

Advancement of dental restoration technique and reviewing the related benefits to Periodontium, dental implant treatments, bone grafts and orthodontic treatments

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Abstract

Micro-leakage and secondary caries post dental restoration are considered as broad challenges in dental treatments, and it happens when microbes, molecules, and liquids penetrate between the two surfaces of the tooth tissue and the restorative materials. This may result in tooth sensitivity, pulpitis, periodontal diseases and etc. Therefore, based on this importance, the effect of time duration and surface coating on micro-leakage in Class V restorations, by using bulk-fill composites has been examined. It was clearly shown that the surface coating has the ability to reduce micro-leakage to a great extent. The duration in the process of treatment had no significant effect on micro-leakage, but the type of treatment method was able to significantly reduce micro-leakage in the occlusal walls. Furthermore, it was found that it is more preferable to perform the polishing and finishing process with a polishing disk without using a burr.

Since micro-leakage causes complications in other oral organs and tissues, especially adjacent tissues, it may involve other dental fields, including periodontics, orthodontics, oral and maxillofacial surgery and etc, in addition to restorative dentistry. Hence accordingly it has been found that by preventing micro-leakage, great steps can be taken in order to maintain the health of the periodontium, achieve greater success in orthodontic treatments, and also reduce the complications related to oral and maxillofacial surgical treatment methods.

Keywords: micro-leakage, bulk-fill composite, surface coating, periodontal diseases, orthodontics, bone graft, implant.

Introduction

Micro-leakage is known as micro-organism interpretation including microbes, fluid and molecules into tooth and tooth restorations[1]. This phenomenon occurs when there are crucial entry regions at the tooth surface specifically when tooth has gone under restoration[2].

Micro-leakage is an important factor in class v restoration which can lead to failure of treatment and secondary caries, sensitivity and pulpitis[3,4]. Polymerization shrinkage creates a gap between the composite restoration and the cavity walls, and as a result, there is a path for liquids and bacteria to pass through the oral cavity, which ultimately leads to recurrent caries[5].

In an effort to reduce the effects of polymerization shrinkage, various clinical techniques have been proposed, such as the incremental technique introduced by Leader in 1948, radiation control of the curing unit introduced by Caulk in 1971, and increasing the filler content and its composition[6]. However, no technique has been shown to be effective in completely reducing the effects of polymerization shrinkage[7]

A new generation of composites has been introduced under the name of bulk-fill. These materials are suitable for placement in the restoration cavity in the form of a 4 mm mass due to their low polymerization stress and high reaction to light curing. As a result, problems caused by polymerization shrinkage and repair time are reduced without reducing the quality of curing[8].

Studies in the field of marginal compliance and polymerization shrinkage with the use of different materials and placement techniques have shown conflicting results. Some researchers have reported that bulk-fill composites have lower polymerization stress than conventional types, while other researchers have not found a statistically significant difference[9].

There are many factors that can affect the marginal integrity of the restoration, including the isolation quality of the area where the restoration margin is located, the restorative material, the technique of placement of the restorative material, and the finishing and polishing methods. One of the most important factors affecting micro-leakage is the finishing and polishing techniques, which are important to achieve an acceptable marginal integrity, and of course, they are also the only factors that are under the control of clinicians[10].

The possible reasons for micro-leakage at the restoration margin can include the shape of the cavity (c-factor), the orientation of the dentin tubules towards the cervical side (CEJ), the amount of organic content of the dentin substrate, the fluid movement in the tubules, the change or incomplete removal of the smear layer, the physical properties of the restorative material, the effects of finish and polishing. On the other hand, the lack of adequate matching in the restoration margins increases the risk of pulp irritations and secondary caries[11].

Therefore, it is very important to use a proper finishing and polishing protocol to maintain the flood of the restoration margin area. The problem that always exists during the polishing of composite materials is the difference in the hardness of the filler and the resin matrix, which causes their abrasion and polishing to be different. The type of filler and particle size are very different among composites, and these factors affect the polish-ability of the composite[12].

Another method that is suggested to improve the surface quality of composites is to create a time interval between the removal of the matrix and the finishing process. Recontouring and finishing of previously defective restorations is usually done in the same session as the restoration is corrected, but a number of researchers believe that immediate finishing increases the possibility of micro-leakage at the tooth-restoration interface[13].

It should be noted that according to all the above-mentioned explanations, which were obtained from a laboratory research conducted in Semnan Dental Faculty, as well as information gained from various scientific sources, our research group decided to make out the relationship between these findings and sciences such as orthodontics, periodontics and oral and maxillofacial surgery, which we will discuss further. As per the relationship with periodontium, according to the above discussions, science and experience have clearly shown that dental restorations, especially Class V, can lead to secondary caries, pulp diseases, and subsequent damage to the periodontium under certain conditions, and this is done in such a way that microorganisms and some toxins can migrate into the dentinal tubules and pulp due to the path occurred after creating a gap between the tooth tissue and the filling material[14].

Furthermore, about the Relationship with orthodontics it would be desirable to mention that the stronger the restored tooth is in terms of tooth structure and restorative materials, and also the stronger the adhesion of restorative materials and teeth is, in order to minimize the chance of fracture and micro-leakage, the possibility of more and more appropriate use in The orthodontist decides[15, 16, 17].

In the next step if we want to relate our findings about the science and profession of oral and maxillofacial surgery, we can say that specialists in this field deal with the correction of jaw, facial and oral abnormalities and diseases through surgery, transplantation of soft and hard tissue is also from this rule. when there is bone grafts around the tooth which undergone restoration and led to micro-leakage and subsequent dentin-pulp, periodontal disorders, as a result if the spread of infection occurs, it is obvious that the chance of failure of the graft treatment increases significantly and the patient faces the related complications. Other complications that can be mentioned in this regard are the failure of implant

treatments, damage to the supporting bones of the adjacent teeth, and subsequently there will be the possibility of being forced to extract them and so on[18, 19].

Theoretical:

Micro-leakage has the ability to cause the passage of liquids, microorganisms, ions, and molecules through the discontinuity that occurred between the tooth tissue and the restorative materials, although it cannot be diagnosed clinically, it will be a big challenge. It should be mentioned that several factors including isolation, type of restorative materials, restorative techniques including finishing and polishing, which are under the control of the dentist, will be effective in creating or not creating micro-leakage in such a way that the better materials and techniques are more basic, the chance of creating micro-leakage and as a result caries. Secondary, sensitivity and pulp diseases will be reduced[20,21]

Bulk-fill composites

These new generation restorative materials are used in the form of a 4mm mass for use in the restoration cavity and are considered very suitable in their place, the polymerization stress in these composites is low and their reaction to light curing is high, so the defects are caused by shrinkage[22]. Polymerization and the duration of the dental restorative treatment process decrease without reducing the quality of curing. Researchers have put forward different opinions about edge matching and polymerization shrinkage, such that some believe that bulk-fill composites have less polymerization stress than conventional types, but others have not found any difference[9, 23].

Polishing and finishing:

The tools that are used in this field are numerous, including diamond carbide finish burs, plastic-based abrasives, polishing pastes, abrasive strips, etc[24]. It should be said that some researchers have commented that the immediate finish, i.e. performing the repair treatment in the same session, increases the chances of micro-leakage, but a single and definite opinion has not been reported on this matter, although the composite manufacturing companies mention the time of their payment[25].

Surface sealants:

Surface sealant is a resin-based material capable of polymerization with light and is capable of penetrating the microscopic gaps that exist in the interface between tooth tissue and restorative materials and reduces the chance of micro-leakage at the edge of enamel and dentin. Minimizes and also reduces the surface roughness, which itself leads to the reduction of plaque accumulation[26, 27].

Review of similar studies:

Researchers believe that the type and quality of the resin composite, as well as the factors that play a role in the dental restoration treatment process are involved in the chance and occurrence of micro-leakage, from which we can refer to the time of polishing and finishing, it means whether this process is done immediately or delayed, another case is the use of surface sealants[25, 28].

How the above findings could improve other complications such as periodontal disorders, bone grafts, orthodontic treatments, etc:

As we discussed in the introduction, micro-leakage and secondary caries are considered as important factors for periodontal and periapical diseases as well as infection formation at the adjacent tissues and etc. Hence we will discuss some of them below:

Periodontium: to begin this section we announce that the micro-leakage is able to lead to invasion of microbes to the gingiva and leads to inflammatory responses in that tissue and adjacent structures including periodontal ligament and periodontium[29]. A good example in this regard is gingivitis which it's clinical symptoms are redness, swelling, bleeding, losing papillary knife edge shape, etc[30]. If it is not treated at the beginning, it enters the chronic phase and can cause periodontitis, which is considered a more severe form. Chronic periodontitis is accompanied by bone loss and periodontal ligament tissue, which ultimately leads to tooth loss, so it is necessary to adopt more appropriate approaches to control micro-leakage in order to maintain the health of the periodontium[31, 32].

Orthodontics: A dental restoration which possesses a good strength and adhesion with tooth tissues matters a lot in orthodontics treatments. Orthodontic treatment is a process which mainly uses to moves the teeth into their proper position and having dental restoration faces the treatment as well as the operator to various challenges and complications. A restoration which is not strong enough might crack or dislodge under orthodontic forces in which the restored teeth may undergo secondary caries, sensitivity, decay, etc. This complications may cause the stoppage of the treatment or lead to excessively prolonged treatment process. Based on the above findings, it is worthy to use advanced techniques and materials to restore teeth, this helps the orthodontic treatments to pass in a more desired and standard way[33, 34, 35, 36].

Oral and maxillofacial surgery: as a result of microleakage and microbial migration to the tooth tissues including pulp, periapical lesions and infection development specially adjacent

to an implanted tooth or bone graft may lead to peri-implantitis, failure of the bone graft, etc. in such a way that infection and Inflammatory conditions prevent osseointegration and inhibits the growth factors to come into play to provide healing[37, 38, 39]. It's important to mention that this treatments are already susceptible to post operation infection. Hence surface coating and advanced restorative material helps a lot to inhibit one of the paths of infection to initiate[40, 41, 42]

Materials and methods:

Totally 48 healthy and normal premolar teeth were collected and care was taken that none of those teeth should have any crack, cavity, etc. In the next step class V cavity preparation has been done in all the teeth and then restored with bulk-fill composite. Furthermore, randomly teeth were divided into 8 groups in which every group had 6 teeth to investigate the effect of polishing and finishing technique by selected instruments and materials which mentioned in the article, on the micro-leakage.

First group: immediate polishing, no surface coating

Second group: instant polishing, Permaseal surface coating

The third group: delayed polishing after 24 hours without surface coating

Fourth group: delayed polishing after 24 hours with Permaseal surface coating

The fifth group: positive control. Immediate polishing-finishing without surface coverage

Sixth group: positive control. Immediate polishing-finishing with Permaseal surface coating

The seventh group: positive control. Late polishing-finishing after 24 hours without surface coverage

Eighth group: positive control. Delayed polishing-finishing after 24 hours with Permaseal surface coverage

It should be noted that half of the restorations, including groups 1, 2, 5, 6, are polished immediately after the restoration, and groups 3, 4, 7, 8 are polished after 24 hours and with a delay Permaseal surface coating also has been done for half of the polished and non-polished restorations, including groups 2, 4, 6, and 8, and permaseal surface coating is not done for the rest of the groups. It's needed to announce that when the polishing and finishing as well as surface coating are done, all those teeth are exposed to thermocycling to simulate wear and tear, and the size of micro-leakage in each restoration is carefully evaluated by using a powerful stereomicroscope. In the next step we analyzed and evaluated data by SPSS 24 software and came to know about the effects of polishing and finishing time and surface coverage on micro-leakage.

Regarding the ethical considerations it should be mentioned that this study received the ethical approval of the ethics committee of Semnan University of Medical Sciences, whose code is IR.SEMUMS.REC.1399.083.

Apart from the information and data from the mentioned thesis which we reviewed the sources and references and rewrite, newer and various information had been collected from the sources and websites such as PubMed, Science Direct, Hindawi, MDPI, to gain more advanced findings.

Data analysis:

As mentioned above, these information are obtained from a laboratory research, hence accordingly it can be stated that the graded disc burs, as well as those composites that are considered bulk-fill, cause less micro-leakage than others. It can also be claimed that the surfaces of the teeth that are smooth compared to non-smooth surfaces reduce the chances of micro-leakage.

Conclusion:

Surface coating reduces the micro-leakage in tooth restoration specially in class v and time duration spent on polishing and finishing as well as the type of technique doesn't have any significant effect. but it differs in the occlusal wall, in such a way that the type of surface coating and polishing technique has a significant effect on how much micro-leakage happens. When bur is used for polishing and finishing, it is very important to perform surface coating to reduce the amount of micro-leakage, but in cases where If surface coating is not performed, it will be preferred to use disc instead of burr. In a general case, it can be said that in cases where bulk-fill composites are used, in the occlusal walls and other walls (this case is much bolder in the occlusal wall), performing coating helps to reduce micro-leakage.

Microleakage relation with periodontics is that it leads to periodontal diseases in such a way that secondary caries occurs as a result and other pathological phases happen further, including gingivitis, periodontitis, tooth mobility, etc. Using a surface coating prevents this from happening and preserves the health of the gingiva

To discuss about orthodontics, if the restoration are brittle, using orthodontic appliances face to a challenging phenomenon but the use of surface coating increases the strength of the fillings and makes the orthodontic treatment more successful.

Prevention of some complications in oral and maxillofacial surgery is also an advantage obtained by following the advanced technique and restorative material in order to restorative teeth. In oral and maxillofacial surgeries, there are a possibilities of infection in bone grafting, implants, etc. once the microleakage is potent to occur, by preventing it and performing the surface coating, chances of such complications after the operation reduces a lot.

According to the results of this study, the use of surface coating in dental restorations with bulk-fill composite is recommended

as a simple and effective method to improve the quality of dental treatments.

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