University J Dent Scie 2024; Vol. 10, Issue 4

Restoration of endodontically treated tooth using BioHPP indirect restorative material: Case series

Abstract:
Endodontic therapy weakens the remaining tooth structure which demands their rehabilitation. Various treatment modalities exist for rehabilitation of severely debilitated endodontically treated tooth including Endocrown, Post and core and Richmond crown depending on the clinical situation. Post and core with Davies crown is a routine practice of rehabilitation of severely debilitated tooth. In endodontically treated tooth with inadequate inter-arch space, endocrown can be safely given, although, presence of atleast 2mm of circumferential enamel is necessary. In cases with inadequate inter-arch space and absence of adequate circumferential enamel, Richmond crown is indicated. Conventional materials for rehabilitation using these modalities have major disadvantage of their high modulous of elasticity which increases the chances of rehabilitation failure. BioHPP, a modified polyetheretherketone (PEEK) can safely replace the conventional materials because of striking advantage of its modulus of elasticity which is similar to that of tooth structure. This case series presents the clinical situation-based rehabilitation of endodontically treated tooth using BioHPP as restorative material. 1.5 years follow-up showed satisfactory results paving the way for higher success rates of endodontically treated tooth with BioHPP as material of choice.

Key-words: BioHPP, Richmond crown, Endocrown, Post and core, PEEK, Adoro composite

Introduction:

Endodontic therapy weakens the tooth structure majorly because of loss of tooth structure due to caries, trauma and access cavity preparation.[1,2,3] Various treatment modalities for restoration of endodontically treated teeth with excessive coronal loss include post and core with Davies or Richmond crown, and Endocrowns.[4]

Certain clinical situations like Root canal treated teeth with narrow or calcified canals and tooth with sharp root curvatures or dilacerations does not allow the restoration to take retention from the root canals which necessitates restoration of such teeth using recent restorative option like Endocrowns. Also, with advancement in adhesive dentistry Endocrowns are becoming a more chosen treatment option because of more conservation of tooth structure. However, presence of adequate amount of enamel remains the pre-requisite for such treatment plan to ensure proper adhesion. In some Root canal treated teeth, where Davies crown has compromised retention because of limited interarch space, specially in anteriors, and where endocrown is not possible because of inadequate enamel, specially in posteriors, Richmond crown is the only option to rehabilitate the tooth. Richmond crown is not popularly used because of the high-stress generation around the post that leads to failure.[5] Such failures can be avoided by changing the material of Richmond crown.

Access this article online

Website: www.ujds.in

Quick Response Code

DOI: https://doi.org/10.21276/ujds.2024.10.4.19

[1]SHEFALI SINGLA, [2]PUNEETSAHORE, [3]MANISHAKHANNA, [4]CHARNPREET SINGH
[1-4]Department of Prosthodontics,
Dr. Harvansh Singh Judge Institute of
Dental Sciences & Hospital,
Panjab University, Chandigarh

Address for Correspondence: Dr. Manisha Khanna
MDS Student
Department of Prosthodontics and Crown and Bridge
Dr. Harvansh Singh Judge Institute of
Dental Sciences & Hospital,
Panjab University, Chandigarh, India
Email: manisha8khanna@gmail.com

Received : 2 April, 2024, **Published :** 31 Dec., 2024

How to cite this article: Singla, S., Sahore, P., Khanna, M., & Singh, C. (2024). Restoration of endodontically treated tooth using BioHPP indirect restorative material: case series. UNIVERSITY JOURNAL OF DENTAL SCIENCES, 10(4).

Common materials for fabrication of these prostheses include metal veneered with ceramics, all ceramic, zirconia or all metal.[6,7,8,9] Materials used for post and core include metal, zirconia, and fiber posts and endocrowns are fabricated with lithium disilicate glass based ceramic. Inherent brittleness of ceramics and frequent wear of opposing dentition by all ceramic or ceramic veneered restoration is a major limitation.[9] In restorations where retention for core is taken from root canal, metal posts increase the chance of unfavourable fracture.[5,8] Modulus of elasticity (MOE) of metals (Co-Cr – 200GPa) and zirconia ceramic (-200GPa) is much higher than that of the enamel (40-83GPa) and dentine (15GPa) which leads to higher amount of stress transferred to the tooth structure to be restored and hence increases the chances of fracture of the remaining tooth structure.[6,7,9,10] Prefabricated Fiber posts with lower MOE, don't exert unfavourable stress but have limitations in terms of their adaptability to the shape of root canal and strength.[8]

Common material for use of endocrown include lithium disilicate all ceramic crowns, metal ceramic crowns, indirect composite resin which have above said disadvantages.[11]

BioHPP (Biocompatible High Performance Polymer) can be used to avoid major disadvantages of current materials because of its MOE which is similar to that of tooth structure which makes the prosthesis and tooth structure nearly a single unit and hence ensures the uniform stress distribution. MOE of BioHPP also provides shock absorbing property. Added advantage of using BioHPP as restorative material for endodontically treated teeth include low plaque affinity, high polishability, and good wear resistance.[5,8, 12,13]

BioHPP has already been well explored with favourable viability as implant supported prosthesis framework and removable partial dentures framework clinically as well as in experimental studies.[13-18] There are In vitro studies supporting the use of BioHPP as endocrown and post and cores material but, clinical evidence to support its use as Endocrown, Richmond crowns and post and core is lacking.[8,9,20,21]

Present series presents 4 cases in which endodontically treated teeth have been restored using BioHPP as material of choice using different modalities.

Case Report:

Case 1: A 20 year old male patient reported to the department of Prosthodontics with chief complaint of broken tooth due to trauma since 11 years. Clinical and radiographic examination revealed Elle's class III fracture and root canal treated #21. Customised BioHPP post and core retained crown made of BioHPP coping layered with Adoro composite was planned. Post space was prepared and indirect impression made using autopolymerising resin. (DPI RR Cold cure) BioHPP pellets (BioHPP; bredent GmbH & Co KG) were pressed into the post and core mold using lost wax technique. Before cementation, root canal was cleaned using 96% ethanol followed by saline irrigation and then dried using paper points. Tooth structure was surface treated using mixture of ED Primer A and B (ED Primer A and B, Kurary) which was air dried after 30 seconds.[20] Intaglio of BioHPP post was sandblasted using 50um Al_2O_3 micro particles for 15 seconds at 2.7atm pressure followed by application of visio.link bonding agent. (Bredent)[10,22,23,24] After surface treatment of all the surfaces, post and core was cemented using dual cure resin cement (panavia F2.0, Kurary).[22] [Figure 1] Impression of #21 with cemented post and core was made using alginate impression material and BioHPP crown with layered Adoro composite (IvoclarVivadent) was fabricated. Intaglio of BioHPP crown was sand blasted with 50 um Al_2O_3 particles, followed by visio.link bonding agent application and cementation using panavia resin cement. (Panavia F2.0 Kurary)[22] [Figure 2]

Figure 1- Cemented BioHPP post and core wrt #21

Figure 2 – Cementated BioHPP crown wrt #21

Case 2: A 37 year old male patient came to the department with chief complaint of dislodged filling in his right upper back tooth region. Dental history revealed root canal treated #17 two months back. Patient had no relevant medical history. Intra-oral examination revealed faulty restoration with

respect to #17 and decreased crown height space. Restoration of #17 was planned using BioHPPEndocrown. Crown height was reduced using round wheel diamond point (shofu #111; ISO #045) to provide occlusal clearance of 1.5mm, restorative material from the pulp chamber was removed and walls of pulp chamber were made divergent upto 6-8 degrees to ensure absence of any undercut using tapered flat end diamond point (shofu#20; ISO#016).[23] After tooth preparation, two stage dual consistency impression of maxillary arch was made using addition silicone. (Coltene, President) Pressed PEEK pellets were used to fabricate Endocrown coping using lost wax technique over which layering of Adoro composite was done. [Figure3] Cementation protocol followed was same as in previous case. [Figure 4]3

Figure 3 – BioHPPendocrown layered with Adoro composite

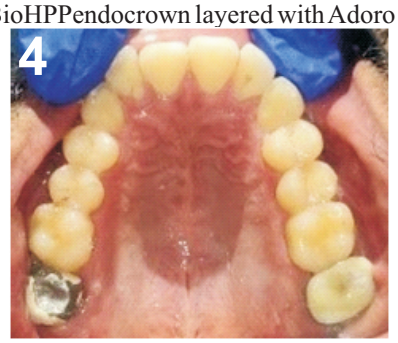

Figure 4 - Cemented Endocrownwrt #17

Case 3: A 38year old female patient reported to our department with chief complain of broken tooth cap in her right upper front tooth region. Clinical and radiographic examination revealed root canal treated and prepared #11 tooth with inadequate interarch space and little coronal tooth structure. BioHPP Richmond crown was planned for its rehabilitation. Post space was prepared with apical 1/3rd gutta percha left to maintain the apical seal. [Figure-5] Post space was recorded using self-cure acrylic resin and pick-up impression was made using single step double consistency addition silicone impression material. BioHPP Richmond crown layered with Adoro composite was fabricated. [Figure 6] Cementation of Richmond crown was done following same protocol as in case 1.

Figure 5 : IOPA after post space preparation

Figure 6: Extra-oral and Intra-oral image of BioHPP Richmond crown layered with Adoro composite

Case 4: A 27 year old male patient reported with chief complaint of lost tooth cap in his left lower back tooth region. Clinical and radiographic examination revealed root canal treated, prepared #36 tooth with decreased interarch space. A Richmond crown using distal canal for primary post and mesiolingual canal for secondary anti-rotational posts was planned. [Figure 7]

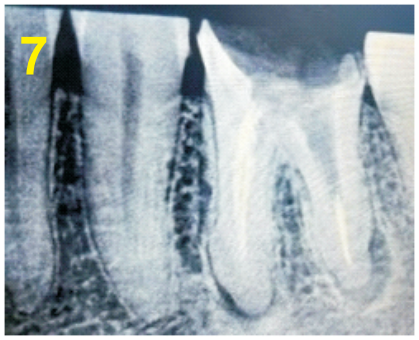

Figure 7- IOPA wrt #36 after post-space preparation

Post space and full coronal contour was recorded in self-cure acrylic resin. (DPI RR Cold cure) This was duplicated in tooth coloured self cure resin using alginate as investment material to be used as interim restoration which was cemented using non-eugenol zinc phosphate temporary cement. (Freegenol, GC) [Figure 8] BioHPP Richmond crown using lost salt technique with Adoro composite layering was prepared as final restoration which was cemented following the same bonding protocol as in case1. [Figure 9]

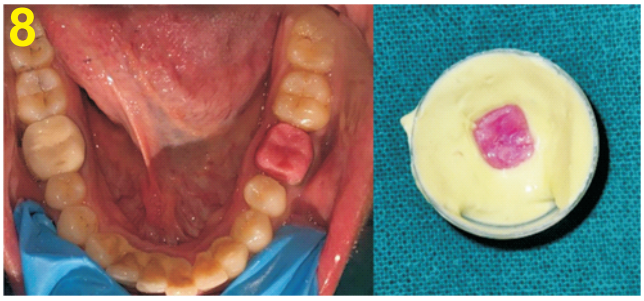

Figure 8 – Post space and full coronal contour recorded in self-cure acrylic resin and duplicated in alginate as investment material

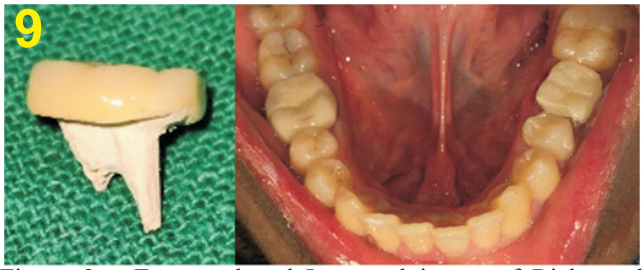

Figure 9 – Extra-oral and Intra-oral image of Richmond crown layered with Adoro composite

Discussion:

This case series described the rehabilitation of endodontically treated teeth having otherwise poor prognosis with Davies crown, Endocrown and Richmond crown made of BioHPP. MOE of BioHPP (4GPa) is closer to that of enamel and dentine (15GPa) than metals (Co-Cr – 200GPa). So, it transfers less stress to remaining tooth structure which improved the prognosis of the tooth by decreasing the chances of unfavourable fracture.[12] In case report 1, widened root canal of #21 led to the decreased amount of surrounding root canal structure which was not capable to resist the load transferred by the metal post for long period of time. Use of BioHPP post ensured increased survival of the debilitated endodontically treated tooth. In case report 2, endocrown was planned since the clinical situation with inadequate crown height demanded extra-retention. Presence of adequate circumferential enamel and advanced adhesive dentistry allowed the execution of conservative treatment option of endocrown. Butt joint preparation design was chosen because of advantages like better fracture resistance, better marginal adaptation and more enamel preservation which is pre-requite for adhesion and hence better retention.[24,25,26,27] In case 3 and 4 also, inadequate inter-occlusal space was present but Richmond crown instead of endocrown was planned because of unavailability of adequate circumferential enamel which obligated to take the retention from the root canals. Debonding of BioHPP prosthesis might be a concern according to some in vitro studies.[9] To avoid debonding, proper surface treatment measures specially for BioHPP restoration were taken. Sandblasting with 50um Al_2O_3particles increased the surface roughness and created fresh and active surface which augmented micro-mechanical interlocking. Visio.link which is a Pentarythritoltriacrylate (PETIA) based adhesive, was chosen since it has proven to be better in modifying the inert PEEK surface.[12,28] 1.5 years of follow-up of these clinical cases did not reveal any signs of debonding. One limitation of using BioHPP for post and core, Richmond crown and endocrown cases is its radiotranslucency that limits the practitioner to evaluate its fit specially in root canals.

5-10 year long follow-up period is required to give idea about the long-term performance of BioHPP post & core, endocrown and Richmond crown with respect to wear and survival rate.

Conclusion:

BioHPP is a new generation material that replaces the conventional materials for rehabilitating endodontically treated teeth because of the major advantages of its MOE, shock absorbing property and esthetics. This case series provides the clinical evidence of simple procedure and satisfactory outcome of restoration of endodontically treated tooth.

Clinical Significance:

Compatible physical and mechanical properties of BioHPP can be utilized to rehabilitate the severely debilitated endodontically treated tooth. Success with such restorations can be achieved by providing adequate preparation design according to the clinical case present. Following strict bonding protocol also majorly contributes to success of BioHPP restorations.

References:

1. Chevalier J. What future for zirconia as a biomaterial?. Biomaterials. 2006 Feb 1;27:535-43. [https://www.sciencedirect.com/science/article/abs/pii/S0142961205007039]
2. Olusile AO, Oginni A. Restoration of endodontically treated teeth: a review The Nigerian. Postgraduate Medical Journal. 2004;11:50–7. [https://pubmed.ncbi.nlm.nih.gov/15254573/]
3. Goodacre CJ. Five factors to be considered when restoring endodontically treated teeth Practical Procedures &. Practical Procedures& Aesthetic

Dentistry. 2004;16:457–62. [https://www.researchgate.net/publication/8261073_Five_factors_to_be_considered_when_restoring_endodontically_treated_teeth]

4. Chahal S, Rathee M, Alam M, Singh S, Divakar S. Saving the pulpless teeth: Approaches to conserve the tooth with severe coronal destruction: A case series. *BLDE Univ J Health Sci*. 2023;8:183. [https://doaj.org/article/9dc37424c83b45b0a042c11595085931]
5. Aparna J, Maiti S, Jessy P. Polyether ether ketone - As an alternative biomaterial for Metal Richmond crown-3-dimensional finite element analysis. J Conserv Dent. 2021 Nov-Dec;24(6):553-7. [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9089765/
6. Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature: part 1. Composition and micro- and macrostructure alterations. Quintessence International. 2007;38(9):733–43.
7. Juloski J, Radovic I, Goracci C, Vulicevic ZR, Ferrari M. Ferrule effect: a literature review. J Endod. 2012;38(1):11–9. [https://pubmed.ncbi.nlm.nih.gov/17873980/]
8. Lee K-S, Shin J-H, Kim J-E, Kim J-H, Lee W-C, Shin S-W, et al. Biomechanical evaluation of a tooth restored with high performance polymer PEKK post-core system: A 3D finite element analysis. Biomed Res Int. 2017;2017:1–9. [https://pubmed.ncbi.nlm.nih.gov/28386547/]
9. Riyad A, El-Guindy F, Kheiralla J. Tensile Bond Strength of (PEEK) vs Lithium Disilicate Endocrown. Ain Shams Dental Journal. 2020;23:1–8. [https://asdj.journals.ekb.eg/article_140007_c0121fc502692270e0952d15a350400c.pdf]
10. Singh S, Appanna P, Manjunath KH, Rai N, Jingade RR, Muniswamy HK.Mechanical Behaviour of Ceramic Layered Zirconia Restorations: A Three Dimensional Finite Element Analysis using Microcomputed Tomography Data.J Clin of Diagn Res.2018;12(7):ZC39-ZC43. [https://www.researchgate.net/publication/326394385_Mechanical_Behaviour_of_Ceramic_Layered_Zirconia_Restorations_A_Three_Dimensional_Finite_Element_Analysis_using_Microcomputed_Tomography_Data]
11. M. Altier, F. Erol, G. Yildirim, and E. E. Dalkilic, "Fracture resistance and failure modes of lithium disilicate or composite endocrowns," *Nigerian Journal of Clinical Practice*. 2018.21:821–6. [https://pubmed.ncbi.nlm.nih.gov/29984710/]
12. Teixeira KN, Duque TM, Maia HP, Gonçalves T. Fracture resistance and failure mode of custom-made post-and-cores of polyetheretherketone and nano-ceramic composite. Oper Dent. 2020;45(5):506–15. [https://pubmed.ncbi.nlm.nih.gov/32101501/]
13. Zoidis P, Bakiri E, Polyzois G. Using modified polyetheretherketone (PEEK) as an alternative material for endocrown restorations: A short-term clinical report. J Prosthet Dent. 2017;117(3):335–9. [https://www.sciencedirect.com/science/article/abs/pii/S0022391316303614#:~:text=A%20modified%20polyetheretherketone%20(PEEK)%20framework,for%20an%20extensively%20damaged%20molar.]
14. Siewert B, De Alarcon P. Survival and Treatment success of full arch implant supported PEEK Prostheses. 5-year clinical retrospective study.2018. [https://www.researchgate.net/publication/331556356_Survival_rates_and_treatment_success_with_fullarch_implant_supported_polyetheretherketone_PEEK_prostheses_A_5_year_clincal_retrospective_study]
15. Al-Rabab'ah M, Hamadneh W, Alsalem I, Khraisat A, Abu Karaky A. Use of high performance polymers as dental implant abutments and frameworks: A case series report: High performance polymers as implant abutment. J Prosthodont. 2019;28:365–72. [https://pubmed.ncbi.nlm.nih.gov/28513977/]
16. Ahmed M, Diederich H, Ghaffar AE. Significance of Implant Distribution on a Screw-retained Implant-Supported Mandibular Hybrid Restoration of PEEK framework with Immediately Loaded Implants applying All-On-Six Protocol: A Two Years Clinical Study. Adv Dent & Oral Health. 2018;9:1–20. [https://juniperpublishers.com/adoh/ADOH.MS.ID.555751.php]
17. Ali M, Helmy E-D. Poly ether-ether ketone veneered with composite versus porcelain fused to metal full arch fixed screw retained prosthesis for atrophied mandibular ridges. One year randomized clinical and radiographic trial study. Egyptian dental journal.2020;66:2439–49. [https://edj.journals.ekb.eg/article_120843_9c944592e0ce7f357a10eb48ba8a537d.pdf]
18. Mustafa Ali S, Talawy DB. Clinical and radiographic outcomes of polyetheretherketone (peek) hybrid prosthesis used for "all on four. Rehabilitation of edentulous maxilla a short-term case series study Egyptian Dental Jourrnal. 2019;65:3699–712. [https://edj.journals.ekb.eg/article_76008.html]

19. Fonseca M, Molinero-Mourelle P, Buser R, Yilmaz B, Schimmel M. Fabrication of an implant-retained overdenture with ceramic crowns cementedon a polyetherketoneketone framework: A clinical report. J Prosthet Dent. 2022;128:1152–7. [https://pubmed.ncbi.nlm.nih.gov/33994192/]
20. Benli M, Eker Gümüş B, Kahraman Y, Huck O, Özcan M. Surface characterization and bonding properties of milled polyetheretherketone dental posts. Odontology. 2020;108:596–606. [https://pubmed.ncbi.nlm.nih.gov/31965408/]
21. Özarslan M, Büyükkaplan UŞ, Özarslan MM. Comparison of the fracturestrength of endodontically treated teeth restored with polyether ether ketone, zirconia and glass-fibre post-core systems. Int J Clin Pract. 2021;75:e14440. [https://pubmed.ncbi.nlm.nih.gov/34096673/#:~:text=Conclusions%3A%20PEEK%20post%2Dcores%20showed,glass%2Dfibre%20and%20zirconia%20posts.]
22. Pourkhalili H, Asli HN, Toreihi N, Falahchai M. Shear bond strength of different luting agents to polyether ether ketone. *Dent Res J (Isfahan)*. 2022;19:45. [https://pubmed.ncbi.nlm.nih.gov/35915713/]
23. Lin, J., Lin, Z. & Zheng, Z. Effect of different restorative crown design and materials on stress distribution in endodontically treated molars: a finite element analysis study. *BMC Oral Health.2020.***20**, 226. [https://pubmed.ncbi.nlm.nih.gov/32811484/]
24. Fadl, A. &Elsewify, Tarek. (2019). Fracture Resistance of Endodontically Treated Mandibular Molars Restored With Two Endocrown Designs (An In-Vitro Study). Egyptian Dental Journal. 65. 3745-50. [https://edj.journals.ekb.eg/article_76020.html]
25. El-Hefnawy W, Ahmed A, El-Mekkawi W. Fracture resistance of CAD/CAM fabricated polyetheretherketone (PEEK) endocrowns and post retained crowns with two preparation designs. *Al-Azhar Dent J Girls*. 2022;9:225-33. [https://adjg.journals.ekb.eg/article_226923.html]
26. Inas A. Elalem, Rabab M. Ibraheem, Ahmed M. Hamdy. Clinical evaluation of the marginal integrity, and internal fit of E-Max endocrown restorations with different marginal preparation designs.Ex-vivostudy. Journal of Dental and Oral Health. 2019 [https://www.researchgate.net/publication/334231296_Clinical_Evaluation_of_The_Marginal_Integrity_and_Internal_Fit_of_E-Max_Endocrown_Restorations_with_Different_Marginal_Preparation_Designs_Ex-Vivo_Study]
27. Soliman KM, Mandor MH, El Mekkawi W. Marginal adaptation of lithium disilicate endocrowns with different cavity depths and margin designs. *Al-Azhar Dent J Girls*. 2019;6:177-85. [https://adjg.journals.ekb.eg/article_42139.html]
28. Zoidis P. The use of modifiedpolyetheretherketone post and core for an esthetic lithium disilicate anterior ceramic restoration: A clinical report. Int J Prosthodont. 2021;34:120–5. [https://pubmed.ncbi.nlm.nih.gov/33570528/]