

INFLUENCE OF THE WAYS FOR REMOVING THE EXCESS OF COMPOSIT RESIN CEMENT MATERIALS ON THE SURFACE ROUGHNESS DEGREE

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Abstract: The microstructure of resin-based cement materials is mostly composed of hybrid fillers. The improvement of chemical- and micro- structure of resin-based cement materials decreased the degree of the surface roughness.

Subgingival region is the area of the most common localization of the demarcation line. Such location of the demarcation zone does not allow a proper removal of the excess cement during cementing procedure of the fixed dental restorations. The most common problems occur during the removal procedures of resin-based cement materials which, after the polymerization, are not soluble in the sulcus fluid. The rough surface of the exposed cement materials represents predilection area for dental plaque accumulation with the possibility of causing gingivitis and parodontopathy.

The aim of the study is to show the influence of methods used to remove the excess of resin-based cement materials on the roughness degree of the exposed surface. Within the experiment, the teeth with cemented ceramic crowns were observed. The removal procedure of the excess cement material was conducted in four different ways. The exposed surface of cement material was, after the polymerization, observed under the scanning electron microscope (SEM).

The results of the analysis performed by using the SEM indicate various roughness degrees in the surface of the cement material. The lowest degree of roughness was observed on the polished surface. The highest degree of roughness was observed within the methods most commonly used in practice, such is breaking off of the excess cement after the roentgenoscopy for 5-second duration, followed by total light polymerization. On the basis of the analysis of the observed surfaces, it can be concluded that methods used to remove excess cement material significantly influence the degree of its surface roughness.

Keywords: Composit resin cement, cement surface, SEM microscop, fixed dental restauration.

INTRODUCTION

Zinc phosphate, polycarboxylate and glass ionomer cement materials have been present in the dental practice over a long of time. The appearance of fixed ceramic restorations has changed the requirements of the profession, which reflected in the application of adequate materials used for their cementing. In this context, the appliance of adhesive techniques of cementation are very significant [1, 2].

Luting composites have to establish a durable bond between the tooth structure and restorations made of various metals and metal alloys, resins and different ceramics [3].

Luting composites are entirely based on the dental restorative composites. They consist of monomers and inorganic filler particles. Their setting is based on a cross-linking of the polymer chains, which is initiated chemically or by light. Composite "cements" are covered by ISO 4049, which also ap-

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plies to the entire range of composite restorative materials [4].

Development and advances in the field of the filler technology have influenced dentistry since the introduction of dental resin composites about forty years ago. Since that time, the composite materials with macro-, micro- and nanofiller particles have been successively proposed. One of the most important advances of the last few years in the field of the filler technology is the application of nanotechnology to dental composites [5]. Nanofillers have been developed with the aim of combining the advantages of hybrid and microfilled composites in the same material. Nanofillers are described as “the discrete particles which have all of three dimensions in the range of about 1–100nm” [6, 7]. They exhibit a higher surface quality, a better polish and gloss, an increased retention, as well as an increased wear resistance [8,9]. Roughness has a major impact on the aesthetic appearance and discoloration of the restorations [10], plaque accumulation, secondary caries and gingival irritation [11, 12].

Composite cement luting materials in prosthodontics are based mostly on the hybrid filler technology. One of them is Multilink Automiks (Ivoclar, Vivadent). Multilink Automix consists of a composite and Multilink Primer A and B. Paste contains dimethacrylates, hydroxyethyl methacrylate (HEMA), inorganic fillers, ytterbiumtrifluoride, initiators, stabilizers and pigments. The corresponding initiator system permits chemical adhesion, which is accelerated by the contact of the composite with the primer. Furthermore, the presence of a photo initiator also enables final polymerization with light.

If we take into account the required depth of applying demarcation line by the aesthetic rules in the dentistry, the question is whether the application of certain cement materials affect the plaque accumulation at the demarcation level. Setting the edge of the reconstruction in submucosal region increases the risk of gingivitis and parodontopathia and always represents the compromise which is to be accepted only under good hygiene conditions. Therefore, there is always a strive for clinically perfect crown's edge in order to minimize the plaque accumulation.

The processing with rotary instruments, oscillating saws and ultrasonic devices is not possible, due to a possible damage on the crown surface. Due to the fact that the excess cement is being removed from the crowns just by means of a dental probe, even the most experienced practitioners cannot totally remove the residues, often leaving coarse crowns surface behind [13]. Such roughness represents a mechanical irritant and it can be suitable for the plaque accumulation. In comparison with the

crowns on the natural teeth, the crowns with the edge in a submucosal position can have some defects caused by material and topography.

The excess composite cement materials in the procedure of cementation crowns and bridges is removed in the different ways. The aim of this study was to investigate the influence of the methods for removing the excess composite resin cement materials on the degree of surface roughness.

MATERIALS AND METHODS

For the purpose of the research, twelve extracted upper first molars were prepared, on which, by performing the Cerec[®]3D system intra-oral scanning technique, twelve ceramic crowns were made. All the teeth, after being extracted, were thoroughly cleared from blood residues and adjacent soft tissue structures. Further on, the teeth were placed and stored in a physiological solution. The preparation of teeth was performed by using a high-revving engine with water-cooling system in accordance with the recommended design for the Cerec[®] system, implying the shape demarcation of the step with rounded internal wall of 1.00 mm width, 6° ascent of the single axial surface and occlusal abbreviation of 1,5mm [13,14]. From the axial surfaces it has been removed 1 to 1,5mm of dental substance, which provides for manufacturing of crowns with minimum acceptable thickness.

In vitro experiment performance included the scanning of dental preparations. Tooth preparation for scanning involved application of a thin film of liquid (CEREC[®]-liquid, VITA, Bad Sackingen, Germany) and powder (CEREC[®]-powder, VITA, Bad Sackingen, Germany). The scanning was performed by using the optical Cerec[®]3D system intra-oral scanner. Computer-aided design was performed by using the Cerec[®]3D software, version 3.10. The crown design was chosen from the existing program database. The thickness of cement film space was 30 μ . (Fig. 1)



Figure 1. Cerec3D CAD-CAM system

Crowns were made of zirconium oxide blocks (IPS e.max zirCAD, Ivoclar Vivadent, Liechtenstein). IPS e.max zirCAD represents presintered yttrium-stabilized zirconium oxide blocks for the CAD/CAM technologies, which is being sintered after the processing. Multilink Automix composite cement was used for cementing the ceramic crowns in accordance with the manufacturers' recommendations, which involved adequate tooth and crown preparation for cementing. Within the cementing procedure of ceramic crowns, the removal of excess cement material was carried out as follows:

1. with a cotton-roll in horizontal direction, after which light polymerization has been performed;
2. with a cotton-roll in vertical direction, after which light polymerization has been performed;
3. the removal of excess cement using a borer after light polymerization and smoothing of exposed cement using aluminum oxide abrasive instruments,
4. the light polymerization duration of 5sec., removal of excess cement and total light polymerization.

Three crowns have been cemented with each of the mentioned cementing types on the prepared teeth. The scanning electronic microscope JOEL JSM - 5800 - SNING MICROSKOPE (SEM) was used for observing the exposed cement film surfaces at the demarcation level (Fig.2).

The observation was conducted on mesial, distal, vestibular and oral surface of the cement film at the demarcation level.



Figure 2. JOEL JSM-5800-(SEM)

RESULTS

The results of the research show the presence of a different degree in surface roughness of the cement at the demarcation level. The sample snapshots involving the removal of excess cement film using a cotton-roll in horizontal direction show less degree

of roughness on the surface texture, horizontally oriented. (Fig. 3, 4)

The samples which involve the removal of cement using a cotton-roll in a vertical direction also show lesser degree of roughness, with the vertically oriented texture (Fig. 5).

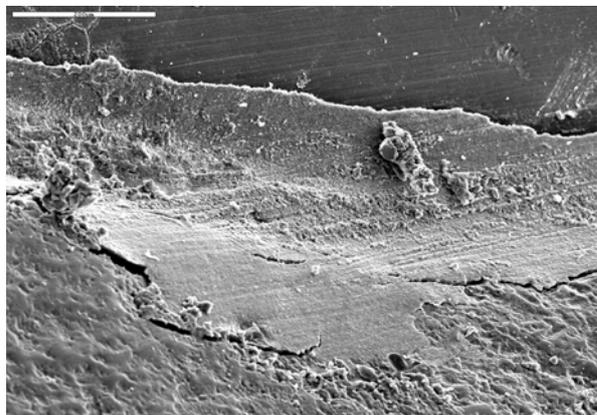


Figure 3. Surface texture (horizontal direction)

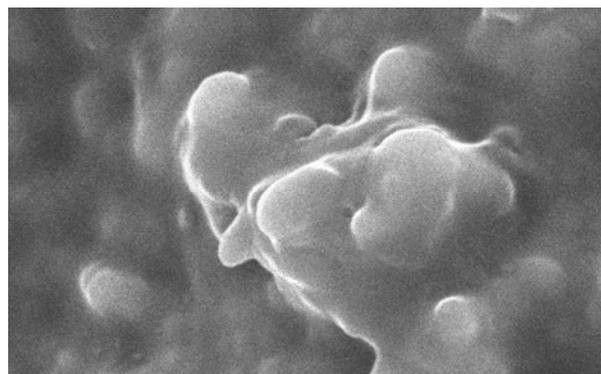


Figure 4. Surface texture (magnification 1000 x)

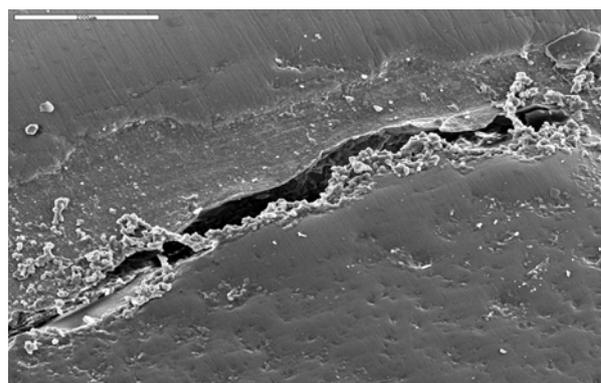


Figure 5. Surface texture (vertical direction)

Minimum roughness degree was observed on the samples which involved the cement removal by using borers, which were smoothed with aluminum oxide abrasive instruments (Fig.6,7).

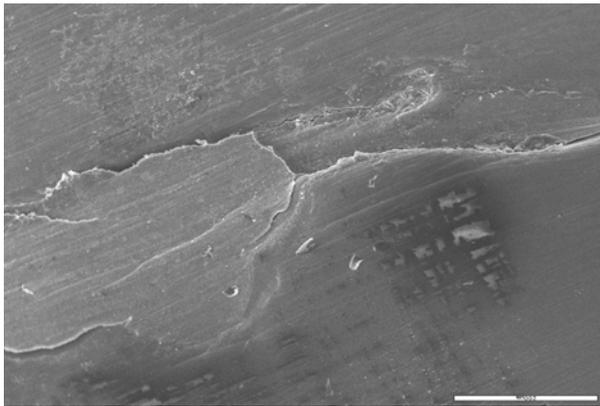


Figure 6. Polished surface

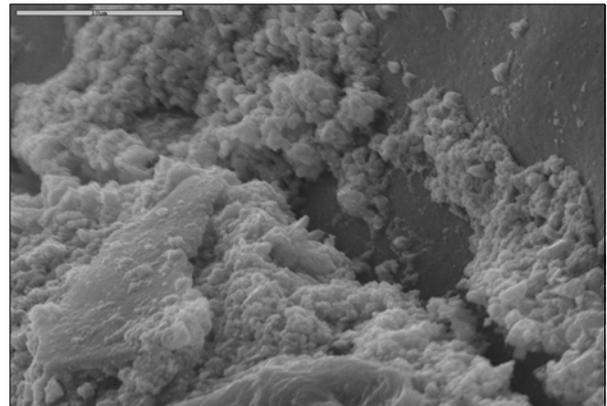


Figure 9. Expressive surface roughness (magnification 500x)

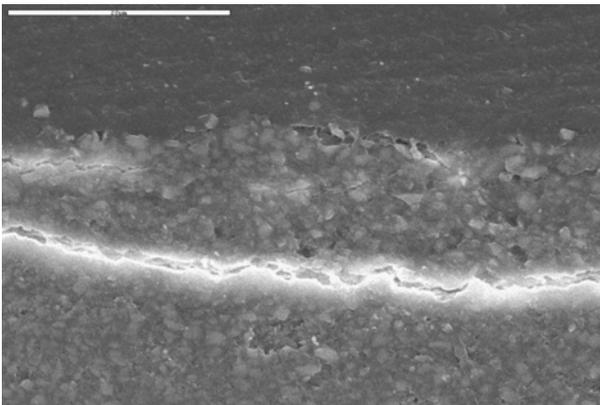


Figure 7. Surface texture (polished surface)

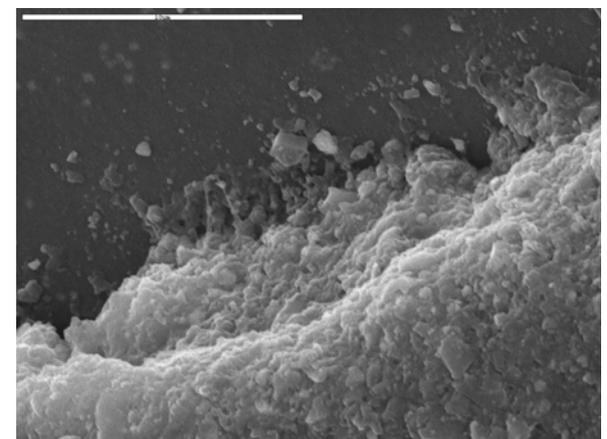


Figure 10. Excess cement material (magnification 900x)

The expressive roughness, as well as the brokenness of cement surface, noted on the samples which involved the cement material, caused its breaking off 5sec after the light polymerization. The expressive roughness with the texture that is prominent outside of the tooth-crown bond which, in a practical sense, means that their location should be in the gingival sulcus area (Fig. 8, 9,10).

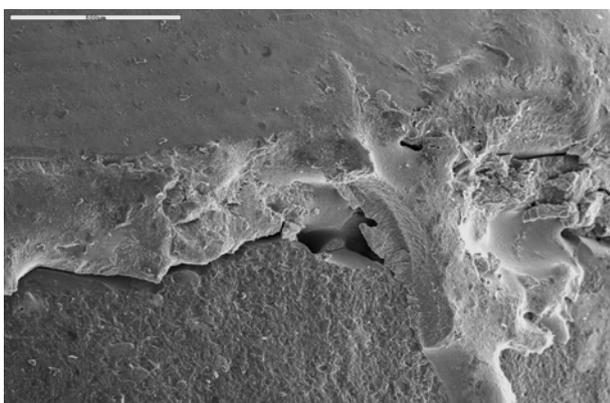


Figure 8. Expressive surface roughness

DISCUSSION

Resin-based cement materials, after polymerization, are not soluble in the sulcus fluid and saliva [15]. The removal of excess cement material during the cementing procedure of the fixed dental restorations is carried out in different ways. The available literature does not contain much data on the influential degree of the existing methods for removing the excess cement materials on their surface roughness degrees. High aesthetic requirements, being one of the major imperatives of contemporary dentistry, stipulate the demarcation of preparation to be localized in the gingival sulcus region. The remains of the polymerized cement materials and irregularities on the surface in subgingival region represent a mechanical irritant and the area of regular dental plaque accumulation, which may potentially cause gingivitis or parodontopathy [16,17]. If the polymerization is carried out thoroughly, and yet the excess cement has not been removed, those cement remains cannot be removed by breaking off the excess as if in the case of the phosphate, polycarboxylate or glass-

ionomer cements, which represents a significant problem for a clinician.

There are various methods for estimating the degree of surface roughness of the composite materials that have been mentioned in the literature.

Optical profilometry and the SEM analysis are the most likely applied methods [18].

Several methods used for the removal of excess composite cement are present in clinical practice. One of the most commonly present procedures is the one that involves breaking off of the excess cement after the roentgenoscopy of 5-second duration, followed by the completion of the light polymerization in accordance with the manufacturers' prescription. The results of this experiment show that such cementing method causes the development of excessive surface irregularity, as well as a high degree of roughness.

Some clinicians use cotton-rolls to remove the excess cement. Within this experiment, the excess cement has been removed by using cotton-rolls in vertical and horizontal directions. The texture of the observed surfaces shows certain degree of roughness, but significantly lesser than in the previously mentioned methods. Considering the demarcation of preparation localized in subgingival region, such removal method can be recommended with the subgingival demarcations. In the case of subgingival demarcations, the cotton-roll could be replaced with a dental probe. Some literature data indicate that these methods of excess cement removal can affect the marginal sealing quality. The removal of excess cement before polymerization is one of the causes for appearance of gap between the cement material and hard dental tissues or a crown. Such submissions can be proven with the experimental results (Fig.11).

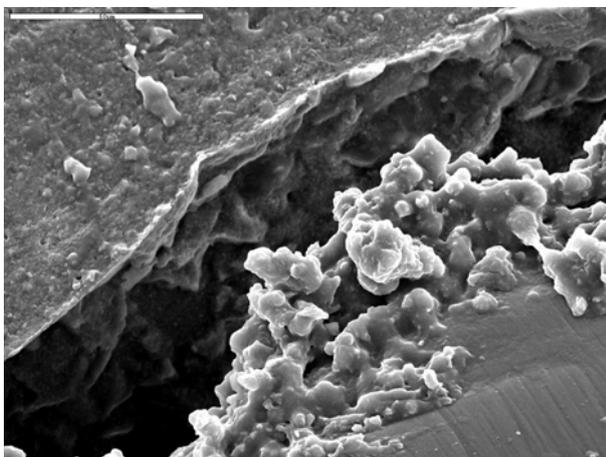


Figure 11- Marginal gap

The lowest degree of roughness was observed on the polished surface, which was the most favorable one from the clinical aspect. In addition, there

were no signs of gaps between the cement material and a tooth and crown respectively, on these samples. It is important to mention that the selection of polishing equipment significantly affect the surface roughness of composites, which has been justified with the results of numerous researches.

The microstructure of resin-based cement materials is mostly composed of hybrid fillers. The results of the researches of surface roughness of the compared hybrid and nanocomposites, reveal no statistically significant difference in the degree of their surface roughness, after having been adequately polished [19]. However, nanocomposites show a slightly lesser degree of surface roughness. Composite cement development technology is oriented toward simplifying and shortening the cementing procedure, resulting in the integration of an acid, bond and cement into one paste. In comparison with the composite developments, where the filler quality has been significantly improved, not much improvement has been done regarding the composite cement materials [20]. This is rather important due to the impossibility, in most of the cases, of polishing the surface of composite cements, which, considering the potential dangers, can be impractical in everyday clinical practice.

CONCLUSION

The results of this study, with the hybrid composite cement used, point out clearly that the polishing procedure provides the surface with the lowest degree of roughness, which is, from the point of clinical aspect, very acceptable. The highest degree of roughness was observed within the methods that are most commonly used in practice. Such results suggest the insufficiency of this method, bringing up to the surface the possibilities of both modification and alteration in the mentioned technique for excess cement material removal.

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УТИЦАЈ НАЧИНА УКЛАЊАЊА ВИШКА ЦЕМЕНТНОГ МАТЕРИЈАЛА НА БАЗИ СМОЛА НА СТЕПЕН ХРАПАВОСТИ ЊИХОВЕ ПОВРШИНЕ

Сажегак: Микроструктуру цементних материјала на бази смола чине углавном хобридни пуниоци. Унапређење хемијске и микроструктуре цементних материјала на бази смола смањило је степен храпавости њихове површине.

Субгингивална регија је зона у којој је локализација демаркационе линије најучесталија. Овакав положај демаркационе зоне отежава правилно уклањање вишка цементног материјала у поступку цементирања фиксних зубних надокнада. Најчешће потешкоће настају у поступку уклањања цементних материјала на бази смола, који након полимеризације нису растворљиви у сулкусној течности. Храпава површина експонираног цементног материјала представља предилекционо место за акумулацију денталног плака, што може да узрокује гингивит и пародонтопатију.

Циљ рада је да покаже како начин уклањања вишка цементног материјала на бази смола утиче на степен храпавости експониране површине. У оквиру експеримента посматрани су зуби на којима су цементиране керамичке круне. Уклањање вишка цементног материјала вршено је на четири различита начина. Експонорана површина цементног материјала након полимеризације посматрана је помоћу скенирајућег електронског микроскопа (СЕМ).

Резултати анализе помоћу СЕМ указују на различит степен храпавости површине цементног материјала. Најнижи степен храпавости забележен је на полираној површини. Највиши степен храпавости уочен је код метода који је највише присутан у пракси, а то је одламање вишка цемента након просветљавања у трајању од пет секунди, након чега следи потпуна светлосна полимеризација. На основу анализе посматраних површина можемо да закључимо да начин уклањања вишка цементног материјала значајно утиче на степен храпавости њихове површине.

Кључне речи: композитни цементи, површина цемента, СЕМ микроскоп, фиксне зубне надокнаде.