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Original Article

Comparison of teeth discolorations induced by Mineral trioxide aggregate, Calcium-enriched mixture and Biodentine sing spectrophotometric analysis

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Abstract

Introduction: Most of the materials used in endodontic procedures may lead to discoloration.This study compared the discolorations induced following treatment by MTA, CEM ,and Biodentine using a spectrophotometric analysis.

Material & Methods: In this experimental study Forty extracted mandibular anterior teeth were selected and sectioned from 2 mm below Cemento Enamel Junction (CEJ) using a disc. A retrograde method was used for drilling cavities 2 mm away from incisal edge. Then the cavities were washed using 5.25% NaOCL and normal saline and the samples were divided randomly into 4 groups. The cavities in groups 1, 2, and 3 were filled by MTA Angleus, Cem cement, and Biodentine, respectively as deep as CEJ level and they were sealed by 2mm of A3 composite color. All of cavities of group 4/control, were all filled by composite A3. Then the samples were stored in a glass incubator with 100% humidity and under laboratory light .they were exposed to a spectrophotometric analysis within 6 periods from placement including base line, 1 week, 2 weeks, 1 month, 3 months, 6 months. The data were analyzed by SPSS 17 ,Tukey HSD and ANOVA statistical test.

Results: The results showed no statistically significant difference in discoloration rate during measurement periodsin each group. However, the discoloration rate varied in various materials. The minimum and maximum discolorations occurred in Biodentine and MTA, respectively and their difference was statistically significant. (p=0.033)Other groups showed no statistically significant difference.

Conclusion: The biodentinehad minimum discolorations compared with other two materials; thus, it seems that it can be recommended for cosmetic areas.

Keywords: Biodentine, CEM cement, Mineral trioxide aggregate

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مقایسه میزان تغییرات رنگی القا شده در دندان ها با ۳ ماده Mineral trioxide aggregate، Calcium-enriched mixture، Biodentine توسط آنالیز اسپکتروفوتومتری

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چکیده

مقدمه: بیشتر مواد مورد استفاده در پروسه های اندودنتیک میتوانند منجر به تغییر رنگ شوند.این مطالعه میزان تغییرات رنگی القا شده پس از درمان با ۳ ماده MTA، CEM و Biodentineرا توسط آنالیز اسپکتروفوتومتری آنالیز کرد.

مواد و روش ها: دراین مطالعه تجربی ،تعداد ۴۰ عدد دندان قدامی کشیده شده فک پایین انتخاب و از ۲ میلی متر زیر (CEJ) cemento enamel junctionتوسط دیسک برش داده شدند. حفره ای به طریق رتروگرید تا حد ۲ میلی متری لبه انسیزال در آن ها تعبیه گردید. حفرات توسط Naocl ۵/۲۵% و نرمال سالین شستشو داده شدند و نمونه ها به طور تصادفی به ۴ گروه ۱۰ تایی تقسیم شدند. گروه ۱، حفرات MTA Angleus، گروه ۲ Cem cement، گروه ۳ Biodentine تا حد CEJ پر شده و توسط ۲ میلی متر کامپوزیت رنگ A_3 سیل شدند.گروه ۴ یا نیز کنترل توسط کامپوزیتA_3 پر شدند. نمونه ها در انکوباتور شیشه ای با رطوبت ۱۰۰٪ زیر نور لابراتوری نگهداری شدند در ۶ زمان Base line، ۱ هفته، ۲ هفته، ۱ ماه، ۳ ماه و ۶ ماه پس از جایگذاری تحت آنالیز اسپکتروفوتومتری قرار گرفتند.اطلاعات بدست آمده با استفاده از نرم افزار آماریSPSS 17 و آزمون آماری ANOVA Tukey HSDمورد تحلیل قرار گرفت.

یافته ها: نتایج به دست آمده میزان تغییر رنگ هر گروه در طول زمان های اندازه گیری اختلاف آماری معنی دار را نشان ندادند. اما میزان تغییر رنگ مواد مختلف متفاوت بود و کمترین تغییر رنگ در Biodentine و بیشترین تغییر رنگ در MTA حادث شد که اختلاف آن ها به لحاظ آماری معنی دار بود($p=0.033$) و سایر گروه ها اختلاف آماری معنی داری را نشان ندادند.

نتیجه گیری: Biodentine کمترین میزان تغییرات رنگی را در مقایسه با ۲ ماده دیگر نشان داد لذا به نظر می رسد که می توان با اطمینان بیشتری کاربرد این ماده را در نواحی زیبایی توصیه نمود.

واژگان کلیدی: Biodentine, CEM cement, Mineral trioxide aggregate

Introduction

Cosmetic plays a crucial role in dentistry and tooth discoloration may have a significant impact on the life quality of an individual. Most of the materials used in endodontic procedures may lead to discoloration and inelegant results.[1]Generally, the selection of a specific material for an endodontic use should be based not only on its biological and functional properties, but also on cosmetic considerations. Thus, the biomaterials used inendodontic applications should have color stability, exhibit the visual features similar to dentinal structures and display no discolorations on hard tissues. [2]Tooth discoloration is a common problem caused by endodontic materials, leading to the dissatisfaction of 31.6-57% of patients.[3]Induced discoloration as a common issue that damages treatment quality. The main cause of discolorationover time is penetration of materials into dentinal tubules. [4] MTA is mainly composed of calcium,silica and bismuthoxide.MTA has

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beendeveloped as an apical sealing material although it has other major indications such aspulp capping, apexification andsealing material for perforation repair. In some situations,MTA has a coronal position.[5]Despite its ideal features as a restorative endodontic material,tooth discoloration is a concern about the use of MTA.[1]

CEM cement containsCaO (51.75%), SO3(9.53%), P205(8.49%) and SiO2(6.32%) as well as its minor components are AL203>Na2O>MgO>Cl.The clinical use of CEM is similar to MTA.CEM compared to MTA is capable of being set in a humid environment in a shorter period of time. [6]It seems that this material may cause discolorations similar to MTA. [3]

New calcium-silicate-based materials (CSM) have been developed to overcome MTA side effects. Biodentine introduced as a newly developed CSM. This materialis adentin bioactive substitute with endodontic indications similar to MTA. Biodentineincludes water-reducing agent, water-based liquid containing calcium chloride as a setting accelerator, zirconium oxide as a radiopacifier, calcium carbonateandtricalcium silicate.[5] Manufacturersclaim that their product has overcome MTA deficiencies such as discoloration probability. [7] This study aimed at comparing the discolorations induced following treatment by Mineral Trioxide Aggregate, Calcium Enriched Mixture, and Biodentine using a spectrophotometric analysis.

Materials & Methods

This study was approved by Ethical Committee of Babol University of Medical Sciences (MUBABOL.REC.1395.168). The samples in this experimental study were40 human mandibular anterior teeth, which had been extracted due to the periodontal causes. All teeth had no coronaldecay, restoration or cracks, and attempts were made to select the teeth with nearly similar sizes. They were immersed in 5.25% sodium (hypochlorite solution)for disinfection for one hour, and then stored in (normal saline)before using them.

Surface pigments wereremoved by an ultrasonic scaling (NSK, Shimohinata, Kanuma, Japan) and then were cleaned using prophylaxis paste (Golchay, Karaj, Iran) and brush. Then, the teeth were horizontallysectioned from 2 mm below the cement–enamel junction (CEJ) by using an IsoMet cutting disc (Buehler, Waukegan, USA).The apparatus was set on the CEJ of the teeth andsectioned 2 mm more apical of that point. Pulp of the coronal area was chemomechanically removed by using Hedstromfiles (MANI,INC,KIYOHARA,JAPAN) and 5.25% NaOCL. Then cavities were drilled 2 mm away from incisal edge in the teeth througha retrograde methodusing a 0010 diamond bur (Teeskavan,Tehran,Iran).

Burs with identical thickness and length was used to make equal cavities. The identical length of 7 mm from the point of entrywas considered for all sampleswith respect to the mean of the approximate length of crowns. The dimension of cavities was7x1x1 mm^3. The cavities were washed by 5.25% NaOCL and 5ml of saline, after that, the teeth were randomly divided into 4 groups. The cavities of group 1, 2, and 3 were filled up to CEJ level by MTA Angelus(Angelus Lodrina,Parana Brazil), CEM cement (Bioniqu Dent, Tehran, Iran), biodentine (Septodont, Saint-Maur-des Fosses, France), respectively, andall cavities of group 4/control were filled by resin composite A3 (3M ESPE,USA). All samples were stored for 48 hours in an incubator at 37°C and humidity of 100%.Then they were sealed by resin composite A3 (3M ESPE,USA)as much as 2 mm. Finally, they were stored in a glass PECO (PECOLAB,Shiraz,Iran) incubator with the humidity of 100% under laboratory light.

Color evaluation was performed by a Ci6X X-Rite (X-Rite, GRAND RAPIDS, USA) spectrophotometer, with wavelength range of 360-750 nm. The light source of the apparatus was at the angle of D65/10 °SPIN to the longitudinal axis of the samples, Color evaluation was conducted in a dark room under standard conditions. For the recurring position of the teeth, they were mounted in identical transparent acrylic resin blocks. The resin blocks had identical shapes, lengths and widths (due to using the same mold) to put labial surfaces of teeth upward in front of the eye of apparatus, as well asthe distances between the samples and the eye of apparatus wereequal for all samples. Color evaluation was performed three times on the 3 points of the surface of each tooth and the mean value was calculated.

Color evaluation was carried out at different interval including: the baseline, one week, one month, 3 months and 6 months after placement and was calculated as per$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{\frac{1}{2}}$formula where L* indicated lightness in the range of 0 (black) and 100 (white). Mark a* representedthe redness/greenness where negative and positive values referred to greenness and redness, respectively. Mark b* illustrated yellowness/blueness where negative and positive values referred to blueness and yellowness, respectively.

The data were analyzed using SPSS 17 and Tukey HSD and ANOVA statistical test. Data distribution normality was examined by the one-sample K-S test.

Results

In our study ΔE in each stage was measured in comparison with baseline.Based on the results, in every step in all groups,the discoloration during the measured periods had no statistically significant difference (P=0.134); however, the discoloration rates of different materials varied over time. (P=0.03)

The minimum and maximum discolorations were related to Biodentine and MTA respectively, with significant difference (P=0.033). Other differences, between MTA and CEM cement (P=0.70) and MTA and control group (P=0.177), and between CEM cement and Biodentine (P=0.988) and CEM cement andcontrol group (P=0.968), and finally between Biodentine and control (P=0.862) were not statistically significant.

The interaction between material and time was not significant (P=0.592) andthe pattern of oscillation of ΔE was the same in different materials over time.

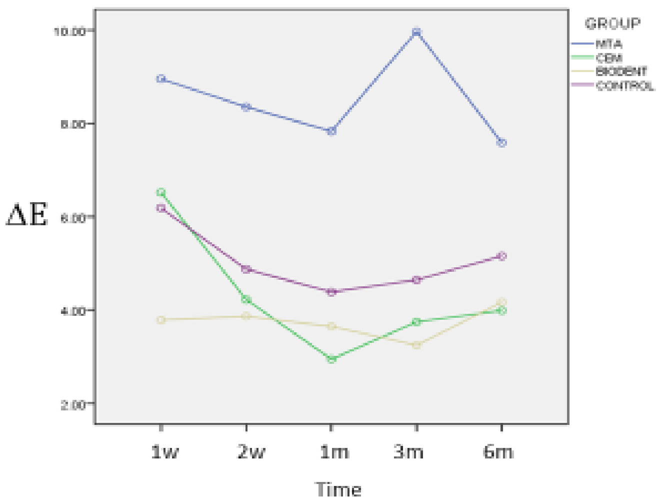

Figure 1. The mean of ΔE in different periods of time and materials
M=month W=week

Discussion

MTA Angelus indicated maximum discolorations in our study. The teeth discoloration associated with MTA has been reported in different in vivo and in vitro studies.[8]Bismuth oxide added to MTA to improve its radiopacity property seems to be responsible for its related discoloration.[1]One of the possible mechanisms for discoloration is the interaction between bismuth oxide and NaOCL.[7] in our study, the 5.25% NaOCL was used while preparing thecavities, which might be one of thepossible reasons for further discoloration of MTA Angelus. In the current study, all samples were placed in a PECO glass incubator under fluorescent laboratory light duringall periods of assessment. Sinceone of other possible mechanisms of discoloration aredecomposition of bismuth oxide into dark metallic color crystals and oxygen, when exposed to a visual light and ultraviolet, [1]our storage condition in a glass incubator and the condition of exposure to a visual light mightbe another reason for further discolorations of MTA Angelus.

In the present study, the MTA Angelus and Biodentine illustrated the maximum and minimum discoloration, respectively. There were statistically significant differences between the two materials as far as various rates of discolorations were concerned. The obtained results of the current study were consistent with those of Shokouhinejad et al. [7], Yoldas et al. [8], Ramos et al. [2], Marconyak et al. [1], Valles et al. [5]and Kohli et al. [9]The results were inconsistent with the study of Beathy et al. [10],who found that the Biodentine discoloration was more thanProRoot MTA.

In Biodentine composition Zirconium oxide was used as the radiopacifier rather than bismuth-oxide. [5]Marciano etal.have concludedthat the zirconium oxide and calcium tungstate representcolor stability. In their study, zirconium oxide and calcium tungstate showed no discoloration in contact with collagen, whilethe bismuth oxide demonstratedclear discolorations in contact with collagen. [11]This finding can explain the Biodentine color stability proved in other studies. [5]In recent studies, Biodentinein comparisonwith other materials exhibited the minimum discoloration and the absence of bismuth oxide in the structure and composition of this material mightbe considered as one of the possible causes of lower discoloration.

In the present study, the discoloration of CEM cement compared to MTA Angelus clearly was lower with no statistical difference. This finding was consistent with the study of Esmaeili et al. [12] and inconsistent with the study of Arman et al. [3] who clinicallyfound no difference in the discoloration of the two materials. Despite MTA, CEM cement have no Iron

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(fe) and bismuth oxide in its composition.[3]The studies have shown that these two factors (fe and bismuth oxide) may cause discolorations. [1,13] Therefore, it is expected that the discoloration of CEM cement will be lower than that of MTA. This study arrived at the same conclusion. Lower discolorations of CEM cement than MTA Angelus in the present study may be due to the lack of iron and bismuth oxide in the composition and structure of CEMcement compared to MTA Angelus.

However, the studies represented that CEMcement may show some discolorationsdue to other components (calcium carbonate, calcium oxide, calcium phosphate, calcium silicate, calcium sulfate, calcium hydroxide and calcium chloride) [3]and this may explain further discolorations in CEM cement compared toBiodentine in the present study. In this study, the discolorations of Biodentinewere lower than that of CEMcement with no statistical significant. No study has ever compared these two materials, and to our best knowledge,this is the first study to prove that the discolorations of Biodentineare lower than CEMcement.

According to studiesthe sealability of Biodentine is similar to MTA, and compared with MTA ,Biodentine handles easily and has a significantly shorter setting time than MTA. [2,8] .As respectsour results proved the lower discolorations of Biodentine, and the fact that its discolorations were significantly lower than MTA, Due to this advantage over MTA,Biodentine can be recommended more confidently for cosmetic areas.

Conclusion

Biodentine showed minimum discoloration potential; thus, it can be recommended as a suitable material for cosmetic areas.

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Conflict of Interest: We declare no conflict of interest.

Authors Contributions

The study was designed by ZahraSadatMadani. AzinJamshidifar and ZahraSadatMadani defined the conceptual content of the research.The study data was collected by AzinJamshidifar.Statistical analysis and interpretation of data were accomplished by Akbarzadeh and AzinJamshidifar.Preparation of manuscript was performed by AzinJamshidifar and its editingand revision was done by ZahraSadatMadani.Study supervision was performed by ZahraSadatMadani.

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