Adhesive cementation protocol in fixed prosthodontics

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ADHESIVE CEMENTATION PROTOCOL IN FIXED PROSTHODONTICS

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Procalamation

To my mentor, Ass. prof. dr. sc. Nikola Petričević, I offer sincere gratitude. For he was not only my mentor in dentistry, patiently and diligently providing answers to all my questions, but he was also my mentor in life. His knowledge and kindness reminded me every day of why I pursued my studies.

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To all my friends who were always by my side, even though I may have wandered without them, thank you.

And to my fifteen-year-old self, this one is for her, because she needed it the most.

“Luck is defined as success or failure apparently brought by chance rather than through one’s own actions. This is far from chance. This is purposeful choices, selfless gestures, relentless hours, and a whole lot of good karma. This is clinical, surgical, militant. Even when they don’t want to compete anymore you find someone to challenge you every single time. Even if that someone is yourself.

It’s not luck my good friends, it’s certain destiny.”

– L. James

ADHESIVE CEMENTATION PROTOCOL IN FIXED PROSTHODONTICS

Summary

The usage of cements in dentistry has been prevalent for decades in various fields of the profession. Although conventional cementation has been deeply ingrained in everyday practices, it is not the best solution for all cases. Due to this, modern dentistry takes a step further by introducing adhesive cementation. It has mostly found its place in minimally invasive procedures such as veneers, since it is the only modality which specifically requires this type of cementation. The use of adhesive cementation expanded to inlays, onlays, overlays and crowns of all types of restorative materials, such as ceramics and composite. To achieve adhesion, two different substrates need to be brought close enough to form an intermolecular bond. The resin cement adheres to these two materials, and it will determine the quality of the bond. If each stage in the adhesive cementation protocol is carefully and thoroughly carried out, a satisfactory outcome can be achieved. Both the abutment and the fixed prosthodontic restoration undergo a series of preparations in the form of etching and silanization of the restoration, followed by etching and applying an appropriate adhesive to the tooth.

The purpose of this thesis is to clarify the step-by-step procedure of adhesive cementation, its theoretical base involving the materials, guidelines, advantages, and disadvantages.

Keywords: Adhesive cementation protocol, resin cements, ceramics

PROTOKOL ADHEZIVNOG CEMENTIRANJA U FIKSNOJ PROTETICI

Sažetak

Upotreba cementa u stomatologiji proteže se desetljećima u raznim područjima struke. Iako konvencionalna cementacija ima duboko postavljene korijene u svakodnevnoj praksi, nije najbolje rješenje za sve slučajeve. Stoga moderna stomatologija ide korak dalje uvođenjem adhezivnog cementiranja. Većinom se koristi u minimalno invazivnim postupcima poput ljuskica jer je to jedina modalnost koja specifično zahtijeva ovakvu vrstu cementiranja. Upotreba adhezivne cementacije proširila se na inleje, onleje, overleje i krunice svih vrsta restaurativnih materijala poput keramike i kompozita. Da bi se postigla adhezija, potrebno je dovesti dva različita supstrata dovoljno blizu da formiraju međumolekularnu vezu. Smolasti cement prianja na ova dva materijala i određuje kvalitetu veze. Ako se svaka faza protokola adhezivnog cementiranja pažljivo i temeljito provede, može se postići zadovoljavajući rezultat. Bataljak te fiksno protetski nadomjestak prolaze kroz niz priprema u obliku jetkanja i silanizacije nadomjestka, zatim jetkanja i nanošenja odgovarajućeg adheziva na zub.

Svrha ovog diplomskog rada je razjasniti postupak adhezivnog cementiranja korak po korak, teorijsku osnovu koja uključuje materijale, smjernice, prednosti i nedostatke.

Ključne riječi: adhezivno cementiranje, kompozitni cementi, keramika

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List of abbreviations

HEMA - hydroxyethyl methacrylate

bis-GMA - bisphenol glycidyl methacrylate

GDPM - glycerophosphate dimethacrylate

MPa - megapascal

nm - nanometre

µm - micrometre

10-MDP - 10-methacryloyloxydecyl dihydrogenphosphate

LiDi – lithium disilicate

s - seconds

1. INTRODUCTION

The influx of new concepts of procedures and protocols in modern dentistry seems to be increasing exponentially in recent times. Most of them are focused on cosmetic dentistry, as patients' needs shifted from visiting the dental office purely out of medicinal reasons to aesthetic procedures. In the last couple of decades, dentists have used conventional methods in fixed prosthetic therapy treatments, but these methods have reached their relative maximum (1). Conventional cementation procedures were based on mechanical retention, and when performed improperly, they resulted in the formation of cracks, dissolution of underlying cement, secondary caries, and restoration decementation.

The popularity of minimally invasive esthetic procedures such as veneers has led to the use of resin luting cements, which are based on mechanical and micro-mechanical retention, as well as crucial chemical intermolecular bonding. Due to this, adhesive cementation does not require extensive preparation, allowing for the retention of more enamel, which is where most of the bonding occurs. Smaller-scale preparations do not necessitate the same amount of cement, since resin luting cements are more expensive, they can be used sparingly due to their strong bonding properties. The underlying color is less noticeable because of the availability of various shades and types of resin cements on the market.

Adhesive cementation requires a dry working field, which is achieved by using a rubber dam, along with retraction chords and Teflon tapes. The dentist needs to choose an appropriate generation of adhesives with the matching resin cement provided by the manufacturer. Although it is a technique-sensitive procedure, it has resulted in heightened patient satisfaction and improved treatment outcomes.

2.1. ADHESION

Adhesion is a chemical bonding process that aims to join two materials with different physical and chemical properties. The goal of adhesion is to create a strong, durable, and aesthetically pleasing restoration that can withstand the stresses of the oral environment.

Conventional methods of cementation rely on pure mechanical retention and require greater tooth preparation (2). The adhesive material needs to be able to bring two different materials into intimate contact with either surface by engulfing them with moisture. The hydrophobic nature of cements in dentistry yields high surface tension and requires a dry working field. The greater contact surface of the liquid and material, the lesser the stress of adhesion. This is optimal bonding for ceramic veneers, for instance (3).

2.1.1. Enamel bonding

Intact enamel is immensely unfavourable for bonding due to low surface tension caused by glycopolysaccharides from the saliva. Enamel for composite bonding needs to be prepared by etching with 37% orthophosphoric acid. The acid melts down the enamel and removes the existing smear layer to create a high surface tension and micro retention spots for the future hydrophobic matrix of the composite material. The optimal etching time is 30 seconds, where 10 micro-meters of enamel is lost, followed by copious irrigation, and controlled drying. The enamel is then ready for application of hydrophobic enamel adhesive (3).

2.1.2. Dentine bonding

The initial difficulty of the complex bonding to dentine is its moist nature. A hydrophilic adhesive material is required, which can penetrate the collagen fibres. The dentine also undergoes the etching procedure, but the proximity of the pulp dictates the time of handling. Dentine for composite bonding needs to be etched for 15 seconds with 37% orthophosphoric acid. When following this process, the collagen fibres are made accessible and prepared for use in order to secure retention by using the adhesive system.

If over-etching occurs, the monomer will penetrate through the etched dentine completely, which contributes to poor adhesion and the creation of cracks. The surface mustn't be overly dried due to the phenomena of the collagen fibres collapsing and inhibiting the monomer to penetrate around them. On the other hand, if the dentin retains excessive moisture, it can result in the occurrence of the excessive wetting phenomenon. This phenomenon causes the adhesive system components to dissolve excessively, thereby impeding the adequate penetration of the monomers and hindering satisfactory results.

The primers used for treating the etched dentine surface should include hydrophilic and amphiphilic monomers, which have the ability to penetrate the collagen network in moist conditions. The penetration is facilitated by the highly hydrophilic nature of the monomer (HEMA) and the use of a hydrophilic solvent, such as alcohol or acetone. Adequate time is necessary for the monomer to penetrate the dentine surface, and it is recommended to follow the manufacturer's instructions regarding the treatment duration (3).

2.2. ADHESIVE SYSTEMS

The resin dental substrate contact is possible because of dental adhesives, which are solutions of resin monomers. Monomers with both hydrophilic and hydrophobic groups form adhesive systems. The chemistry of the monomers is what distinguishes them the most. Hydroxyethyl methacrylate (HEMA) and bisphenol glycidyl methacrylate (bis-GMA) are monomers that are most often utilized in adhesive systems. The first, HEMA, is a superb polymerizable wetting agent for dental adhesives and is completely miscible in water. Bis-GMA, which is the primary monomer used in many adhesives and most dental composites, is far more hydrophobic and will only allow 3% of water by weight to enter its structure when polymerized. Solvents are always added to the mixture as diluting agents to improve the wetting, propagation, and penetration of the polymerizable monomers into the dentin substrate. Commonly used solvents include water, acetone, and alcohol (ethyl and butyl). Water and alcohol are highly hydrophilic and improve the way in which monomers interact with the surface water, whereas acetone is effective when removing water from the dentin. If the solvent is not removed during the placement process, for example, by suitable drying, it may become part of the bonding layer and potentially act as a contaminant that weakens the bond. Additionally, curing initiators, inhibitors, or stabilizers, and, in certain situations, inorganic fillers, are included in the chemical makeup of adhesives (4).

2.2.1. History of adhesives systems

In 1951, a Swiss scientist, Oskar Hagger, was the first to propose glycerophosphate dimethacrylate (GDPM) as a functional adhesive monomer capable of penetrating the dentin surface and creating an intermediate layer (5). It eventually became known as the "Sevriton Cavity Seal", after being polymerized by using a sulfinic acid initiator. The monomer was used by Kramer and McLean in 1952 to form the first-generation adhesive. The inadequate adherence of the smear layer to the underlying dentin caused the first generation of dentin adhesives to operate poorly (5). So, their attachment strength to dental tissues was low (2 – 6 MPa). The smear layer was kept in the second generation throughout the 1970s, although with unsatisfactory results (1 – 10 MPa). The third and fourth-generation methods, which depended on the complete removal of the smear layer and partial decalcification of the dentin by acid treatment, swiftly followed the second generation of adhesives.

The 3-step golden standard was introduced by Nakabayashi in 1982. The protocol includes the following: etching and rinsing, which exposes the collagen fibres, then priming resulting in the formation of the hybrid layer which consists of a resin-infiltrated collagen network and bonding, and its subsequent light polymerization (5).
The fourth-generation adhesives are the first to fully establish the fundamental processes of adhesion since they use 30% to 40% phosphoric acid, which was no longer considered to be dangerous (5). They provide adhesive strength of $20-50$ MPa. and $13-80$ MPa to enamel and dentin, respectively.

As time progressed, clinical professionals and manufacturers both met with a great need to create more straightforward adhesive solutions. In the late 1990s and early 2000s, two-step self-etch adhesives and total-etch adhesive systems were released on the market, known as the 5th and 6th generation (4). Recent advancements have concentrated on the shortening of the application process to decrease method sensitivity and manipulation time. The sixth, seventh, and eighth generations rely on one-bottle systems. This specific self-etch adhesive is referred to as “universal” or “multi-mode”, since it may be applied using either the etch-and-rinse method or the self-etch method. It combines the benefits of the etch-and-rinse technique when applied to enamel, with the simplified self-etch method on dentin, while also providing additional chemical bonding to the remaining carbonated apatite crystallites in those bonding substrates. Even though these techniques are convenient, they produce several problems. The newest self-etching one-step adhesives are very hydrophilic and permeable to water produced from the bonded dentin underneath them, so the resin-dentin linkages may deteriorate as a result of this permeability. Additionally, self-etching methods are unable to adequately etch enamel when used in one-bottle systems (5). Universal adhesives are recommended to be utilized in self-etch mode and covered by a second coat of hydrophobic adhesive (5).

Table 1. Chronologic adhesive milestones and generations of dentin bonding systems. Acquired from (5).

1951	First adhesive monomer:glycerophosphate dimethacrylate (GDPM) by Hagger (Switzerland)
1952	First-generation adhesive with GDPM (Sevriton, Kramer, and McLean UK)
1955	Enamel etching (Buoncore, USA)
1956	Dentin etching with 85% phosphoric acid for 30 seconds (Buoncore)
1960	Concentration of acid reduced to 35% for 20-30 seconds
1970s-1980s	Second-generation, smear layer maintained but with poor results (5-6 MPa)
1979	Removing the smear layer (Fusayama et al, Japan)
1980s	Third-generation, modified or completely removed smear layer
1982	Hybrid layer (Nakabayashi et al, Japan)
Late 1980s	Fourth-generation, three-step (etch-and-rinse)
Early 1990s	Fifth -generation, two-step (etch-and-rinse)
Late 1990s	Sixth-generation, two step (self-etch) and one- step (with mixing)
2000s	Seventh-generation, one-step (without mixing)
2010s	Eight-generation, multimode universal adhesives

2.3. COMPOSITE CEMENTS

With the introduction of adhesive cementation, the creation of composite cements has become an integral part of the process. The use of composite cements allows for a more predictable and reliable adhesion to the tooth structure, providing a strong and long-lasting bond. These cements exhibit excellent resistance to moisture, high compressive and tensile strength, and establish a micromechanical bond with enamel, dentine, dental alloys, and ceramics. This bond is further strengthened by the application of an adhesion system. Therefore, resin luting agents have become the preferred choice for bonding all-ceramic restorations (6).

Moreover, resin luting agents also offer excellent colour stability, which is essential for achieving good aesthetics with all-ceramic restorations. They are available in a variety of shades and translucencies, allowing the clinician to select the most appropriate colour for each individual restoration.

Composite cements a combination of organic resins such as bis GMA, methacrylate, inorganic filler particles, and silane. They can be divided by their particle size and polymerization type. Regarding the particle size, there are macro-filled (1 – 20 µm), micro-filled (0.04 – 0.06 µm), and hybrid composites (0.04 – 5 µm) (6, 7).

Depending on the polymerization type we have:

- chemically cured,
- light cured,
- dual cured

The chemical reaction occurs between the base and catalysing agent. For light curing, we require a photo initiator (camphorquinone) which is activated by specific light wavelength (440 – 480 nm) (7).

2.3.1. The choice of composite cements in adhesive cementation

Clinical studies have found that there is no difference in the performance of dual-cured cements and light-cured cements. Rather, it has been concluded that the most important factor in choosing the right cement is the working time. Dual-cured composite cements have a shorter handling time compared to light-cured cements, which may inhibit proper cementation. The lower viscosity of dual-cured resins creates a tougher environment for the removal of the cement itself. When polymerization is incomplete, resin cements are less biocompatible than certain conventional cements. The primary concern is the polymerization shrinkage that generates microcracks between the restoration and the tooth. These microcracks allow for the penetration of liquids and bacteria, leading to cement dissolution, marginal staining, and a higher risk of caries.

The stability of the colour of the underlying dual-cured cement may also contribute to a poor aesthetic result (8). Achieving accurate colour reproduction requires considering the restoration thickness, the prepared tooth colour, and the colour of the cement (9).

Figure 1. Various shades of luting materials

The cement layer is very thin in clinical conditions and not thicker in ideal conditions of 120 μm (10). Such thin layer in most cases will not contribute to a change of colour of the ceramic restoration. Only opaque cements, like glass ionomer, will change the colour of the ceramic restoration, especially in the cases of thin restorations made of glass ceramics (Li2O5Si2).

2.4 . INDIRECT CERAMIC MATERIALS

Dental ceramics are used in the development of dental prostheses to replace damaged or missing dental structures. These materials are classified as inorganic and non-metallic, as they are synthesized through the application of high temperatures to raw minerals (11). The bond between composite cement and ceramic material is achieved by ionic, covalent bonds and micro-mechanical bonds.

The classification of ceramics can be based on their microstructure, which encompasses the quantity and type of the present crystalline phase, as well as the composition of the glass component (12). Two main categories of ceramics are:

- silicate ceramics,
- polycrystalline ceramics.

The quantity of the glass phase determines the strength of the bond due to the glass particles being able to undergo the etching process (4).

2.4.1. Silicate ceramics

Despite being the oldest type of ceramics, silicate ceramics continue to be widely used in modern times. This category includes feldspathic ceramics and glass ceramics. These materials are primarily composed of silicon dioxide, also referred to as silica or quartz, and may also contain varying quantities of alumina (12). Feldspathic ceramics are renowned for their superior aesthetic properties and flexural strength of 120 MPa, however they are also the weakest and softest type of ceramic material necessitating exclusive use of adhesive cementation. They are employed as coating ceramics for creating veneers, inlays, onlays, and individual crowns in the anterior section (8). Leucite-reinforced ceramics, which are improved versions of this material due to the presence of leucite crystals, give the material better properties such as greater hardness (160 MPa) and the blocking of crack propagation (13). Some examples of this ceramic include: IPS EMPRESS, IPS EMPRESS CAD (Ivoclar Vivadent Liechstenstein), VITA VMK 68 (VITA Zahnfabrik, Bad Säckingen, Germany), Optec OPC (Jeneric, Wallingford, CT, USA) and Finesse All-Ceramic (Dentsply, York, PA, USA).

The most common aesthetic material in prosthetic dentistry is glass ceramics, which is produced by regulating the crystallization of glass. There are several types of glass ceramics, such as hydroxyapatite, fluorapatite, and lithium disilicate glass ceramics. The key benefit of this type of ceramics are its enhanced physical characteristics, resulting in a flexural strength increase of 250 – 350 MPa, while maintaining exceptional optical properties. As a result, it is recommended to be used in a variety of dental applications, including veneers, inlays, onlays, overlays, single crowns, and even short-span bridges, with the second premolar serving as the final abutment. Lithium disilicate glass ceramics are composed primarily of prismatic lithium disilicate (Li2Si2O5), which makes up approximately 65% of the material by volume (14). Ceramic ingots are available for heat-press production technique, while ceramic blocks can be used for CAD/CAM machining. Some examples of this ceramic system include: IPS e.max Press/CAD (Ivoclar Vivadent Liechtenstein), CEREC Tessera, (Dentsply, York, PA, USA), VITA AMBRIA Press (VITA Zahnfabrik, Bad Säckingen, Germany).

Figure 2. IPS e.max Press/CAD and Initial LiSi ceramic blocks

2.4.2. Oxide ceramics

The category of oxide ceramics includes ceramics made of aluminium oxide and zirconium oxide, which are produced by sintering closely packed particles of these materials. These ceramics lack glass particles in their structure, resulting in exceptional strength (800 – 1200 MPa) and resistance to cracking. They are indicated in long span bridges in the posterior region.

Bonding to silica-based dental ceramics using etching techniques and silanization is well-established, but no particular method is generally accepted for the bonding of dental oxide ceramics with little or no silica (15). Although conventionally cemented, there are cases where these ceramics may benefit from adhesive cementation. Research suggests that utilizing air abrasion in conjunction with the application of tribochemical silica or aluminium oxide, followed by the use of adhesive agents, can enhance the bond strength of resin cements (16). Sandblasting is carried out with particles of aluminium oxide ($Al2O3$) size 30 – 50 µm under pressure, or with synthetic diamond particles. Also, the surface of the restoration can be treated by the application of ceramic primers containing phosphate monomers 10-MDP (10-methacryloyloxydecyl dihydrogen phosphate) that chemically bonds with metal oxides in ceramics, for example Clearfil Ceramic Primer or Alloy primer (Kuraray Dental, Okayama, Japan). After applying this type of primer, it is recommended to apply dual curing or chemically curing composite cements with the same monomer composition, as well as primer (e.g. PanaviaF 2.0 (Kuraray Dental, Okayama, Japan) (17).

Figure 3. Ceramic restorations in forms of three - unit oxide ceramic bridge and lithium disilicate veneers

Table 2. Surface conditioning according to material. Acquired from (5).

STEPS	*FIELDSPATHIC PORCELAIN*	*LiDi*	*LEUCITE REINFORCED*	*OXIDE CERAMICS*	*POLYMER*
1. Airborne particle abrasion with Al_2O_3 30 – 50 microns at 30 psi	No	No	No	Yes	Yes (preceded by roughening with coarse diamond bur)
2. Hydrofluoric acid	Yes (9% – 10% HF for 90 s)	Yes (5% HF for 20 s)	Yes (5% HF for 60 s)	No	No
3. Post-etching cleaning in ultrasonic bath (water or 90% alcohol)	Yes	Yes	Yes	Yes	Yes
4. Silane application	Yes	Yes	Yes	Yes (or special primer)	Yes (or special primer)
5. Wetting with adhesive resin	Yes	Yes	Yes	Yes	Yes

2.5. ADHESIVE CEMENTATION PROTOCOL

2.5.1. Patient preparation

Pre-prosthetic treatment begins by discussing with the patient, followed by a thorough medical history, intraoral and extraoral examination, and X-ray analysis. Periodontal treatment consists mostly of removing tooth plaque and calculus or, if necessary, one of the surgical procedures. Therapy takes into consideration surgical treatments like apicetomies, tooth, and residual root extractions. Conservative therapy, such as endodontic and restorative procedures, is the most common during the patient preparation procedure. In rare cases, but also important, it is necessary to perform orthognathic surgery combined with orthodontic therapy (18). Once the patient is rehabilitated and has provided informed permission, the treatment's practical modalities can begin.

After tooth preparation, the analogue or digital impression is taken. The laboratory's patient management is underway, with the production of the indirect ceramic replacement. A thorough try-in of the finished restorations must be performed before final cementation (8). The ceramic restorations are first checked on a working model, then in the patient's mouth. The restoration should be checked in groups to determine their approximal surface relationship. Following the patient's acceptance of the aesthetics, the contaminated restorations must be cleansed with the appropriate solvent (ethanol, acetone, methylene chloride) (8). Isolating the working field from blood contamination and other oral fluids is critical for the proper application of composite cements, therefore, rubber dams are instructed. If a dry working environment cannot be guaranteed, the use of composite cements is not permissible (18).

2.5.2. Indirect ceramic replacement preparation

According to scientific data, it is now widely accepted that the success of glass ceramic adhesive bonding depends on micromechanical retention (etching) and chemical bonding (silanization). Adhesive cementation can be categorized based on the type of the ceramic material used in the restoration. This includes adhesive cementation for restorations made of ceramics with a glass phase, such as silicate ceramics, glass ceramics, and infiltrated ceramics, as well as adhesive cementation for restorations made of polycrystalline ceramics like zirconium oxide ceramics and aluminium oxide ceramics (19). The ceramic restoration is etched with 10% hydrofluoric acid for 90 seconds. The rest of the free-floating ceramic particles are then removed and copiously irrigated in distilled water or in an ultrasonic bath filled with acetone or alcohol for 4-5 minutes (8).

The connection between the restoration and the composite cement is enabled by the chemical bond formed through the silicon dioxide particles found in glass ceramics. The application of silane treatment to ceramics results in increased surface wetting, leading to enhanced bonding properties (20). For this bond to occur, a binding molecule such as organic silane must be present. The ceramic is silanized, which creates a promoting action of bonding between the inorganic material of the ceramic and organic polymers in the composite cements (8). Silane formulations that come in single-bottle form are already pre-hydrolyzed, and due to their shorter shelf-life, they tend to lose their effectiveness over time, such as Monobond Etch&Prime (Ivoclar Vivadent) (18). Therefore, double-bottle solutions are the preferred choice, such as Bis- Silane (BISCO) (21). Silanes that come in two-component form single consist of acetate acid in the first component and non-hydrolyzed silanes in the second component. The acid from the first component activates the silanes in the second component. These components need to be mixed right before the application. To prepare the ceramics, multiple layers of silane are applied, and each layer must be dried for the solvents to evaporate before the next layer is added. After silanization, an adhesive resin is applied to the restoration and properly dried and polymerised with blue light.

Figure 4. 10% Hydrofluoric acid and silanization agent

2.5.3. Tooth preparation for adhesive cementation

Tooth preparation is a crucial step in the adhesive cementation of restorations, as it can affect the bond strength and the restoration longevity. The tooth should be cleaned thoroughly, removing all plaque and debris, then disinfected using alcohol or chlorhexidine. Alcohol is only suitable for disinfecting vital teeth because its use on non-vital teeth can cause postoperative hypersensitivity and tooth dehydration. Hydrogen peroxide or sodium hypochlorite should not be used due to polymerization inhibition. A dry working field is essential for adhesive cementation because the presence of moisture can negatively affect the bond strength and the restoration longevity. To prevent gingival crevicular fluid from interfering with the adhesive cementation process, the tooth should be isolated using either a rubber dam or a gingival retraction cord (6).

Table 3. Tooth preparation according to product and its category. Acquired from (22).

Product name	*Company*	*Category*	*Etch and rinse*	*1st bottle*	*Air-dry*	*2nd bottle*	*Air-dry*	*UV*
G-aenial bond	GC	1-step self-etch	/	10 s application	5s	/	/	10 s
Bond-Force	Tokuyama	1-step self-etch	/	20 s application	10 s	/	/	10 s
Clearfil SE Bond	Kuraray	2-step self-etch	/	20 s	slightly	apply	slightly	10 s
OptibondFL	Kerr	3-step etch and rinse	15 s	15 s	5s	15 s	3 s	20 s

Micromechanical retention can be created on the enamel by applying 37% phosphoric acid after isolating the working field. The acid is then rinsed off and dried for 30 seconds (23). In modern clinical practice, two-phase systems are commonly utilized wherein after the etching, the primer and the bond are applied and rubbed onto the demineralized surface of both the enamel and the dentin for 20 seconds, dried off appropriately and polymerised for 10 seconds (18). When opting for self-etching systems in tooth preparation, modern practice leans towards all-in-one systems, although a two-step system may also be used. In this method, an acidic monomer is applied to both enamel and dentin via a single bottle adhesive. The adhesive is allowed to sit for a duration of 5-10 seconds and subsequently blown out with air, with no water rinse. Examples of such systems include All-Bond SE from Bisco in Schamburgh, Illinois, OptiBond XTR from Kerr in Orange, CA, USA, and GC G-Bond from GC Corporation in Tokyo, Japan. The literature suggests that only the enamel should be selectively etched, while the dentin is etched with the acid present in the adhesive. It is recommended to pair a suitable adhesive system with a compatible composite material (24).

Figure 5. **Total Etch**, 37% ortophosphoric acid

Figure 6. **Adhese Universal**, single-component, light-cured adhesive for direct and indirect bonding procedures and all etching protocols

2.5.4. Cement application

Cement mixing and application procedure are always done according to the manufacturer's recommendations. A self-adhesive cement (GCem, GC Corporation, Tokyo, Japan or RelyX, 3M/ESPE, St. Paul, USA) comes in an automix form of either a syringe or a capsule (25). Self-adhesive luting cements offer longer working time and simple handling compared to other types of dental cements. This allows the dentist to take more time to properly place and adjust the restoration before the cement sets, reducing the risk of any mistakes or complications during the cementation procedure. The cement is placed into the ceramic restoration and distributed evenly for optimal bonding and to avoid air inclusions (26). After placing the restoration onto the tooth, it is firmly pressed to allow the surplus cement to flow out over the edges. During light polymerization, applying a glycerine gel onto the margins is crucial to prevent oxygen from reaching the cement, which could impede polymerization. Typically, the excess elimination occurs following a light cure of 2 to 5 seconds, the margins are cleaned with the dental explorer and interdentally with dental floss. The final curing takes place subsequently (27). The restoration is then polished with appropriate fine abrasives and checked in occlusion.

3. DISCUSSION

The last step that will determine the quality of fixed prosthodontic restoration is cementation. Conventional cementation techniques have become arbitrary choices, and even prosthodontic specialists seem to get perplexed in the plethora of available cements on the market. The standard protocols used in the variety of conventional cements have seemingly lost their way in clinicians' everyday practice. The restorations longevity and durability has started to suffer. The aesthetics has been hard to achieve, especially according to today's standards, which seem to be higher by the minute. Some conventional cements such as zinc-oxyphosphate can even exhibit pulp cell cytotoxicity. Choosing the right cement should include factors such as: high strength bond, improved aesthetics, durability, biocompatibility, and versatility. The choice always correlates, and it should be in accordance with the fixed prosthodontic restoration which will be used.

The predictability of a procedure's outcome makes it a protocol. Adhesive cementation has allowed step-by-step guidelines where that predictability is achievable. It has also introduced the usage of minimally invasive preparations. One might conclude that minimally invasive preparations are the biggest advantage that adhesive cementation holds over the conventional techniques (28). Those minimally invasive preparations have allowed for the creation of highly aesthetic restorations. Veneers are becoming the golden standard for aesthetic restorations. Inlays, onlays, and overlays are starting to trade places with conventional composite fillings, so even better aesthetics and mechanical properties are achieved. Adhesive cementation of short span bridges is also starting to be implemented in dental practice.

While these cements have many advantages, there are several potential drawbacks of their use. For a certain material to be able to perform, it needs to be reliable in the hands of skilled clinicians. This is considered fairly challenging when it comes to technique sensitivity. Resin luting cements require a dry working field, multiple consecutive layer applications, delicate drying and wetting demands, additional extraoral working time, and more. Even clinicians who have considerable experience and skills avoid adhesive cementation because of its financial aspect. Not only do they have to acquire more expensive resin luting cements but they also need all the additional equipment necessary for appropriate cementation. The patient's financial power also dictates the future of fixed prosthetic restorations, since all ceramic systems and composites entail resin luting cements, while metal-ceramics do not. The most important factor when it comes to adhesive cementation is to follow the manufacturer's

4. CONCLUSION

In contemporary dentistry, adhesive cementation has taken over as the method of choice for cementing indirect restorations. The usage of adhesive cements has several benefits, including greater marginal adaptability, reduced microleakage, excellent aesthetics and improved retention and resistance to masticatory forces. However, effective adhesive cementation depends greatly on a delicate technique, careful material selection, and strong bonding to the tooth structure. Additionally, it is crucial to consider the adhesive cements' long-term clinical performance, including their durability and capacity to withstand the challenges of the oral environment. Despite these difficulties, adhesive cementation is still a useful tool for today's dentists, and further advancements in this area have the potential to raise the calibre and durability of dental restorations.

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