Sci. 2020;7:51–56.
3. Ingle JI, Taintor JFJ. Endodontics. 3rd ed Lea &Febiger, Philadelphia, 1985:46–52.
4. Lanza A, Aversa R, Rengo S, Apicella D, Apicella A. 3D FEA of cemented steel, glass and carbon posts in a maxillary incisor. Dent Mater. 2005. August;21(8):709–15.
5. Ferrari M, Vichi A, Garcia-Godoy F. Clinical evaluation of fiber-reinforced epoxy resin posts and cast post and cores. Am J Dent. 2000. May;13(Spec No):15B–18B.
6. Hassan-Ahangari A, Geramy A, Valian A. Ferrule Designs and Stress Distribution in Endodontically Treated Upper Central Incisors: 3D Finite Element Analysis. J Dent (Tehran). 2008. February;5(3):105–110.
7. Geramy A, Eghbal MJ, Ehsani S. Stress distribution changes after root canal therapy in canine model: a finite element study. Iran Endod J. 2008. Fall;3(4):113–8.
8. Yang HS, Lang LA, Guckes AD, Felton DA. The effect of thermal change on various dowel-and-core restorative materials. J Prosthet Dent. 2001;86:74–80
9. Spazzin AO, Galafassi D, Meira-Júnior AD, Braz R, Garbin CA. Influence of post and resin cement on stress distribution of maxillary central incisors restored with direct resin composite. Oper Dent. 2009;34:223–229.
10. Boschian Pest L, Guidotti S, Pietrabissa R, Gagliani M. Stress distribution in a post-restored tooth using the three dimensional finite element method. J Oral Rehabil. 2006;33:690–697
11. Barjau-Escribano A, Sancho-Bru JL, Forner-Navarro L, Rodríguez-Cervantes PJ, Pérez-Gónzález A, Sanchez-Marín FT. Influence of prefabricated post material on restored teeth: fracture strength and stress distribution. Oper Dent. 2006;31:47–54
12. Adhesive dentistry and endodontics: materials, clinical strategies and procedures for restoration of access cavities: a review. Schwartz RS, Fransman R. J Endod. 2005;31:151–165.
13. Four-year survival of endodontically treated premolars restored with fiber posts. Juloski J, Fadda GM, Monticelli F, Fajó-Pascual M, Goracci C, Ferrari M. J Dent Res. 2014;93:52–58.
14. Randomized controlled trial comparing glass fiber posts and cast metal posts. Sarkis-Onofre R, AmaralPinheiro H, Poletto-Neto V, Bergoli CD, Cenci MS, Pereira-Cenci T. J Dent. 2020;96:103334
15. Effects of post material on stress distribution in dentine Chen XT, Li XN, Guan ZQ, Liu XG, Gu YX. 2004;4:302–305.
16. Evaluation of stress distribution in an endodontically treated tooth restored with four different post systems and two different crowns- a finite element analysis. Nahar R, Mishra SK, Chowdhary R. J Oral BiolCraniofac Res. 2020;10:719–726.
17. Nokar S, Bahrami M, Mostafavi AS. Comparative Evaluation of the Effect of Different Post and Core Materials on Stress Distribution in Radicular Dentin by Three-Dimensional Finite Element Analysis. J Dent (Tehran). 2018 Mar;15(2):69-78. PMID: 29971124; PMCID: PMC6026308.
18. Lazari PC, Oliveira RC, Anchieta RB, Almeida EO, Freitas Junior AC, Kina S, Rocha EP. Stress distribution on dentin-cement-post interface varying root canal and glass fiber post diameters. A three-dimensional finite element analysis based on micro-CT data. J Appl Oral Sci. 2013 Nov-Dec;21(6):511-7. doi: 10.1590/1679-577720130203. PMID: 24473716; PMCID: PMC3891274.