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Analysis between Resinous Composite and Glass Ionomer Cement For Restorative Dental Application in Deciduous 1st Molar

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Abstract:
Background*: Research into composites that offer more durability, and biocompatibility, among other characteristics, to resin and glass ionomer cement has been held seeking to ensure adequate treatment, aesthetics, and improvement of the quality of the restorative material and its advantages and disadvantages, thus seeking innovation.*
Objective*: Chemical-physical understanding of characteristics of restorative materials, glass ionomer cement, and composite resin, analyzing the structures of glass ionomer and composite resin, the main restoratives of molars deciduous used in contemporary odontopediatrics and how they behave in the deciduous teeth molar restoration.*
Materials and Methods: *Explanatory in three stages: a bibliographic survey on the Scielo platform, in Portuguese, Spanish, and English, in an open period, by the descriptors: Composites /OR/Composite Resin/AND/ Odontopediatrics /OR/Deciduous Teeth and Glass Ionomer Cement /AND/ Odontopediatrics; visits to university libraries at the Federal University of Pará; Nondirective interview with odontopediatrics about the choice of restorative material for deciduous first molars; Data analysis.*
Conclusion: *The evolution of restorative dental materials makes it possible for the population to have greater access to dental care, ensuring the quality, efficiency, and durability of restorations, however, there is still a need for research into more economically viable and resistant materials, as they are still relatively expensive. for underserved populations. Aesthetically, the composite resin stands out from other restorative materials, such as glass ionomer cement, however, because the technique is faster, and the release of fluoride by the product, for children, is still the best option in most cases, even Composite resin has more strength and durability.*
Key Word*: Composite biomaterials, Composite resins, Glass ionomer cement, Deciduous teeth, Odontopediatrics, Materials Engineering*

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I. Introduction

Dental problems are not relatively new, the result of a change in human nutrition, but old ones that have been affecting humanity over the ages, since with the lack of care in the preparation of food, several particles of impurities were crushed by the tooth, wearing them down quickly and exposing the pulp to the bacteria and leaving no other method of solution than the total extraction of the tooth[1].

Material engineering together with dentistry, carries out research with diverse substances, providing more durable and biocompatible dental materials, and biomimetics, among others, ensuring the health, durability, and aesthetics of dental restorations, improving the quality of the restorative material, Laboratory studies aim to understand dental restoration biomaterials, their advantages and disadvantages, proposing innovations.

Composite materials have a composition of at least two components or two dissimilar phases, with distinctly physical and chemical properties, designed to functionally meet properties that cannot be obtained in conventional chemical compositions, the properties of composite materials are highly dependent on their structure. Composites differ from homogeneous materials in terms of the control over the structure, which can be exercised on a larger scale, and consequently over the desired properties. The properties of composite material will depend on the shape of the structural heterogeneity, their distribution in the structure, and the interfaces between its components[2].

In dentistry, composite materials stand out for their versatility, being used as a restorative material, cementing agents, and metallic coating on endodontic posts and cores. To add and improve certain physical and mechanical characteristics of these materials, resins were added initially, fluid polymeric compounds that, when polymerized, become rigid, thus forming resin composites or composite resins[1].

The result of a metabolic discordance of the biofilm is caries, a disease that comes from several factors, external and internal, (2 Dental Caries from a Molecular Microbiological Perspective: NyvadB.a, CrielaardW.b, Mira A.c, Takahashi N.d, BeightonD.e) apud AAPD (American Academy of Pediatric Dentistry), the diagnosis of caries in children is more common than asthma, for example, often due to the lack of correct hygiene in the child's teeth. In Odontopediatrics, you could opt for the glass ionomer since, in the composite resin, other caries may appear near the restoration due to a concentration of biofilm in the restored site[3].

The main function of the mechanical property is to evaluate the strength and how the material behaves in permanent deformation or fracture through an applied force or tension to characterize its strengths[4]. In dentistry, knowing these mechanical properties is extremely important so that the appropriate choice of restorative material occurs, thus avoiding fractures and consequently decreasing the quality and longevity of the treatment[5].

The study of the physical properties of these materials should also be considered for good quality and durable dental restoration, since in the oral cavity there are constant changes, such as temperature, and the pulp tends to react in different ways to these sudden variations. However, in the contemporary world, there is also a greater aesthetic demand and with that the search for materials with an increasingly similar appearance to teeth without restoration.

Given the above, this work intends to understand the chemical-physical characteristics of the restorative materials, glass ionomer cement, and composite resin, analyzing the structures of glass ionomer and composite resin that are the main restorers of deciduous molars used in contemporary odontopediatrics, providing an understanding basic understanding of how these biomaterials behave in the restoration process of deciduous molars teeth.

II. Material and Methods

Explanatory exploratory research, is developed in three stages:

a) Bibliographic survey on the Scielo platform, in Portuguese, Spanish, and English, in an open period, using the descriptors: Composites /OR/Composite Resins /AND/Pediatric Dentistry/OR/Deciduous Teeth and Glass Ionomer Cement /AND/Pediatric Dentistry; visits to university libraries at the Federal University of Pará;

b) Non-directive interview with two odontopediatrics about the criteria for choosing the restorative material for deciduous first molars.

c) Data analysis.

III. Restoring Materials in Dentistry

All material that reacts with the human body without causing negative effects is considered a biomaterial, there are several areas of applications and research focused on these biomaterials and their use, from bone implants to blood circulation tubes, and with the advancement of technologies and research on of these biomaterials, many uses have been discovered and/or improved.

One of the several areas of application of these biomaterials is in dentistry, where they are crucial for a better quality of life for the patient, improving the quality of chewing, digestion, speech, smile, facial muscle support, and self-esteem, among other important factors for such quality of life.

Historically, a wide variety of materials have been used for crown and root replacements, including animal teeth, bones, human teeth, ivory, shells, ceramics, and metals. Restorative materials to replace only lost parts of the tooth structure have developed more slowly over the past centuries[6].

Archaeological studies have shown that the Etruscan, a people that preceded the Romans, coming from the “Near” East and who settled in the Italian peninsula, wore down the teeth of corpses and shaped them in a way that looked natural using gold to adapt the tooth[7].

With the evolution of techniques and materials applied to cadavers, so that they could follow the cultural standard of the time, knowledge and skill were acquired so that such techniques could be applied to living people, changing how society sees and cares for oral health, increasing the demand for a better aesthetic dental arch, wooden prostheses, and restorations.

Dental Amalgam

Black in 1895 introduces in dentistry the use of dental amalgam composed of Mercury (Hg), Silver (Ag), Copper (Cu), and Tin (Sn), which may have other metals, forming an alloy. This composition may vary by manufacturer and dental technical requirements.

Dental amalgam has the advantages of durability, resistance, low cost, and formation of oxidants, helping to combat the formation of some types of cariogenic bacterial plaques. Thus, as disadvantages, there is a great loss of dental tissues in the cavity form of retention for the amalgam, risk of fractures of the material and/or of the dental element that receives the amalgam, aesthetic compromise, mercury is a pollutant at the time of amalgamation and in the disposal, among others. Given that, amalgam is still in use today, even in rare and local cases, mainly due to its applicability in some dentistry situations, however many countries have already abolished or established deadlines to enter into disuse. Even with all the durability that silver amalgam offered, researchers continued the search for a durable material with better aesthetics, such as glass ionomer cement and composite resin, which are materials of great use in the dental environment and the objective of this study.

In the first half of the 20th century, silicates were the aesthetic materials of choice for cavity restorations, silicates release fluoride and are excellent for preventing caries but are nowadays almost exclusively used to restore deciduous teeth due to the significant wear and tear they undergo over the course of just a few years. Acrylic resins, similar to materials used in the manufacture of bases for trays and dentures Individual (polymethyl methacrylate, [PMMA], soon replaced silicates because of their aesthetic, insolubility in oral fluids, easy handling, and low cost, unfortunately, these acrylic resins have relatively low wear resistance and high shrinkage, which pulls material away from the cavity walls, opening cracks that facilitate the infiltration of oral fluids and bacteria. In 1962, Bower developed a new type of material that overcame all these problems[6].

Bower's major innovations were the synthesis of bisphenol, glycidylmethacrylate (bis-GMA), a monomer that forms a very durable high-density cross linked matrix, and the development of surface treatment using a silane organic compound called a “bonding agent silane” to bind the filler particles to the resin matrix. Restorative aesthetic materials, until now, continue to use this technology, but many other innovations have been introduced since 1962. Filler has evolved into smaller and smaller particles, primarily to improve aesthetics and polish. Barium glasses, other specialty glasses, and mineral inorganic fillers have been developed to impart radiopacity, improve handling characteristics, compensate for shrinkage, and improve mechanical properties[6].

Composite Resin

Composite materials have a composition formed by at least two components or two different phases, with distinctly different physical and chemical properties, designed to functionally meet properties that cannot be obtained from conventional chemical compositions of properties, the properties of composite materials depend a lot on their structure. Composites differ from homogeneous materials in terms of control over the structure, can be exercised on a larger scale, and consequently, over the desired properties, the properties of composite material will depend on the shape of the structural heterogeneity, their distributions in the structure, and the interfaces between its components[2].

Composite resin has three main components: a resin matrix; inorganic particles composed of particles such as, glass, quartz, and/or fused silica; and, finally, a binder, usually a silane-organe, which improves the bond between the particles and the resin matrix through chemical bonds[8,9]. The introduction of composite materials took place around the second half of the 20th century, through the manufacture of composites of different phases designed deliberately[4].

Composite resin has evolved to seek a direct and indirect restoration with qualities very close to the natural tooth, including composite resins (composite) specific for dentin and others specific for enamel and finishes, and with different shades of pigmentation.

If before, the dental element had to undergo acid conditioning, with a different time between the dentin and the enamel, then washed, and then the adhesive was applied to be light cured to receive the composite resin. Today, adhesives on the Market do not require acid attacks on the dental element.

Composite resins are generally polymerizable by layers or stratification, varying the amount of application by a manufacturer, working time, characterization of the resin, and its classification in hybrid composites; microhybrids; nanohybrids; fluid microparticulate, and so on, can also be classified according to the setting time when submitted to the light of the light curing unit, it is worth mentioning that there are composite resins that are self-curing and others that present color mimicry, facilitating the work of the dental surgeon.

One of the disadvantages of composite resin is that during its polymerization, the composite resin exerts a contraction and a relatively large effort to be able to polymerize and thus can end up causing problems, such as future infiltration, formation of margins and discoloration, the possibility of sensitivity in the restored tooth, and others.

The chemical reaction in the polymerization of composites involves the breaking of carbon-carbon double bonds to form polymer chains with carbons joined by single bonds. The polymerization shrinkage of monomers is due to the conversion of intermolecular forces called Van der Waals into single covalent bonds during polymerization, so shrinkage is the consequence of the polymerization reaction[10].

Such problems can be alleviated when controlling the intensity and time of light curing, making it more advantageous to apply light curing at short intervals and with lower strength.

Composite resin is a composite formed by an organic matrix (monomers, initiators, color modifiers, and others), an inorganic matrix (filler), and a bonding agent[11].

In addition to evaluating the effects of mechanical loads, it is also important to characterize how these resin materials can act in a mouth environment exposed to different pH levels. That immediate exposure to citric acid after light curing does harm the microhardness of the composite and the same does not occur when it comes to flexural strength[12].

Glass Ionomer Cement

Glass ionomer cement (GIC) is a composite initially formed by silica powder (SiO_2), alumina (Al_2O_3), calcium fluoride (CaF_2), and a specific liquid composed essentially of polyacrylic or polymeric and tartaric acid[13]. The glass particles type of calcium, aluminum, and silicate are blended with an aqueous solution of acids resulting in a paste with the capacity of filling and cation source so that together with the polymer chains, formed a cross-link[14].

The glass ionomer is characterized as an extension of the zinc polycarboxylate cement that can adhere to enamel and dentin, releasing fluoride, thus attracting the attention of dentists who have used it in several dental restorations, being one of the most accepted in the field of orthodontics[15].

Glass ionomer cement is mainly composed of a chemical reaction of a powder and an aqueous solution, the conventional glass ionomer, and essentially constituted by polymer, homopolymer, and copolymer, acrylic acid containing tartaric acid. What makes glass ionomer cement an interesting material compared to zinc phosphate cement and the huge variety of compositions that can be obtained, the main components of a GIC are glass, polyacid, water, and tartaric acid[1].

The glass ionomer has numerous advantages that can be listed as: (a) biocompatibility; (b) low sensitivity to moisture about resin composites; (c) having a chemical bond to enamel and dentin (d) containing their thermal expansion similar to that of the tooth; (e) release of fluorine ions over time[16].

With the advance in research, several variations began to appear involving the glass ionomer cement, to improve its physical properties and reduce its sensitivity to moisture, thus creating the modified glass ionomer through the composite resin, which implied composed of polymerizable organic monomers resulting in addition in the polymerization reaction, which can be self-activated or photoactive.

IV. Comparative Analysis

Table no 1: Comparative table of dental restorative materials.

COMPARATIVE TABLE		
DESCRIPTION	**GLASS IONOMER CEMENT**	**COMPOUND RESIN / RESIN COMPOUND**
Biocompatibility	Yes	Yes
Polymerizable	No	Yes
Moisture resistance	Yes	Yes
Thermal expansion	Low	High
Radiopacity	Variable - Depends on the composition	Excellent
Adhesion to tooth enamel	Good	By use of adhesive
Adhesion to dentin	Weak	By use of adhesive
Fluoride Dispersion	Excellent	Bad
Water absorption	Yes	Yes
Mechanical resistance	Low	High
Solubility	High	Low
Thermal expansion coefficient	Low	High
Viscosity grade	Average to high. + used = average	Low to High + Used = High
Color selection	Variable	Variable
Particle size	Microparticles - 50 µm to 45 µm for aesthetic purposes	Microhybrids and nanoparticles
Basic composition	Powder: Inorganic particles of calcium fluoride (CaF_2), aluminum oxide Al_2O_3), silicate oxide SiO_2), and glass dispersed in an insoluble hydrogen matrix, among others.Liquid: itaconic acid ($C_5H_6O_4$) or carboxylic acid (CO_2H), polyacrylic acid ($C_3H_4O_2$), tartaric acid ($C_4H_6O_6$), aqueous compounds.	Organic matrix (Bis-Gma) + binding agent (silanes) + filler particles (silica, barium glass, zirconium/silica) + chemical reaction initiating agents (camphorquinone, benzoyl peroxide).
Basic composition **Thermal expansion coefficient α**	10^{-6}/°C	22 x 10^{-6}/°C
Handling for activation	Yes – requires agglutination of powder and liquid	No
Application technique	Simple	Complex/Detailed
Prey reaction	Fas	Starts with light curing
Polishing capacity	Fair	High
Workmanship	Fair	Excellent
Aesthetics	Fair	Excellent

Deciduous teeth, according to interviews with pediatric dentists, are the first teeth to develop, totaling 10 in each dental arch, which will later be replaced by permanent teeth, usually 16 in each arch. Care to avoid dental caries in deciduous teeth should be through brushing assisted or supervised by an adult, adequate food and at the right time, and periodic visits to the pediatric dentist, among others.

As the child often still does not have a motor activity developed for the correct brushing, hygiene and prophylaxis measures such as the application of fluoride varnish must be adopted, however, some children develop occlusal dental caries, especially in the deciduous molars, requiring dental intervention to avoid the early loss of that tooth, harming the next set of teeth (permanent teeth).

The progression of early childhood caries is quite rapid, which can be explained by the dimensions of the primary tooth, which are smaller than the permanent tooth, and because it is rich in calcium carbonate since this crystal is more susceptible to demineralization. If the diagnosis is not made quickly, the entire primary dentition can be destroyed, greatly compromising the quality of life of the child patient[17].

Regarding the choice of restorative material to seal this cavity, the systematic review available shows that there is insufficient evidence to recommend which restorative material we should use in deciduous teeth[18,19].

In Brazilian schools, when the lesions affect only the occlusal surface, high-viscosity glass ionomer cement, considered the material of choice for atraumatic restorative treatment (ART), is the restorative material most used by teachers who teach Pediatric Dentistry. On the other hand, when these lesions also affect the proximal surfaces, composite resin, used by the incremental technique[18].

The odontopediatrics interviewed say that if the child has a strong tendency to caries, the glass ionomer, for restoration of molars, is an advantage, because for some time it releases fluoride in the oral environment, which favors the fight against caries, another advantage for the use of glass ionomer is the easy manipulation of the technique, however, in anterior teeth, the composite resin shows advantages, mainly concerning durability and aesthetics, however, the technique is more complex[7.20].

V. Conclusion

The evolution of dental restorative materials, qualitatively and economically, today makes it possible for the population to have greater access to dental care, ensuring the quality, efficiency, and durability of restorations. However, even with the evolution of these materials, there is still a need to support research for the development of more affordable, durable, resistant dental restorative biomaterials with simplified application techniques.

Due to economic factors, both in the past and today, it still exists, mainly in underdeveloped countries, many patients opt for extraction instead of restorative dental treatments, since some restorative materials are still relatively expensive for poor populations.

Aesthetically, the composite resin stands out from other restorative materials, such as glass ionomer cement, as it involves several components that contribute to a restoration aesthetically closer to the natural character of the tooth, however, it can still suffer infiltration due to the technique and color change by the time and dietary characteristics of the food consumed by the patient and the acids present in the mouth.

The dental professional needs to evaluate the patient and the type of restoration before deciding which restorative material to choose because depending on the tooth to be restored and the age of the patient, the glass ionomer cement becomes more suitable, which has a simple technique of application and release of fluoride, preventing caries in pediatric patients, even the composite resin presenting greater resistance to time, more durability and better aesthetics but with more complex application technique.

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