

RENATA CHAŁAS¹, MARTA JURCZYKOWSKA¹,
RAFAŁ MARCZYŃSKI², ELŻBIETA PELS³

Composite inlays as a modern way of posterior restorations in the dental arch

Abstract

Modern restorative dentistry offers many methods of restoring qualitative cavities within the clinical crowns. Due to the concept of maintaining continuity of the dental arch and maintaining the correct plane of occlusion, for reconstruction of posterior teeth, there are especially recommended indirect restorations, which are made in the dental laboratory, i.e. crown inlays.

The aim of the study was based on the literature to describe indications, classifications and advantages of indirect composite inlays. Additionally, factors affecting the durability of indirect composite inlays and the influence on stomatognathic system were noted. Authors concluded that composite inlays can be recommended restoration method, not only in situations of loss of clinical crown tissue, but also in situations where it is necessary as structural reinforcement, e.g., in the case of Cracked Tooth Syndrome or Molar Incisor Hypomineralization.

Keywords: composite inlays, indirect restorations, posterior restorations.

DOI: 10.2478/pjph-2014-0023

INTRODUCTION

Progress in restorative dentistry and informing actively the public about the basic principles of oral hygiene result in a growing awareness among patients about the consequences of breaking the continuity of the dental arches, not only due to loss of teeth, but in case of the loss of hard tissues of the clinical crown. In addition, patients are becoming more and more aware of the opportunities offered by the materials used for reconstruction of tooth tissues, simultaneously expecting conservative treatment procedures from dental practitioners as much as possible in accordance with the principle that the performed reconstruction is not able to reproduce fully all the features of tissues. Clinical studies suggest that the smaller the scope of preparation for restoration, or permanent inlay, the more willingly the patients undergo the proposed procedure for reconstruction of dental arches in an aesthetic and, above all functionally correct way [1].

Modern restorative dentistry offers many methods of restoring qualitative cavities within the clinical crowns. Due to the concept of maintaining continuity of the dental arch and maintaining the correct plane of occlusion, for reconstruction of posterior teeth, there are especially recommended indirect restorations, which are made in the dental laboratory, i.e. crown inlays. This technique was introduced in order to minimize the disadvantages of composite restorations made directly in the oral cavity [2].

Disadvantages of direct restorations performed in the patient's mouth

Most of the disadvantages of direct composite restorations are inextricably linked to failures of the composite materials themselves. Despite the introduction of more and more new modifications of resins and fillers in composite resins, their negative qualities could only be minimized. When choosing the direct method in posterior teeth mainly material wear and marginal adaptation should be taken into account [3,4].

Marginal adaptation is inseparably connected with the polymerization shrinkage phenomenon, which depends not only on the material properties, but also on the method of its application to the cavity. The application depends on such factors as the method of applying the individual layers and their volume, the curing method and the type of curing light used. It should be emphasized that skills and experience of the operator are of great significance [2]. If the adhesion strength of the material to the hard tissues of the tooth exceeds 20 MPa [4,5], it will be able to withstand the force generated by the polymerization shrinkage. Otherwise, the restoration will not be bonded with tissues in an appropriate manner, thus creating the marginal micro leakage and penetration of microorganisms, the consequence of which would be postoperative hypersensitivity [3].

Occlusal wear of composite resins used for direct restoration in the patient's mouth has still by far worse performance than enamel wear; it is definitely greater. Aforementioned fact is all the more important that in posterior teeth

¹ Chair and Department of Conservative Dentistry and Endodontics, Medical University of Lublin, Poland

² Department of Prosthetics, Medical University of Lublin, Poland

³ Chair and Department of Paedodontics, Medical University of Lublin, Poland

the restorations must often cope with relatively high biting forces. One should be also aware of the increased occlusal wear of the composite resins within the contact surfaces. Due to the limited access of light generated by the polymerization lamp, it is far more difficult to achieve an appropriate degree of polymerization [5].

In addition to the failures of the restoration itself, one should not forget about the phenomenon of aging and gradual degradation of systems of bonding composite resins with tooth tissues [6].

The advantages of indirect composite restorations

The technique of indirect composite restorations was introduced to eliminate the disadvantages of direct composite restorations. The main aim was elimination of polymerization shrinkage. Crown inlays are polymerized outside the oral cavity on precise working models made of plaster, which enables precise control of the whole process of polymerization by a dental technician [6]. This results in the improvement of physical properties. In addition, limitation of the marginal fissure is of great importance, because polymerization shrinkage is limited only to the cementation, which is the bond between the restoration and tissues of the clinical crown. Additionally cement bases, on which restorations are applied, are not only bonded by the polymerization light, but also by chemical reactions.

An important advantage of using this indirect restoration method is increased resistance to compression, increased surface hardness and reduced risk of fractures and cracks in the internal structure of the material [7].

A positive feature of the indirect restorations is the possibility of extra-oral working. It allows for obtaining a high degree of surface smoothness, better polished, which is directly related to smaller adhesion of colorants and faster adaptation of the patient to the new conditions in the dental arches and the partial elimination of a foreign body in the mouth [8]. If correction is needed, the doctor may do it without the laboratory, even outside the oral cavity [9].

Crown inlays additionally allow for sharply-contoured restoration of tooth structure, such as points of contact, or the correct anatomical form of the occlusal surface of molars and premolars. The exact restoration of the walls and occlusal surface in aesthetic terms, it is not possible with the direct technique.

The classification of crown inlays

Crown inlays can be divided due to the amount of tissues needed for reconstruction into: inlays, onlays, overlays. Taking into account the material of which they are made, we can distinguish the uniform and complex inlays. The uniform ones include composite resin inlays, ceramic, metal inlays (at present mainly gold). The complex ones are mostly metal-ceramic, especially with the use of gold and its alloys. Most often used by clinicians are composite inlays, due to the simpler cementing algorithm formula and the ability to make small adjustments in the dentist's office. Patients pay particular attention to the lower cost compared to ceramic inlays [10].

The choice between direct and indirect restoration method in reconstructing posterior teeth crowns

In the case of reconstruction of posterior teeth a number of factors will be decisive about the method of choice (classical direct and indirect restoration) determining the proper maintenance of filling within the clinical crown. The decisive factor will be the quality and quantity of the remaining tissues in a tooth. It is important also to assess the tooth with regard to the position in the dental arch, occlusal conditions, the thickness of the remaining walls, the geometry of the cavity that conditions the retention of the restoration [11].

Indications for using the indirect method

Indications for performing indirect composite restorations are primarily situations where it is possible to use the remaining dental hard tissues, while there is such a level of degradation that the classical composite reconstruction would fail to meet its basic functional and aesthetic performance. The use of the indirect method is indicated in the following situations [9]:

- thin mined side walls,
- destruction of at least one cusp of the tooth,
- cavities exceeding the dimension of 1/3 to 1/2 of the distance between the peaks of cusps
- difficult to restore points of contact,
- teeth after endodontic treatment, with good quality of the remaining hard tissues,
- cavities located above the gingiva.

Using indirect composite restorations is intended to achieve the greatest degree of polymerization in each case, also the consistency of the material, which involves the maximum elimination of the possibility of the loss of own tooth tissues by, e.g., breakage of tooth cusp or loss of the entire side wall. It has been proven that the use of indirect restorations and appropriate cementing procedures lead to the strengthening of the remaining cusps and tooth structure, constituting with them functional – aesthetic block. Moreover, this eliminates about 60% of the material internal stresses that are generated in the direct technique [12].

Factors affecting the durability of indirect composite inlays

The durability of each reconstruction in the oral cavity is affected by many overlapping factors: the precise analysis of the bite-occlusion conditions, knowledge of the indications for the planned inlay, accurate working out and preparation of tissues, careful technical performance. Also the precise evaluation of the accuracy of inlay performance and its correct cementing is of great importance. Knowledge of the properties and selection of appropriate materials for the reconstruction of teeth should be carefully considered before they are used [9].

Use of the indirect restoration to reconstruct the correct points of contact

The technique of indirect restoration, among other things, is recommended in situations of reconstruction of points of contact, which are responsible for harmony in the anterior-posterior dimension of the dental arch. Changing the position of the tooth in the arch often leads to the occurrence of premature contacts and disorders of the stomatognathic

system [13]. In addition, adequate surface reconstruction, or points of contact will have a protective function in relation to the dental papilla and periodontium during mastication. This will be largely preventing the formation of pathological pockets and development of periodontium diseases as a result of traumatization of gingiva by mechanical factors [14]. One of the most common examples are cavities in the first upper and lower molars after removal of orthodontic rings, when dental caries occurs at the contact surfaces with concomitant open interdental spaces.

The influence of the correct restoration of the clinical crown on stomatognathic system

Improper restoration in at least one support zone will result in the impairment of proper position of occlusal plane and occlusion height, which may have an unpredictable effect on the reactions of the temporomandibular joint. Glossary of prosthodontic terms defines the vertical dimension as the distance between two selected anatomical points [15]. The height of occlusion is determined by the contact of existing antagonists, and therefore the loss of dental hard tissues has a negative impact on the proper height of occlusion. The change in the occlusion height can disrupt the function of the entire stomatognathic system [13].

Many authors have assumed that the occlusion height is constant throughout life, and each of its variation leads to abnormal physiology of the masticatory system and the patient's ability to adapt [16]. The TMJ tissues may react by increased tension around the stomatognathic system, which may result in pain responses. Abnormal reactions resulting from exceeding the adaptability of the joints may occur after a certain period; therefore, sometimes it is hard to associate them with an abnormal situation occurring in the mutual position of the dental arches.

Use of the indirect method in the treatment of Molar Incisor Hypomineralization

Crown inlays are also a good alternative in the treatment of congenital disorders of hard tissue of teeth, especially in children and adolescents. An example might be a therapy of Molar Incisor Hypomineralization (MIH) in cases where it is absolutely necessary to avoid extraction for orthodontic reasons. Hypomineralization may relate to individual cusps of molars, biting surface, and in some cases the buccal and the lingual surface [17,18]. Many patients suffering from this condition have, in addition to modified morphology, sensitive teeth and avoid basic hygiene procedures, which is the direct cause of degradation of the hard tissue by the carious process [19,20]. It has been found that the enamel with hypomineralization constitutes the risk factors for premature loss of restoration or secondary caries formation. The existing restoration should be relatively often replaced. This is due to continuous enlargement of the cavity and gradual loss of valuable hard tissues, and thus, reduction in the stability of the entire reconstruction [19].

The porous structure of the enamel, which favors the accumulation of bacterial plaque should not be disregarded either. Fagrell et al. [18] have showed that through the enamel affected by hypomineralization bacteria can easily penetrate into the dentin, and to the pulp. Tightly closure of pathways of microorganisms allows for reducing or even eliminating

the inflammation of the pulp. The studies of Feierabend [21] have confirmed a reduction in or no tooth sensitivity, no further loss of hard tissue and improving oral hygiene after performing indirect composite restorations.

Use of the indirect restorations in the treatment of Cracked Tooth Syndrome

Indirect restorations are particularly recommended for the treatment of cracks of tooth – Cracked Tooth Syndrome (CTS). CTS is a term referring to incomplete breaking of the tooth, which is accompanied by a number of unpleasant symptoms, such as pain when biting or hypersensitivity to thermal stimuli-especially cold. Review of patients of Practice-based Research-network in Oral Health of Oregon Health and Science University, covering more than 14,000 molars showed the ubiquity of cracks in teeth examined [22]. American Association of Endodontists (AAE) specified five types of tooth cracks [23]: fracture of enamel, breaking off cusp, fracture of tooth, splitting of tooth and vertical root fracture. On the basis of 12 clinical trials [23,24] after averaging the results, the following data were obtained: 48% of fractures involved the lower molars, 28% – the upper molars, 16% – upper premolars, 6% – lower premolars, and 2% of the remaining teeth.

Signore et al. conducted a retrospective analysis of the efficacy of indirect composite onlays in the treatment of symptomatic cracks of tooth [25]. Over the 6-year follow-up in 93.02% of cases, they reported therapeutic success both in terms of the viability of reconstruction, as well as absence of clinical signs.

Use of the indirect restorations for restoring endodontically treated teeth

It is worth emphasizing that composite inlays, onlays, overlays are universal ways to restore the function of the clinical crown of tooth, both the dead and alive. Endodontically treated teeth must be protected with functional and sustainable restoration as soon as possible, because of the possibility of reinfection of restored dental canals [26]. It is also an important issue to prevent loss of clinical crown following a fracture. Over the years, it has been noted that endodontically treated teeth are more likely to fracture than teeth with vital pulp.

It has been conjectured that root canal treatment is the cause of the fragility of hard tissue [27]. We found that fractures are the result of the elimination of tissue during endodontic treatment, and not the physical properties of hard tissues. Goodacre and Spolnik tried to determine based on literature review, whether endodontically treated teeth require the implementation of indirect reconstruction. Based on a retrospective analysis they have found that this type of restoration in posterior segment has a positive impact on long-term functioning of the clinical crown of tooth in the mouth [28].

CONCLUSIONS

Based on the literature analysis, it can be concluded that the method of indirect composite restorations is a recommended procedure and versatile solution in many difficult situations. It is a good alternative to direct composite

restorations and allows for maximum conservative treatment of teeth previously qualified for inlay and a crown. It is a recommended restoration method, not only in situations of loss of clinical crown tissue, but also in situations where it is necessary as structural reinforcement, e.g., in the case of cracked tooth syndrome or molar-incisor hypomineralization. With the indirect method, we can offer patients an aesthetic and, above all, durable and functional composite restoration in posterior dental arches.

REFERENCES

1. Van Meerbeek B, De Munck J, Yoshida Y, et al. Buonocore memorial lecture. Adhesion to enamel and dentin current status and future challenges. *Oper Dent*. 2003;28:215-35
2. Murray PE, Hafez AA, Smith AJ, Cox CF. Bacterial microleakage and pulp inflammation associated with various restorative materials. *Dent Mater*. 2002;18(6):470-8.
3. Kakaboura A, Rahiotis C, Zinelis S, et al. In vitro characterization of two laboratory-processed resin composites. *Dent Mater*. 2003;19:393-8.
4. Soares CJ, Pizi EC, Fonseca RB, Martins LR. Mechanical Properties of light-cured composites polymerized with several additional post-curing methods. *Oper Dent*. 2005;30:389-94.
5. Thordrup M, Isidor F, Horsted-Bindslev P. A 5-year clinical study of indirect and direct resin composite and ceramic inlays. *Quintessence Int*. 2001;32:199-205.
6. Pires-de-Souza Fde C, Garcia Lda F, Hamida HF, Casemiro LA. Color stability of composites subjected to accelerated aging after curing using either a halogen or a light emitting diode source. *Braz Dent J*. 2007;19:119-23.
7. Borba M, Della Bona A, Cacchetti D. Flexural strength and hardness of direct and indirect composites. *Braz Oral Res*. 2009;23:5-10.
8. Terry DA, Touati B. Clinical consideration for aesthetic laboratory-fabricated inlay/onlay restorations: a review. *Pract Proced Aesthet Dent*. 2003;13:51-8.
9. Sobolewska E, Frączak B. Wpływ materiałów nowej generacji stosowanych w protetyce odtwórczej na środowisko jamy ustnej. *Ann Acad Med Stetin*. 2010;56;3:66-80.
10. Żarow M, Krupiński J. Pośrednie wypełnienia kompozytowe w przypadku znacznego zniszczenia koron zębów bocznych. *Cz. IV. Mag Stomatol*. 2005;1:44-7.
11. Żarow M. Odbudowa zębów bocznych po leczeniu endodontycznym. *Cz. I. Mag Stom*. 2005;10:10-4.
12. Hood JA. Biomechanics of the intact, prepared and restored teeth: some clinical implications. *Int Dent J*. 1991;41:25-32.
13. Okeson JP. Leczenie dysfunkcji narządu żucia i zaburzeń zżarcia. *Lublin: Wyd. Czelej*; 2005.
14. Leinfelder KF. Indirect posterior composite resins. *Compend Contin Educ Dent*. 2005;26:495-503.
15. The glossary of prosthodontics terms. *J Prosthet Dent*. 2005;94:10-92.
16. Keough B. Occlusion based treatment planning for complex dental restorations: Part I. *Int J Periodont Restor Dent*. 2003;23:237-47.
17. FDI Commission on Oral Health, Research and Epidemiology. A review of the development defect of enamel index (DDE index). *Int Dent*. 1992;42:411-26.
18. Fagrell TG, Lingström P, Olsson S, et al. Bacterial invasion of dentinal tubules beneath apparently intact but hypo mineralized enamel in molar teeth with molar incisor hypomineralization. *Int J Paediatr Dent*. 2008;18:333-40.
19. Rodd HD, Morgan CR, Day PF, Boissonade FM. Palpal expression of TRPV1 in molar incisor hypomineralisation. *Eur Arch Paediatr Dent*. 2007;8:184-8.
20. Kellerhoff NM, Lussi A. Die "Molaren-Inzisiven-Hypomineralisation". *Schweiz Monnatschr Zahn-Med*. 2004;114:243-9.
21. Feierabend S, Halbleib K, Hellwig E. *Quintessenz* 2011;62(12):1637-1643.
22. Hilton TJ, Ferracane JL, Madden T, Barnes C. Cracked Teeth: a practice based prevalence survey. *J Dent Res*. 2007;86:abstr. 2044
23. Cracking the cracked tooth code. *Endodontics: AAE Colleagues for Excellence*, 1997;(fall/winter):1-13.
24. Bader JD, Martin JA, Shugars DA. Incidence rates for complete cuspal fracture. *Community Dent Oral Epidemiol*. 2001;29:346-53.
25. Signore A, Benedicenti S, Covani U, Ravera G. A4-to 6-year retrospective clinical study of cracked tooth restored with bonded indirect resin composite onlays. *Int J Prosthodont*. 2007;20:609-16.
26. Lynch CD, Burke FM, NiRiordáin R, Hannigan A. The influence of coronal restoration type on the survival of endodontically treated teeth. *Eur J Prosthodont Restor Dent*. 2004;12:171-6.
27. Tang W, Wu Y, Smales RJ. Identifying and reducing risks for potential fractures in endodontically treated teeth. *J Endod* 2010;36:609-617.
28. Goodcare CJ, Spolnik KJ. The prosthodontics management of endodontically treated teeth: a literature review. Part I. Success and failure data, treatment concepts. *J Prosthodont*. 1994;3:243-0.

Corresponding author

Dr hab. n. med. Renata Chałas
Karmelicka 7 st., 20-081 Lublin, Poland
tel. (81) 528-79-20
E-mail: renata.chalas@gmail.com