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Minimally Invasive Approach for Endodontically Treated Molar: Ceramic Inlay Onlay

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ABSTRACT

The amount of residual tooth structure stands as a paramount déterminants for the longevity of endodontically treated teeth. Recent advancements in endodontics and restorative dentistry have been oriented towards a paradigmatic transition from conventional practices to a more scientifically driven, conservative, and minimally invasive approach aimed at conserving maximal tooth structure. Inlay/onlay restorations have emerged as a conservative and efficacious modality for restoration posterior teeth afflicted with extensive cavitations, considering aesthetic, biological, and mechanical imperatives. However, the efficacity and durability of inlay/onlay restorations hinge upon achieving optimal coherence among clinical indications, preparatory protocols, material choices, and bonding techniques. This article presents a contemporary perspective on such partial restorations *via* a clinical case study, elucidating the restoration of a severely compromised mandibular molar utilizing an indirect CAD/CAM-fabricated ceramic inlay-onlay.

Keywords: Endodontically treated molar; Inlay-onlay; Ceramic; Minimally invasive approach

INTRODUCTION

The principles of tissue preservation and the therapeutic gradient have become crucial in the field of modern dentistry. The advancement of digital technology and the availability of improved aesthetic materials have fueled this transition. Adhesive techniques have substantially aided the adoption of a conservative strategy that prioritizes dental tissue conservation and limiting the requirement for extensive peripheral preparation during tooth restoration. The advancement of minimally invasive cosmetic dentistry has drastically altered how we restore devitalized teeth. Even in cases of mild deterioration, root-free prosthetic devices can now be used to treat these teeth.

Bonded indirect restorations have made significant advances in the field of restorative dentistry in recent decades. When it comes to dental structure restoration, they provide numerous benefits in terms of aesthetics, biological compatibility, and biomechanical factors. (IBCRs) are divided into two categories: anterior IBCRs, which comprise veneers and chips, and posterior IBCRs, which include inlays, onlays, overlays, veenerlays, and tabletops.

Among these possibilities, bonded ceramic inlays-onlays stand out as a modern, highly cosmetic, and cost-effective therapeutic option for the restoration of decaying teeth, whether *vital* or pulpless. The quality and durability of these restorations, however, are dependent on the careful alignment of clinical indications, adherence to preparation principles, careful material selection, and the implementation of appropriate bonding techniques.

CASE REPORT

A 45-year-old female patient, with no significant medical history, presented at the Fixed Prosthodontics Department at the dental clinic in Monastir seeking for treatment for her molar tooth (46).

Radiographic and clinical examinations revealed a deep cavity in the tooth, necessitating endodontic intervention. During the endodontic treatment procedure, an instrumental fracture occurred, leading to the misdirection at the mesial root. Due to technical difficulties, the case was referred to the endodontic department for completion of root canal shaping and root canal filling, particularly for narrow canals with calcifications.

After successful endodontic therapy, the prosthodontics management was planned to restore the compromised molar tooth (46). Initially, an all-metal Monoblock was considered for prosthetic restoration. However, during the preparation of the canal space, an unfortunate miscarriage occurred, resulting in a small cervical perforation.

Considering the high-risk endodontic history, including misdirection at the mesial root and the distal cervical perforation, the treatment plan was modified. Considering the patient's acceptable oral hygiene and favourable occlusion, a ceramic inlay-onlay was selected as the appropriate prosthodontics solution.

In this case, it is crucial to perform a cervical margin relocation using composite resin to optimize bonding and facilitate the impression-taking process. This step will enhance the overall success of the restorations (Figure 1-8).

Figure 1: Initial condition: Preoperative retro alveolar view Occluso-distal supraosseous decay.

Figure 2: Postoperative retro alveolar: Removal of fractured instrument and definitive root canal filling.

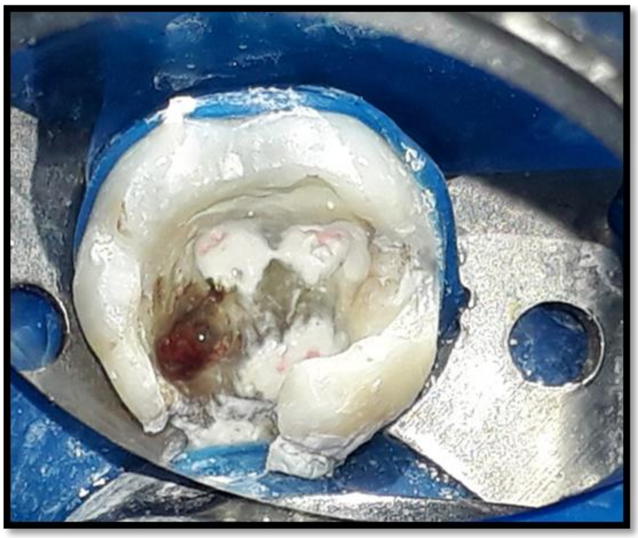

Figure 3: Root canal filling and perforation closure with biodentine.

Figure 4: After 21 weeks: Preparation for inlay-onlay while leaving a biodentine cavity base

Figure 5: Preparation architecture Preservation of biodentine: (cavity floor and filling of undercut areas) A distal juxtagival border.

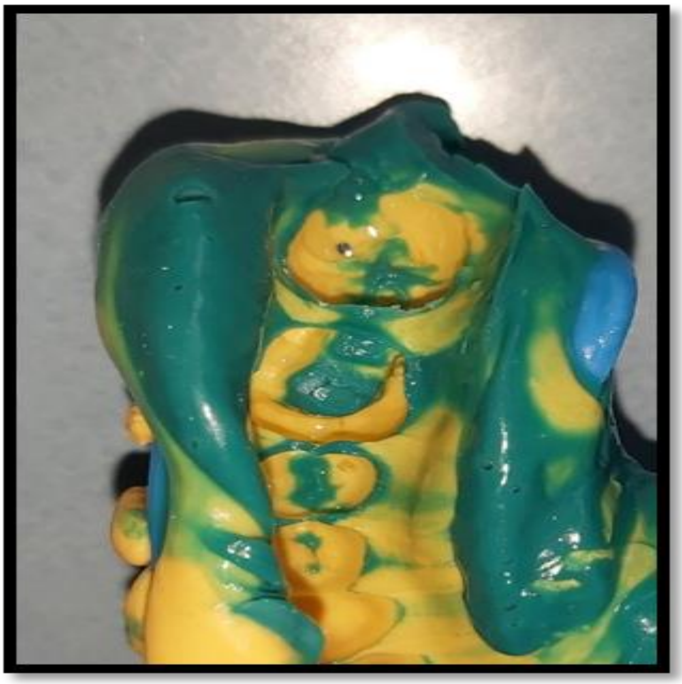

Figure 6: One-phase impression.

Figure 7: Prosthetic part: glass-ceramic (E-max).

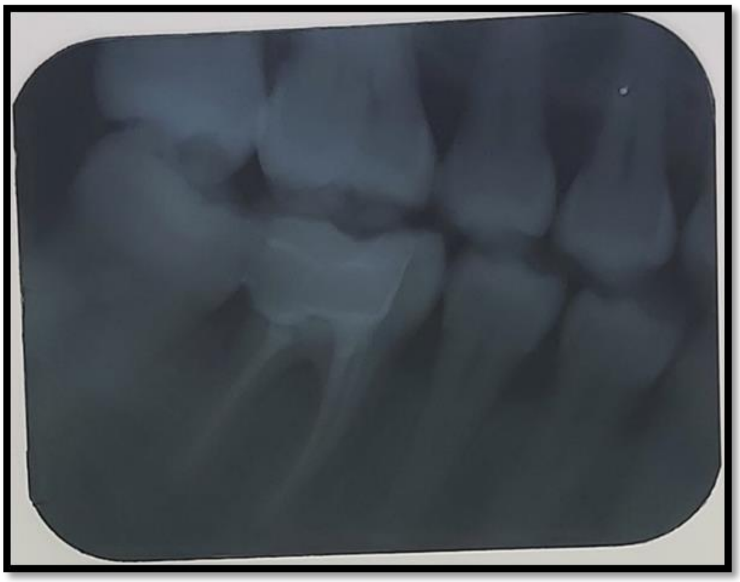

Figure 8: X Ray post bonding.

DISCUSSION

Endodontically Treated Teeth (ETT) exhibit an elevated susceptibility to fracture in comparison to their *vital* counterparts, primarily attributable to inherent structural distinctions and the consequential reduction in dental tissue [1-4]. The phenomenon of post-endodontic tooth fractures is a plausible consequence, arising from the diminution of dental substance during multifarious stages, encompassing endodontic access cavity preparation, manipulation of the root canal through instrumentation, execution of root canal filling procedures, and potential inadequacies in post space preparation and selection [5]. Remarkably, the process of endodontic access cavity preparation has been identified as a prominent contributor to the substantial loss of dental structure, ranking second in prevalence [6].

The challenge lies in restoring the lost fracture resistance resulting from cavity preparation. Effective restoration must ensure biomechanical performance akin to intact teeth, achieved through proper integration between root dentin, core reconstruction, and the final restoration [7].

Various restorative possibilities have been suggested for pulpless teeth, spanning from minimally invasive to more invasive approaches. These options encompass direct composite resin restorations, bonded partial restorations (including inlay-only, overlay, and endocrown), as well as full-coverage crowns, with or without a post [8].

From a biomimetic standpoint, the preservation and conservation of tooth structure are pivotal for maintaining a harmonious interplay among biological, mechanical, adhesive, functional, and esthetic parameters. The strategic preservation of coronal tissues, coupled with the avoidance of invasive endodontic procedures, assumes significance as these interventions can disrupt the delicate biomechanical equilibrium, thereby compromising the long-term performance of restored teeth [9].

The remaining vertical coronal tooth structure, referred to as the "ferrule," emerges as a critical factor integral to optimizing the biomechanical behaviour of endodontically treated teeth. However, clinical scenarios may present challenges where sufficient coronal structure is deficient, rendering teeth incapable of providing the necessary sound structure to establish a ferrule effect. This underscores the importance of addressing such inadequacies to enhance the biomechanical integrity of treated teeth [10-14].

When the remaining tooth structure falls below the threshold needed to support a crown (less than 2 mm in height), the application of a cast post-and-core becomes necessary to ensure the retention of the restoration. This method is typically recommended in cases where there is minimal or no coronal tooth structure available for antirotational features or bonding [15].

However, it's crucial to note that the traditional cast post-and-core technique is characterized by increased time demands and often incurs higher laboratory and material costs [16].

Moreover, this approach is associated with a higher risk of catastrophic failures, given that posts exhibit a higher elastic modulus compared to dentin [17].

Research has established that the use of a post, irrespective of the material type, may lead to catastrophic tooth failure [18].

The most identified failure types in both *invitro* studies and clinical observations are classified as either reparable or catastrophic. Repairable failures encompass cohesive and cohesive/adhesive fractures, minor damage, as well as chipping or cracking of the underlying tooth structure. On the other hand, catastrophic failures involve tooth or root fractures that necessitate tooth extraction [11,20-23].

Due to the additional removal of sound tissue required for post preparation, some studies have shifted their focus towards alternative post less treatments for Endodontically Treated Teeth (ETT).

Direct composite resin restorations find their principal indications in cases of teeth featuring minimal to moderate decay and devoid of noteworthy discoloration, particularly under favourable occlusal circumstances. They are directly placed within the cavity or defect, thus facilitating heightened preservation of the inherent tooth structure. However, in instances characterized by extensive cavity dimensions, the application of direct composite restorations entails substantial mechanical stresses induced by the polymerization shrinkage of the composite material. These stresses, incurred during the direct technique, have the potential to culminate in adverse outcomes such as recurrent caries, the emergence of cracks, or even fractures [23-24].

In our clinical case, the loss of substance occurs at the expense of a proximal wall with a loss of more than one-third of the buccolingual width. In such cases, the direct technique cannot be performed primarily due to mechanical reasons. Relative to the direct approach, the indirect method offers advantages including cusp protection and reinforcement of the compromised tooth.

Aquilino and Caplan (2014) discovered a significant difference in the results of endodontically treated posterior teeth with and without cuspal covering. Teeth without cuspal coverage had a six-fold higher rate of less than those with cuspal protection [25].

Cuspal replacement restorations should take tooth structure preservation and the type of restorative material into account. Among the several aesthetic treatment options available, bonded ceramic restorations are less invasive than full-coverage porcelain-fused-to metal crowns, which necessitate the removal of sound tooth tissue [26-28]. Within this context, partial restorations have assumed significance as a conservative therapeutic option. This is attributed to their favourable aesthetic outcomes, robust durability, sustained colour stability, wear resistance, biocompatibility, and noteworthy long-term survival rates [29-31]. The development of this restorative approach culminates in restrained tooth reduction during the preparation phase, thereby facilitating superior preservation of dental tissues. The classification of partial restorations is contingent on the targeted restoration area, yielding inlays (excluding cusp coverage), onlays (encompassing at least one cusp), and overlays (extending coverage over all cusps) [32-36].

Ceramic inlays and onlays represent *viable* options for the restoration of extensively damaged posterior teeth, demonstrating a notable survival rate. Notably, a study conducted by Nag Bhushan Mandal has reported a high success rate of posterior restorations using ceramics, with a survival rate of 92.21% [37]. The success of ceramic inlays/onlays hinges upon meticulous consideration of several factors, including appropriate patient selection based on suitable indications for this restoration type, meticulous material selection, and adherence to established principles governing preparation and bonding protocols.

Preparation protocols are dictated by three fundamental factors: the preservation of dental integrity, the material properties of the restorative substance employed [38-40], and the configuration of retention [41]. Nonetheless, substantial carious damage and the loss of tooth structure in posterior teeth undergoing endodontic therapy may preclude the creation of an "optimal" onlay inlay preparation scheme. In instances where a tooth lacks a cusp or exhibits partial cuspal fracture, an alternative approach to preparation design may prove necessary. Upon determining that an indirect restoration offers the most suitable treatment avenue, the clinician must consider the mechanical attributes of the restorative materials when configuring the geometric arrangement of the cavity [42,43].

Specific parameters must be strictly followed during the dental restoration process. These requirements include maintaining a consistent depth and width of the preparation, with a minimum width of 1.5 mm for composite restorations and 2 mm for ceramic restorations. The cavity's base should be flat, and the walls should have a divergence angle of no more than 10 degrees. Furthermore, the preparation's profile should have a wide fillet or shoulder with a rounded interior angle. The preparation's outermost boundary should be supragingival, and the upper limit should extend beyond occlusal impact zones, whether in the intercuspal occlusal position or during dynamic occlusion [44-47].

Restoring cavities with deep cervical margins can lead to two significant issues in clinical practice: biological concerns and technical challenges [48].

Biological issues involve the potential violation of the "biological width," which is a recommended gap of at least 3 mm between the restoration margins and the alveolar crest. [49].

This space is crucial to prevent harm to nearby soft and hard periodontal tissues. When this space isn't respected, there are two suggested solutions: surgical crown lengthening [50] or orthodontic tooth extrusion [51].

Technical challenges begin with difficulties in preparing the tooth in subgingival (below the gumline) areas and continue with challenges in making accurate impressions, bonding the restoration, and finishing and polishing the margins [52].

Most of these issues arise due to limited visibility and access to deep parts of the cavity, as well as difficulties in isolating the operating area with a rubber dam, which can lead to problems with moisture control and contamination by blood and saliva [53].

To simplify and reduce the chances of errors in these clinical procedures, a technique called "Cervical Margin Relocation" (CMR) was introduced by Dietschi and Spreafico in 1998. Similar terms like "coronal margin relocation", "Deep Margin Elevation" (DME) and "proximal box elevation" are also used in practice and literature. This technique involves applying composite resin in the deepest parts of the proximal areas to reposition the cervical margin above the gumline. This repositioning aims to improve isolation, enhance impression-taking, and optimize the bonding process for indirect restorations. In a way, CMR can be seen as a less invasive alternative to surgical crown lengthening [54].

Recent investigations have unveiled compelling evidence affirming the efficacy of this approach in mitigating ceramic fractures, particularly in scenarios where the preparation margin extends beneath the boundary delineated by the enamel-cement junction.

Various materials, including ceramics (such as conventional feldspathic ceramic, leucite-reinforced ceramic, and lithium disilicate ceramic), hybrid materials (like resin nanoceramic and hybrid ceramic), and composite resins, are employed in dental restorations [55,56]. This materials possess distinct chemical compositions that underlie their clinical characteristics.

Ceramic materials, while harder than composite materials and thus more resistant to wear, are also fragile and prone to fracture. This hardness can lead to surface wear on opposing teeth [57,58]. On the other hand, hybrid materials combine features of both ceramics and composites, boasting an elastic modulus like natural teeth. Like composite materials, they are easily adjustable, repairable, or modifiable.

A Systematic Review and Meta-Analysis conducted by Bustamante-Hernández N has shown that composite materials exhibited a lower survival rate at 90%, whereas hybrid and disilicate materials demonstrated higher survival rates at 99% and 98%, respectively. This aligns with findings from Mangani [59], who reported a superior survival rate for ceramic restorations (94.9%) compared to composite restorations (91.1%). Furthermore, consistent results were obtained from various studies, with ceramic restorations achieving an 88.7% success rate after 10 years, while composite resins exhibited a success rate of 84.78% after five years of follow-up [60-61].

When selecting a material for dental restoration, numerous criteria are considered. Considering the restoration of the opposing tooth is critical to achieve equivalent wear, thus use the same material for both teeth. The substrate to which the material attaches is important, with a preference for a material with a modulus of elasticity like tooth tissue to provide comparable deformation during functional movements. Glass-ceramic restorations are preferred for bonding to enamel, whereas composite restorations are suited for bonding to dentin. The presence of parafunctions such as bruxism should also be considered, as composite restorations are less likely to break in these circumstances. Composite is also the recommended material for repairs because it is easy to fix and reconfigure.

CONCLUSION

Severely damaged teeth with extensive lesions present a challenging situation for the practitioner to preserve valuable tooth structure and ensure a proper impression-taking and luting procedure. With the advances in the field of adhesive technology and materials, as well as the use of techniques such as CMR and CDO, a minimally invasive, defect-oriented restoration can be performed either chairside in one visit, or through a conventional approach. The approaches described in this case presentation are evidence- based; nevertheless, the combination of the several techniques and materials can be different in every case, depending on the clinical situation and the preferences of the practitioner.

REFERENCES

1. Udoye CI, Sede MA, Jafarzadeh H. The pattern of fracture of endodontically treated teeth. Trauma Mon. 2014;19(4):e17054.
2. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? J Endod. 1992;18(7):332-5.
3. Papa J, Cain C, Messer HH. Moisture content of vital vs endodontically treated teeth. Endod Dent Traumatol. 1994;10(2):91-3.
4. Basaran ET, Gokce Y. Evaluation of the influence of various restoration techniques on fracture resistance of endodontically treated teeth with different cavity wall thicknesses. Niger J Clin Pract. 2019;22(3):328-34.
5. Soares CJ, Rodrigues MP, Faria-E-Silva AL, Santos-Filho PCF, Veríssimo C, Kim H-C, et al. How biomechanics can affect the endodontic treated teeth and their restorative procedures? Braz Oral Res. 2018;32(suppl 1):e76.
6. Plotino G, Grande NM, Isufi A, Ioppolo P, Pedullà E, Bedini R, et al. Fracture strength of endodontically treated teeth with different access cavity designs. J Endod. 2017;43(6):995-1000.
7. Harsha MS, Praffulla M, Babu MR, Leneena G, Krishna TS, Divya G. The effect of cavity design on fracture resistance and failure pattern in monolithic zirconia partial coverage restorations - an in vitro study. J Clin Diagn Res. 2017;11(5):ZC45-ZC48.
8. Decup F. Inlay, Onlay, Overlay. 2éme. paris.France; 2022. 83 p.
9. Magne P, Belser U. Bonded porcelain restorations in the anterior dentition: a biomimetic approach. Batavia, Ill: Quintessence; 2003. Understanding the intact tooth and the biomimetic principle. p. 23-55.
10. Juloski J, Radovic I, Goracci C, Vulicevic ZR, Ferrari M. Ferrule effect: a literature review. J Endod. 2012;38(1):11-9.
11. Zicari F, Van Meerbeek B, Scotti R, Naert I. Effect of ferrule and post placement on fracture resistance of endodontically treated teeth after fatigue loading. J Dent. 2013;41(3):207-15.
12. Santos-Filho PC, Veríssimo C, Soares PV, Saltarelo RC, Soares CJ, Marcondes Martins LR. Influence of ferrule, post system, and length on biomechanical behavior of endodontically treated anterior teeth. J Endod. 2014;40(1):119-23.
13. Magne P, Lazari PC, Carvalho MA, Johnson T, Del Bel Cury AA. Ferrule-effect dominates over use of a fiber post when restoring endodontically treated incisors: an in vitro study. Oper Dent. 2017;42(4):396-406.
14. Lazari PC, Carvalho MA, Del Bel Cury AA, Magne P. Survival of extensively damaged endodontically treated incisors restored with different types of posts-and-core foundation restoration material. J Prosthet Dent. 2018;119(5):769-76.
15. Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod. 2004;30(5):289-301.
16. Heydecke G, Peters MC. The restoration of endodontically treated, single-rooted teeth with cast or direct posts and cores: a systematic review. J Prosthet Dent. 2002;87(4):380-6.
17. Torbjörner A, Fransson B. A literature review on the prosthetic treatment of structurally compromised teeth. Int J Prosthodont. 2004;17(3):369-76.

18. Figueiredo FE, Martins-Filho PR, Faria-E-Silva AL. Do metal post-retained restorations result in more root fractures than fiber post-retained restorations? A systematic review and meta-analysis. J Endod. 2015;41(3):309-16.
19. Magne P, Lazari PC, Carvalho MA, Johnson T, Del Bel Cury AA. Ferrule-effect dominates over use of a fiber post when restoring endodontically treated incisors: an in vitro study. Oper Dent. 2017;42(4):396-406.
20. Magne P, Goldberg J, Edelhoff D, Güth JF. Composite resin core buildups with and without post for the restoration of endodontically treated molars without ferrule. Oper Dent. 2016;41(1):64-75.
21. Silva NR, Raposo LH, Versluis A, Fernandes-Neto AJ, Soares CJ. The effect of post, core, crown type, and ferrule presence on the biomechanical behavior of endodontically treated bovine anterior teeth. J Prosthet Dent. 2010;104(5):306-17.
22. Zicari F, Van Meerbeek B, Scotti R, Naert I. Effect of fibre post length and adhesive strategy on fracture resistance of endodontically treated teeth after fatigue loading. J Dent. 2012;40(4):312-21.
23. Nandini S. Indirect resin composites. J Conserv Dent. 2010;13(4):184-94.
24. Pizzolotto L, Moraes RR. Resin Composites in Posterior Teeth: Clinical Performance and Direct Restorative Techniques. Dent J (Basel). 2022;10(12):222.
25. Aquilino SA, Caplan DJ. Relationship between crown placement and the survival of endodontically treated teeth. J Prosthet Dent. 2002;87(3):256-63.
26. Felden A, Schmalz G, Hiller KA. Retrospective clinical study and survival analysis on partial ceramic crowns: Results up to 7 years. Clin Oral Investig. 2000;4(4):199-205.
27. Magne P, Belser UC. Porcelain versus composite inlays/onlays: Effects of mechanical loads on stress distribution, adhesion, and crown flexure. Int. J. Periodontics Restorative Dent. 2003;23:543-55.
28. Frankenberger R, Taschner M, Garcia-Godoy F, Petschelt A, Krämer N. Leucite-reinforced glass ceramic inlays and onlays after 12 years. J Adhes Dent. 2008;10(5):393-8.
29. Krämer N, Taschner M, Lohbauer U, Petschelt A, Frankenberger R. Totally bonded ceramic inlays and onlays after eight years. J Adhes Dent. 2008;10(4):307-14.
30. Santos GC, Santos MJMC, Rizkalla AS, Madani DA, El-Mowafy O. Overview of Cerec CADCAM chairside system. Gen Dent. 2013;61(1):36-40.
31. Krämer N, Frankenberger R, Pelka M, Petschelt A. IPS empress inlays and onlays after four years- a clinical study. J Dent. 1999;27(5):325-331.
32. The Glossary of Prosthodontic Terms. J. Prosthet. Dent. 2017;117(5S):e1-e105.
33. Felden A, Schmalz G, Federlin M, Hiller KA. Retrospective Clinical Investigation and Survival Analysis on Ceramic Inlays and Partial Ceramic Crowns: Results up to 7 Years. Clin Oral Investig. 1998 :2(4):161-7.
34. Fuzzi M, Rappelli G. Survival Rate of Ceramic Inlays. J Dent. 1998 ;26(7):623-6.
35. Schulz P, Johansson A, Arvidson K, Schulz P, Johansson A, Arvidson K. A Retrospective Study of Mirage Ceramic Inlays over up to 9 Years. Int J Prosthodont. 2003 ;16(5):510-4.
36. Morimoto, S.; Rebello de Sampaio, F.; Braga, M.; Sesma, N.; Özcan, M. Survival Rate of Resin and Ceramic Inlays, Onlays, and Overlays: A Systematic Review and Meta-Analysis. J. Dent. Res. 2016, 95(9), 985–994.

37. Mandal NB, Kumari A, Baldev KC, Sarangi P, Chauhan R, Rajesh D, et al. A Clinical Evaluation of Onlay and Inlay in the Posterior Ceramic Restorations: An Original Study. J Pharm Bioallied Sci. 2022 Jul;14(Suppl 1):S310-S312..
38. Saridag S, Sevimay M, Pekkan G. Fracture resistance of teeth restored with all ceramic inlays and onlays: An in vitro study. Oper Dent. 2013;38(6):626-34.
39. Banks R.G. Conservative posterior ceramic restorations: A literature review. J. Prosthet. Dent. 1990;63(6):619–626.
40. Hopp CD, Land MF. Considerations for ceramic inlays in posterior teeth: a review. Clin Cosmet Investig Dent. 2013;5:21-32.
41. Ausiello P, Rengo S, Davidson CL, Watts DC. Stress distributions in adhesively cemented ceramic and resin composite class II inlay restorations: A 3D FEA study. Dent Mater. 2004;20(9):862-72.
42. Dejak B, Mlotkowski A, Romanowicz M. Strength estimation of different designs of ceramic inlays and onlays in molars based on the Tsai Wu failure criterion. J Prosthet Dent. 2007;98(2):89-100.
43. Etemadi S, Smales RJ, Drummond PW, Goodhart JR. Assessment of tooth preparation designs for posterior resin bonded porcelain restorations. J Oral Rehabil. 1999;26(9):691-7.
44. Emmanuel D, Zunzarren R. Evolution des formes de préparation pour inlays/onlays postérieurs à la mandibule. Réalités cliniques: revue européenne d'odontologie. 2014;25(4):317-26.
45. Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique [Internet]. Quintessence Verlags-GmbH. [cité 15 janv 2023]. Disponible sur: https://www. quintessence publishing.com/deu/en/article/852288 [10].
46. Restaurations_indirectes_posterieures.pdf [Internet]. [cité 16 janv 2023]. Disponible sur: https://www.colibri.ac/wpcontent/uploads/Restaurations_indirectes_posterieures. pdf [11].
47. Rocca GT, Rizcalla N, Krejci I, Dietschi D. Evidence based concepts and procedures for bonded inlays and onlays. Part II. guidelines for cavity preparation and restoration fabrication. Int J Esthet Dent . 2015 Autumn;10(3):392-413.
48. Veneziani M. Adhesive restorations in the posterior area with subgingival cervical margins: new classification and differentiated treatment approach Eur J Esthet Dent. 2010 Spring;5(1):50-76.
49. Ingber JS, Rose LF, Coslet JG. The "biologic width"-a concept in periodontics and restorative dentistry. Alpha Omegan. 1977 Dec;70(3):62-5.
50. Lanning SK, Waldrop TC, Gunsolley JC, Maynard JG. Surgical crown lengthening: evaluation of the biological width. J Periodontol . 2003 Apr;74(4):468-74.
51. Felippe LA, Monteiro Júnior S, Vieira, LC, Araujo E. Reestablishing biologic width with forced eruption. Quintessence Int . 2003 Nov-Dec;34(10):733-8.
52. D'Arcangelo C, Vanini L, Casinelli M, Frascaria M, De Angelis F, Vadini M, et al. Adhesive cementation of indirect composite inlays and onlays: a literature review Compend Contin Educ Dent. 2015;36(8):570-7; quiz 578.
53. Keys W, Carson SJ. Rubber dam may increase the survival time of dental restorations. Evid Based Dent. 2017 Mar;18(1):19-20.
54. Dietschi D, Spreafico R. Current Clinical Concepts for Adhesive Cementation of Tooth-Colored Posterior Restorations. Pract Periodontics Aesthet Dent. 1998;10(1):47-54; quiz 56.

55. Amesti-Garaizabal A, Agustín-Panadero R, Verdejo-Solá B, Fons-Font A, Fernández-Estevan L, Montiel-Company J, et al. Fracture Resistance of Partial Indirect Restorations Made With CAD/CAM Technology. A Systematic Review and Meta-Analysis. J Clin Med. 2019;8(11):1932.
56. Gracis S, Thompson V, Ferencz J, Silva N, Bonfante E. A New Classification System for All-Cermic and Ceramic-like Restorative Materials. Int J Prosthodont. 2015;28(3):227-35.
57. Fron Chabouis H, Smail Faugeron V, Attal J-P. Clinical Efficacy of Composite versus Ceramic Inlays and Onlays: A Systematic Review. Dent Mater. 2013;29(12):1209-18.
58. Solá-Ruíz MF, Baima-Moscardó A, Selva-Otaolaurruchi E, Montiel-Company JM, Agustín-Panadero R, Fons-Badal C, et al. Wear in Antagonist Teeth Produced by Monolithic Zirconia Crowns: A Systematic Review and Meta-Analysis. J Clin Med. 2020;9(4):997.
59. Mangani F, Marini S, Barabanti N, Preti A, Cerutti A. The Success of Indirect Restorations in Posterior Teeth: A Systematic Review of the Literature. Minerva Stomatol. 2015;64(5):231-40.
60. Goujat A, Abouelleil H, Colon P, Jeannin C, Pradelle N, Seux D, et al. Marginal and Internal Fit of CAD-CAM Inlay/Onlay Restorations: A Systematic Review of in Vitro Studies. J Prosthet Dent. 2019;121(4):590–597.e3.
61. Zimmer S, Göhlich O, Rüttermann S, Lang H, Raab W H-M Raab, Barthel CR. Long-Term Survival of Cerec Restorations: A 10-Year Study. Oper Dent. 2008;33(5):484-7.