International Journal of Applied Dental Sciences 2023; 9(4): 154-158

ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2023; 9(4): 154-158

www.oraljournal.com
Received: 25-08-2023
Accepted: 05-10-2023

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Materials used in rehabilitation of anterior teeth with Maryland adhesive bridge

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DOI: https://doi.org/10.22271/oral.2023.v9.i4c.1865

Abstract
Introduction: Adhesive bridges are introduced to the market due to the need to provide more patient comfort and promote minimal invasiveness in restorative dentistry.
Objective: Analyze the literature about the different materials that can be used to make a Maryland adhesive bridge. It is particularly analyzed about its manufacture with zirconia, its manufacture with Lithium Disilicate and its manufacture with metal ceramics and finally with PMMA as an alternative to a minimally invasive treatment.
Methodology: Qualitative and retrospective systematic bibliographic review, an electronic search was carried out through PubMed, Google Scholar and Elsevier using the terms "adhesive bridge", "minimally invasive", "zirconia" and "E.Max".
Results: There is a wide variety of materials for the manufacture of Maryland adhesive bridges such as: Zirconia, which has excellent physical and mechanical properties; Lithium Disilicate with a highly aesthetic property due to its translucency, porcelain metal with its various favorable characteristics and PMMA with its simplicity in manufacture.
Conclusions: There are different situations for which the Maryland bridge is indicated, mainly to maintain some space after orthodontic treatment. It is important to have previous knowledge of the protocol indicated for the adhesion of the adhesive bridge and its materials.

Keywords: adhesive bridge¨minimum invasion¨zirconia¨and¨E. Max¨

Introduction
Missing teeth in the anterior aesthetic region represent an urgent need for dental intervention and often require an early treatment strategy that restores the aesthetic and functional aspects of the dentition. (Kern M, *et al*. 2017) [14].
The world of dentistry was introduced to a revolutionary and aesthetically pleasing adhesive-retained fixed partial denture for the replacement of previous missing teeth. (Gutman JL, 2019) [10] In the 1980s and 1990s, improvements in preparation methods, metal alloys, and bonding techniques made adhesive bridging a more predictable option. (Wyatt CC, 2007) [32].
Two-unit cantilever resin (CL2) bonded fixed partial dentures (RBFPDs) are a highly successful and reliable tooth replacement option. (Lam WYH, 2019) [18] Preservation of the upper lateral incisor space after orthodontic treatment traditionally requires the use of a retainer with a lateral pontic; A pontic is constructed with fluid composite while the retainer is maintained until the patient is of age for a more permanent restoration. (Kravitz ND, 2020) [17].
Although implants are considered a better treatment option for the rehabilitation of patients with missing anterior teeth, resin-bonded bridges (RBBs) can conservatively restore missing teeth and have therefore gained popularity over the years. (Rathee M, 2022) [25] In such cases, resin-bonded bridges (RBBs) are considered a better treatment option. It can be used as a permanent and intermediate prosthesis when planning implants and fixed partial dentures. (Gutman JL, 2019) [10].

Justification
A Maryland adhesive bridge is a solution for patients with some dental absence, which offers us a wide variety of materials with different favorable characteristics, mostly in aesthetics and satisfactory function.

There is no research specifically focused on the materials available for its manufacture. It is of interest to analyze its indications, contraindications, advantages and disadvantages in order to favor the survival rate of this type of restoration.

Objective

The objective of this review article is to present and update the existing information to date on the literature about the various materials in the manufacture of Maryland adhesive bridges such as zirconia, lithium disilicate, porcelain metal and PMMA.

Methodology

An electronic search was conducted through articles published in the last 5 years (2018-2022) using the PubMed, Google Scholar and Elsevier databases. Keywords used for the search include "adhesive bridge", "minimal invasion", "zirconia" and "E.Max". Articles were collected only from high-impact journals, literature reviews and systematic reviews related to the different materials for the manufacture of Maryland-type adhesive bridges as an alternative to a minimally invasive treatment. It was taken into account that the search for the respective articles and journals were within 5 recent years.

Results

Zirconia in Maryland Adhesive Bridge Manufacturing

Indications

Zirconia structure is used in adhesive bridges to prevent pontic fractures since zirconia has the highest load failure. (Zhang Y, Lawn BR, 2019) [33] Today, the most commonly used type is a non-perforated, sand-polished, non-precious metal frame prosthesis fixed with a chemically active resin cement. (Shahdad S *et al*., 2018) [27] The researchers have found that an ideal surface treatment of this ceramic, considered chemically inert, should be carried out by tribochemical sandblasting, followed by silane and a bonding agent based on 10 MDP. (Fernández Franco DA *et al*., 2022) [5].

Contraindications

The manufacturer's recommendations for the preparation of CAD-CAM YTZP structures state that sandblasting the surface with Al2O3 can cause damage and deformation in the crystal lattice structure, which could lead to a phase change (from tetragonal to monoclinic), requiring thermal heat treatment to reverse this. Therefore, a sandblasting cleaning regimen is not used, as it is thought that this could cause surface micro-cracks and phase changes that would affect the survivability of thin YTZP substrates. (Shahdad S *et al*., 2018) [27]]Milling tools create a thin area that can reduce the mechanical properties of the substrate in contact with the antagonist dentition and its susceptibility to low-temperature degradation. CAD-CAM enables fast and accurate manufacturing of YTZP substrates; However, it is important to carefully evaluate the three-dimensional design before the manufacturing process due to the geometry of the milling cutters and the efficiency of the subsequent sintering process. (King PA *et al*., 2015) [16].

Advantages

Zirconia has been found to be chemically and dimensionally stable. Zirconia has opened up new horizons towards metal-free restorations in recent years and contains superior wear resistance compared to other ceramic materials. (Kakkad N *et al*., 2022) [13] The structure is designed on a computer and then milled, as this method has been shown to demonstrate proven accuracy and fit. One of the main advantages of using this material is the superior aesthetics that could be achieved, especially when replacing teeth in relatively young adults with associated translucent teeth and the relative biocompatibility compared to non-precious metals. (Shahdad S *et al*., 2018) [27] The use of machined zirconia (3Y-TZP) has become an ideal option nowadays, since mechanical properties are very high, in these restorations its cementation is mechanical-retentive with non-adhesive or low adhesion sealing cements. (Bueno Cancino, 2019) [2].

Disadvantages

The most common problems associated with zirconium restorations are chipping and disbonding. The roughness of the surface and the type of bonding agent used determine the binding strength of zirconia. (Moraldi Z *et al*., 2021) [21] A major deficiency of zirconia is the absence of durable bonding to achieve long-term stability, this can be due to improper preparation of the abutment teeth or incorrect application technique, but the main reason is the absence of the bonding agent. (Saleh N. *et al*., 2019) [26].

Discussion-Conclusion

It is found that Maryland adhesive bridges based on zirconia have a high degree of resistance and clinical performance, thanks to its favorable characteristics we can use this material in the manufacture of bridges only adhered under the strict adhesion protocol with an unmatched quality, however, be careful with its contraindications to give greater longevity to the restorations.

Lithium Disilicate for Maryland Adhesive Bridge Manufacturing

Indications

The combination of a conventional metal-free prosthesis is an efficient alternative for the management of upper anterior partial edentulism with minimal tooth wear. (Hoyle WA, 2019) [12] The type of functional occlusion of the patient is very important for metal-free ceramic adhesive bridges, because in each type of occlusion different forces can focus the adhesive bridges. (TGPT, 2017) [30] IPS e.Max lithium disilicate (Ivoclar Vivadent) is the most widely used glass-ceramic in dentistry in two forms, a milling block (IPS e.Max CAD) and an automatic pressable system using the lost-wax technique (IPS-e.Max Press). (Butt K *et al*., 2019) [3] A material that is often used for individual crowns and partial ceramic restorations is lithium disilicate, which has good material properties for use. (Hallmann *et al*., 2018) [11].

Contraindications

Lithium disilicate is not widely used as it is not indicated by manufacturers. (Gresnigt MMM *et al*., 2020) [9] There is little experience with lithium disilicate as the manufacturer does not support an overhang on adhesive bridges made of lithium disilicate. (Sun *et al*., 2013) Unfortunately, lithium disilicate adhesive bridges with two conventional retainers showed a relatively high fracture rate during the first year of clinical service, however, the often unilaterally fractured adhesive bridges remained in situ as cantilever adhesive bridges for five and ten years. (Kern M, 2017) [15].

Advantages

Lithium disilicate has been used by clinicians to replace

metal-framed resin adhesive bridges. (Alraheam IA, *et al*., 2019) [1] The microstructure is needle-like and homogeneously intertwined in the glass matrix; It plays an important role in crack propagation, resulting in increased flexural strength between 300 and 400 Mpa. (Butt K, 2019) [3].

Disadvantages

A problem associated with the treatment of adhesive bridges with ceramic material is fracture, however, the clinical results are convincing due to their significant improvement in materials and clinical techniques. (Mourshed B *et al*., 2018) [21] Ceramic faults were characterized by disunion and fracture of the connector site respectively. (Gresnigt MMM *et al*., 2020) [9].

Lithium disilicate materials are increasingly replacing conventional ceramic metal treatments due to their suitable aesthetic advantages in the anterior area. Lithium disilicate materials have an important function due to their excellent properties and demonstrate their superiority over other materials thanks to their variety of indications.

Metal Porcelain for Maryland Adhesive Bridge Fabrication

Indications

Previously, in the 1980s, adhesive bridges were made with a metal structure, however, the biggest aesthetic problem was that the metal caused the tooth attachment to lose its natural translucency and become grayish through its adhesion to the lingual surface. Nowadays, with technological advances, they are made completely metal-free. (Tezulas E *et al*., 2018) [29] Adhesive bridges with metal structure demonstrate adequate fracture resistance and cost-effectiveness, however, they have been criticized for their aesthetic limitations due to the grayish effect of the abutment teeth due to the shine of the metal. (Shahdad S. *et al*., 2018) [27] Fixed dentures bonded with metal cantilever resin (RBFDP) are widely used when anterior teeth are missing. (Gresnigt MMM *et al*., 2020) [9].

Contraindications

The survival rate of adhesive bridges differs greatly depending on the type of metal alloy and the adhesion system used. The wide range of reported survival rates indicates that although the adhesive bridge is a reliable prosthesis, it is prone to failure if some processes are not completed. (Tanoue N. *et al*., 2021) [28] As a combination of noble metals, the alloy requires surface treatment to improve its bonding, particularly when manufactured into resin-bonded prostheses. (Chen X *et al*., 2018) [4].

Advantages

Silicate coating techniques have evolved, increasing the success of metal adhesive bonds. The developments greatly increased the choice of metals and allow for simple preparations. (Tanoue N. *et al*., 2021) [28] A primer for metals has been confirmed to effectively increase the bond strength between alloys and other materials. The use of a silica coating in combination with silane increases adhesion. (Chen X *et al*., 2018) [4] Cast metal-based resin-retained bridges (RRBs) offer a practical and conservative approach to restoring edentulous spaces. (Dunn K, *et al*., 2022) [5].

Disadvantages

The disadvantages of metal adhesive bridges include reduced long-term survival rates compared to conventional bridges. (Dunn K, *et al*., 2022) [5] The most common complication is debonding. (Thoma DS. *et al*., 2017) [31]

There are limitations to this type of material, however, its use in adhesive bridges promises favorable results and an acceptable survival rate.

PMMA for Maryland Adhesive Bridge Fabrication

Indications

Resin adhesive bridges are indicated in patients who are growing with the absence of any previous tooth in the long term or for patients who are not candidates for a more aggressive treatment due to their age, medical condition or economy. (Alraheam IA *et al*., 2019) [1] It is considered a medium-term alternative treatment option for

replacement of an absent part due to its adhesion capacity, ease of processing, repairability and low cost in the anterior or posterior sector, both in young and adults. (Pankratz *et al*., 2018) [23] In oral rehabilitation, the use of fibers is widely used due to their proven clinical success, being indicated as a support structure in adhesive prostheses, fulfilling a function similar to the metal structures of conventional fixed prostheses. (Goyatá, 2020) [8].

Contraindications

Contraindications for a Maryland adhesive bridge made of resin are patients with limited interocclusal space, parafunctional habits, and teeth with a short clinical crown. (Alraheam IA *et al*., 2019) [1].

Advantages

Polymethylmethacrylate (PMMA) is one of the best-known materials in the manufacture of dental prostheses and implants, with optimal properties for dental application due to the flattering characteristics such as: good aesthetics, biocompatibility, low level of absorption in water, being transparent, light and strong. (Lango-López *et al*., 2022) [19] Adhesive prostheses with fiber-reinforced composite resin have demonstrated good performance in clinical applications due to their good mechanical properties and minimally invasive approach. (Lowery & Vallittu, 2018) [24].

Disadvantages

A fracture of a temporary fixed prosthesis is more likely than that of a permanent prosthesis.

Whereas the strength of the intermediate material, e.g. poly (methyl methacrylate) resin (PMMA), is approximately one-twentieth that of metal-ceramic alloys. (Gegauff & Holloway, 2006) [7].

The construction of adhesive bridges with PMMA material can be manufactured in CAD/CAM technology and is one of the most used materials in cases of temporary and partial restorations due to its advantages such as aesthetics, high resistance and low toxicity.

Conclusion

A very important factor for the success of any restoration depends significantly on the material used to make it. Oral rehabilitation specialists find themselves in a major dilemma when selecting the right material for restoration. It is important that the material is compatible with each patient and that it fulfills its function and aesthetics.

Acknowledgement

Not available

Author's Contribution
Not available

Conflict of Interest
Not available

Financial Support
Not available

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How to Cite This Article
Leos MFS, Flores LEC, Cruz N, Palencia PG. Materials used in rehabilitation of anterior teeth with Maryland adhesive bridge. International Journal of Applied Dental Sciences. 2023;9(4):154-158.