Maxillary Midline Diastema closure with a single lithium disilicate ceramic fragment: avoiding staining and increasing long-term color stability

<table>
<thead>
<tr>
<th>Journal:</th>
<th>International Journal of Interdisciplinary Dentistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuscript ID</td>
<td>REVISTA-2020-0047.R1</td>
</tr>
<tr>
<td>Manuscript Type:</td>
<td>Clinical Reports</td>
</tr>
<tr>
<td>Date Submitted by the Author:</td>
<td>21-Oct-2020</td>
</tr>
<tr>
<td>Complete List of Authors:</td>
<td>Durán, Gerardo; Universidad Arturo Prat, Facultad de Ciencias de la Salud Sobral, Camila; Universidad de los Andes Facultad de Odontología, Odontología Restauradora Romero, Victor; Universidad Nacional Andrés Bello, Departamento de Odontología Restauradora</td>
</tr>
<tr>
<td>Keywords:</td>
<td>ceramic, midline diastema closure, ceramic fragment</td>
</tr>
</tbody>
</table>
FIGURE LEGENDS

Figure 1. A: Initial situation. The patient presented with a maxillary midline diastema. B: Digital planning results showed shape alteration in tooth 11. Restoring tooth 11 was planned with a ceramic fragment to close diastema between both upper central incisors.

Figure 2. Ceramic fragment restoration over working model.

Figure 3. A: Try-In of the ceramic restoration. B: Application of adhesive system to the enamel surface. The procedure is performed under rubber dam isolation. C: Cementation of the ceramic restoration after surface treatment of the teeth and the ceramic fragment. D: Light curing the ceramic restoration.

Figure 4. Patient was scheduled for an appointment the week after the cementation, although she did not show up. Three months after cementation procedure, the patient arrived to the appointment presenting visible staining at the ceramic fragment/tooth interface.

Figure 5. Using fine diamond burs, the thickness of the ceramic restoration and the slight excess is carefully removed.
Figure 6. A: First diamond wheel used to smoothen the ceramic surface and also the interface. B: Medium coarse diamond cup, used to soften the tooth-ceramic interface and also the ceramic restoration. C: Gloss diamond wheel, used to ensure a high luster surface with an imperceptible tooth-ceramic interface.

Figure 7. 18-month control. Final result.
To Whom It May Concern:

I, Pablo J. Atria, certify that the English version of the manuscript entitled “Maxillary midline diastema closure with a single lithium disilicate ceramic fragment: avoiding staining and increasing long-term stability” was corrected for language mistakes.

My TOEFL ID of approval is: 35946336

Sincerely,

Pablo. J. Atria
Figure 1. A: Initial situation. The patient presented with a maxillary midline diastema. B: Digital planning results showed shape alteration in tooth 11. Restoring tooth 11 was planned with a ceramic fragment to close diastema between both upper central incisors.
Figure 2. Ceramic fragment restoration over working model.
Figure 3. A: Try-In of the ceramic restoration. B: Application of adhesive system to the enamel surface. The procedure is performed under rubber dam isolation. C: Cementation of the ceramic restoration after surface treatment of the teeth and the ceramic fragment. D: Light curing the ceramic restoration.
For Review Only

Figure 4. Patient was scheduled for an appointment the week after the cementation, although she did not show up. Three months after cementation procedure, the patient arrived to the appointment presenting visible staining at the ceramic fragment/tooth interface.
Figure 5. Using fine diamond burs, the thickness of the ceramic restoration and the slight excess is carefully removed.

146x98mm (299 x 299 DPI)
Figure 6. A: First diamond wheel used to smoothen the ceramic surface and also the interface. B: Medium coarse diamond cup, used to soften the tooth-ceramic interface and also the ceramic restoration. C: Gloss diamond wheel, used to ensure a high luster surface with an imperceptible tooth-ceramic interface.
Figure 7. 18-month control. Final result.
CONSENTIMIENTO INFORMADO DE PARTICIPACIÓN EN ESTUDIO

El presente formulario de consentimiento informado se dirige a
Nombre del paciente: [Nombre del paciente]
RUT: [RUT del paciente]
Edad: [Edad del paciente]
Dirección: [Dirección]
Nacionalidad: [Nacionalidad]

Investigador principal: Gerardo Patricio Durán Ojeda
Nombre propuesta o versión: “MAXillary Midline Diastema closure with a single lithium disilicate ceramic fragment: avoiding staining and increasing long-term color stability”

Introducción

El investigador a cargo, pertenece al equipo docente de la facultad de Ciencias de la Salud de la Universidad Arturo Prat sede Iquique. Por medio del presente consentimiento, queremos invitarle a participar de este estudio, en el cual se enviará el presente caso clínico para publicación en revista especializada de odontología restauradora y rehabilitación oral.

Propósito

La rehabilitación oral actual está fuertemente fundamentada en la adhesión y en la restitución completa de la forma, color y función de las estructuras dentarias originales, manteniendo al mismo tiempo la salud periodontal (encías). El presente estudio tiene por objetivo presentar y publicar un caso de rehabilitación oral adhesiva de fragmento cerámico para el cierre de diastemas (espacios entre dientes), en la que se devuelve la salud y función de las piezas dentarias a través del cierre de diastemas (comprévase cierre de espacio entre incisivos centrales superiores) utilizando técnicas y materiales de alta calidad, basados en la evidencia científica más actualizada disponible.

Tipo de intervención de Investigación

El presente estudio constituirá un reporte de caso clínico en odontología estética restauradora para solucionar el cierre de diastemas entre ambos incisivos centrales superiores mediante un fragmento cerámico unitario en un inciso central unitario (diente 1.1).
DECLARACIÓN DE PARTICIPACIÓN VOLUNTARIA

Su participación en el presente estudio es **ANÓNIMA y VOLUNTARIA.** Usted puede o no aceptar participar en esta investigación. Ya sea que decida no autorizar el uso de la información clínica y fotográfica, no tendrá ningún efecto en la continuidad del tratamiento.

**Procedimientos y protocolos**

El investigador principal recopilará la información clínica y científica relevante y la desarrollará bajo el formato de artículo para publicación. A su vez, editará los registros fotográficos necesarios para la elaboración del artículo.

Solo los investigadores designados tendrán acceso a la información médico-odontológica y fotográfias, previa autorización del investigador encargado.

**NADIE AJENO A LA INVESTIGACIÓN TENDRÁ ACCESO A ESTA INFORMACIÓN MÉDICO-ODONTOLOGICA SENSIBLE.**

**UNICAMENTE SE UTILIZARÁN REGISTROS FOTOGRAFICOS INTRAORALES, quedando descartados en la publicación los registros extra orales y faciales, de manera de resguardar el anonimato.**

**Duración**

Al haber concluido la primera etapa del tratamiento, solo requerirá el tiempo necesario para los respectivos controles, que pueden oscilar entre 20 a 60 minutos.

**Efectos secundarios y riesgos**

No existen efectos secundarios o riesgos asociados a la publicación del caso clínico.

**Beneficios**

Al autorizar el uso de los registros para publicación, se obtendrá información valiosa y relevante para mejorar la calidad de los procedimientos rehabilitadores adhesivos, los que actualmente se aplican en base a la evidencia científica.

**Incentivos**

Este estudio no contempla incentivos por participación (recomendación de la Organización Mundial de la Salud - OMS).
Confidencialidad

La participación en el presente estudio es **anónima**. La información registrada solo podrá ser utilizada por el investigador responsable, los investigadores colaboradores y/o comités de ética (institucional o de publicación) cuando sea requerido. **Ninguna persona que no fuera parte del equipo de investigación tendrá acceso a la información sensible de la ficha clínica.**

Derecho a negarse o retirarse

La participación en el presente estudio es **voluntaria**. Ya sea que decida no autorizar el uso de la información del caso clínico, no tendrá ningún efecto en la continuación de su tratamiento odontológico.

A quién contactar

Si tiene cualquier pregunta puede hacerlas ahora o más tarde, incluso después de haberse iniciado el estudio. Si desea hacer preguntas más tarde, puede contactar cualquiera de las siguientes personas:

Gerardo Patricio Durán Ojeda

Dirección Avenida Arturo Prat 2120, Iquique, Carrera de Odontología, Facultad de Ciencias de la Salud, Universidad Arturo Prat, Iquique, Chile.

Celular: 972115778

E-mail: Gerardo.duran@unap.cl

FIRMA INVESTIGADOR PRINCIPAL

[Signature]

FIRMA PACIENTE AUTORIZANTE

[Signature]

FECHA: 26/05/2019
Maxillary Midline Diastema closure with a single lithium disilicate ceramic fragment: avoiding staining and increasing long-term color stability

ABSTRACT

Nowadays, maxillary midline diastema (MMD) can be treated with different multidisciplinary approaches. When restorative dentistry is needed, glass-matrix ceramic materials is one of the best choices, since they present good optical behavior and high survival rates in the anterior dentition. To obtain an adequate interphase, and color integration are one of the main restorative goals, and for that purpose, specific finishing and polishing procedures must be employed to avoid staining and ensure the restoration’s color stability. In the case report presented in this article, a single lithium disilicate ceramic fragment was performed to close a MMD produced by the shape alteration of one of the maxillary central incisors. Also, the finishing and polishing procedure is discussed.

Keywords: ceramic; midline diastema closure; ceramic fragment; lithium disilicate

Introduction

Closing a maxillary midline diastema (MMD) are commonly asked daily in dental offices by patients who seek for esthetic restorative treatments, and for that purpose, different restorative treatments can be performed, such us direct and indirect resin composite restorations, ceramic laminate veneers and ceramic fragments. To correctly treat a MMD, clinicians must be aware of its etiological causes, as well as the multidisciplinary approaches that can be performed \(^{1,2}\).
The progress in dental materials and the knowledge of bonding to dental substrates have made possible to restore MMDs using **glass-matrix ceramics** with little to no tooth preparation, conserving sufficient dental structure and thus ensuring optimal bonding to enamel, as well as allowing for long-lasting results \(^{(3)}\). For this purpose, ceramic veneers have demonstrated strength, longevity, biocompatibility, and esthetics, and are also conservative. When a choice is given to the patient, most of them will choose the least amount of tooth structure removal. Patients are highly motivated to have no dental reduction while achieving as many of his treatment goals as possible \(^{(4)}\).

No-prep veneers is a trendy option due to its tooth structure minimum wear or maximum preservation, however, it has been frequently criticized for some potential limitations including esthetic outcomes and periodontal complications \(^{(4)}\). **No-prep ceramic fragments**, also called sectional or partial veneers, are a small fragment of glass type ceramic indicated for the treatment and reconstruction of teeth fractures, closing diastemas, re-anatomization of conoid teeth, restoring canine guidance and correcting tooth morphology \(^{(5)}\). High-quality no-prep veneers or partial ceramic fragments also, can be more challenging to perform than conventional veneers, and a combination of good case selection, margins’ position, adhesive principles, clinical, and technician experience is paramount for a long-term result \(^{(4)}\).

As ceramic fragment restorations do not need for a classical finishing line, the existing adhesive interface may be of concern since there is no clearly visible adaptation between the tooth substrate and the ceramic fragment, leading to possible biofilm accumulation and color pigmentations within the interface \(^{(5)}\).
Since there is a lack of evidence documented regarding this type of procedure, the following case report describes a step-by-step technique in which a MMD was restored using a lithium disilicate ceramic fragment in a single maxillary central incisor.

Case Report

A 27-year-old female patient presented with a chief esthetics complaint produced by the presence of maxillary midline diastema between both upper central incisors. After anamnesis, clinical examination, radiographs, photographs and study stone models, it was concluded by a digital analysis tool the alteration in shape and size of tooth 11 (Fig. 1). After explaining the patient about the advantages and disadvantages of every treatment alternative, it was decided to perform a single ceramic fragment to restore tooth 11 in order to close the MMD.

A die model was obtained by a one-step impression with polyvinyl siloxane with two consistencies (Elite HD Putty Soft and Elite HD Light Body, Ivoclar Vivadent), in which a lithium disilicate ceramic fragment (IPS e.max PRESS, Ivoclar Vivadent) was made using an A1 HT ingot and characterized by cut-back technique with a nanofluorapatite ceramic (Power Enamel, IPS e.max Ceram, Ivoclar Vivadent) (Fig. 2).

The fitting and adjustment of the ceramic restoration was proved clinically using a translucent try-in paste (Variolink Esthetic Try-In Paste Neutral, Ivoclar Vivadent) which also allowed the verification of color integration between the restoration and the tooth enamel surface (Fig. 3A).

Bonding procedure was performed under rubber dam isolation (Fig. 3). Enamel surface was first cleaned with airborne-particle abrasion (Aquacare, Velopex). 35%
phosphoric acid was then applied for 30 seconds (Ultra-etch, Ultradent Products Inc.), rinsed-off with water for the same time, and air-dried. A thin layer of a 2-step adhesive system (Optibond S, Kerr) was softly applied and gently air-dried to evaporate the solvents (Fig. 3B). No light curing was performed at this time, leaving the adhesive uncured.

The inner surface of the ceramic restoration was conditioned with 9.5% hydrofluoric acid for 20 seconds (Porcelain Etchant, Bisco), and cleaned with 97% alcohol under ultrasonic bath for 5 minutes. Silane coupling agent was applied and heated at 100°C for 60 seconds (Monobond Plus, Ivoclar Vivadent), a thin layer of ceramic bonding was applied (Heliobond, Ivoclar Vivadent) and a small amount of resin cement was charged into the conditioned surface (Variolink Esthetic LC Neutral, Ivoclar Vivadent). No light curing was performed at this stage.

Once the teeth surface and the ceramic restoration were conditioned, the restoration was positioned over the tooth using light finger pressure (Fig. 3C). The excesses of resin cement were eliminated using a clean brush. 30 seconds of light curing at low power mode (650 mW/cm² of intensity, Bluephase, Ivoclar Vivadent, Liechtenstein) was performed to ensure the maintenance of the correct positioning of the restoration, and then a final 60 seconds of high power program (1200 mW/cm², Bluephase, Ivoclar Vivadent, Liechtenstein) was done to ensure the correct degree of conversion of monomers of the resin cement (Fig. 3D). Resin cement excesses were cleaned with a brush and patient was supposed to be back after a week for polishing, however she did not show up for the control session.
After 3 months of cementation, resin ceramic fragment margins and the tooth was presented with staining on its surface (Fig. 4), thus, finishing and polishing procedures needed to be performed to bring back the quality and esthetic of the restoration. The finishing procedure started using a diamond bur at high speed to reduce vestibular volume of the restoration (Fig. 5), verifying the maintenance of tooth shape (Komet 8850.314.016), being careful for not touching sound enamel. A coarse diamond wheel for ceramics was used to smoothen the fragment restoration and the interface surface at low speed using soft pressure (Blue Coarse Twist, Diapol® Twist RA, EVE, Germany) (Fig.6A), followed by a medium diamond cup (Medium cup Diapol®, EVE Germany) (Fig.6B) and a fine diamond wheel for surface gloss of the interface (Yellow Coarse Twist, Diapol® Twist RA, EVE, Germany) (Fig.6C). A final image was taken after 18-months for controlling the restoration, showing esthetic margins and perfect color stability (Fig. 7).

Discussion

Maxillary midline diastemas can be treated with different restorative approaches. The present clinical case described the use of a glass-matrix ceramic fragment as a first restorative treatment choice for closing a MMD in a single tooth, since the shape of tooth 1.1 was altered. According to the digital planning, there was no need to restore tooth 2.1. Direct composite resins for this cases may be a viable option that requires of a highly trained clinician for higher esthetic outcomes. In the presented case, ceramic fragment was chosen because of surface gloss properties maintenance, less biofilm accumulation and less surface degradation. Also, as this case was managed by the laboratory technician through the indirect method, better contact point control could be
achieved and also the ceramic characterizations of the incisal edge can be controlled with confidence of the working cast model. Under no circumstances was laminate veneers chosen for this treatment due to the need to prepare the enamel, leading to further removal of healthy enamel unnecessarily.

Due to ceramic fragment’s small thickness (0.3 or less), it is possible to restore tooth shape abnormalities with a minimal invasive approach, with little to no tooth preparation. The fact that no tooth structure is removed means intermediate provisional restorations are not required (4). Moreover, the failure rate of dentin-bonded veneers is much greater than those bonded to enamel, as this substrate promotes increased strength and long-term durability (6). Glass-matrix ceramics are the most used as ceramic fragments, which presents higher wear resistance than resin composite materials (7), as well as increased maintenance of gloss and luster, color stability and less biofilm accumulation (8).

Bonding interfaces from full crowns, conventional veneers and ceramic fragments are different within each other. When dealing with ceramic fragments, fitting is performed in undefined margins, thus, it is recommended that the laboratory create slight excesses over the tooth to improve adjustment (5), and there is no edge to edge junction from the tooth surface and the restorations, which represents a continuous area of adhesive interface (6). Since light-cured adhesive resin cements present low filler charge, staining of the adhesive interface can be expected, as well as wear in the long-term. It has been recommended the use of pre-heated composite resin as luting agent due to its higher filler content, however, its film thickness is greater than from resin cements (9), and try-in is not possible as try-in pastes are not available, thus color selection may be a problem.
In the present clinical case, staining of the interface was observed after 3 months of the cementation of the restoration. The chromatic change observed could be due to hydrolytic degradation of either the adhesive system or the resin cement used for cementation of the ceramic fragment. At the time of luting the ceramic, the water in the system may have been incorporated by hydrophilic groups in the resin cement or adhesive system and cause degradation. The presence of TEGMA in the materials also contributes to color degradation due to release of large quantities of monomers in an aqueous medium. The contact of such components with the oral environment, which gets into contact with common colorful foods and drinks, can cause color changes in resinous materials.

Although noticeable unaesthetic staining was observed after a short term period, in the present case, polishing helped on solving the chromatic changes and promoting an initial esthetic situation back again. No-prep veneers are indicated for a selected number of cases only, while a higher number of cases do require some kind of tooth modification and preparation. Discoloration of adhesive resin cements can be caused by intrinsic or extrinsic factors, such as the material itself, polymerization type, photoinitiator, filler type, beverages and foods. In the present clinical case, after cementing the ceramic fragment, cleaning of the excesses was performed only with a brush, it was previously mentioned that in this situation staining occur more easily, and it can be decreased when the oxygen-inhibited layer of the adhesive resin cement is removed after polymerization by the polishing procedure.

Finishing the excesses of ceramic over the tooth as well as resin cement and adhesive excesses must be carefully performed with burs, always taking into account to...
reduce ceramic material and not tooth enamel. Also, as diamond burs leaves irregular and rough surfaces, thus polishing the ceramic and also the interface is mandatory to ensure a smooth and luster surface and it must be performed with diamond for ceramics finishing cups or wheels indicated for the selected ceramic system. It has been emphasized that a small rough surface or minimal porous surface with 0.2 micrometers (Surface Ra Values) could lead to biofilm accumulation in any surface (14), turning the once imperceptible interface, now visible. This needs to be controlled in time, and re-polishing must be considered once a year during control appointments to ensure the quality and survival of the restoration.

Finally, occlusion must also be carefully considered, since high stress could be distributed at direct oclusal and inclined forces (15), thus, direct contact to the interface must be avoided to ensure the integrity of the restoration.

Conclusion

Sectional veneers or ceramic fragments are a suitable option to restore maxillary midline diastema with optimal esthetic results when indicated. Bonding procedures must be highly respected to increase survival rates, and polishing procedures must be performed using the correct polishing system indicated for the specific ceramic type selected. The authors strongly indicated that, when performing ceramic fragments, appropriate polishing must be performed in the interface after cementation, and periodic controls and proper maintenance of the restorations must be performed for assurance of long lasting results.
DISCLOSURE

The authors do not have any financial interest in any of the companies whose products are included in this article.

REFERENCES


