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Review Article

Intracoronal esthetic restorative materials in pediatric dentistry: concepts revisited

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ABSTRACT

A plethora of restorative materials currently exist to repair carious teeth in children, and numerous options are available for restoring primary and young permanent incisors and molars esthetically. Intracoronal esthetic restorations most commonly used for primary and young permanent dentition include direct restorative materials mainly as composite resins, glass ionomer cement, their modifications, and indirect restorative materials like laboratory-processed inlays, onlays, overlays, and endo-crown prostheses. A pediatric dentist needs to be aware of the composition, indications, advantages, and limitations associated with these restorative materials to employ them judiciously in children. However, the clinical data is insufficient to suggest the most superior type of restoration to be used in pediatric patients. Through this platform; the authors discuss esthetic restorative treatment alternatives along with established recommendations and directions for future developments, familiarizing clinicians with evidence for and against the use of appropriate materials for pediatric restorative dentistry.

Keywords: Restorative materials, Children, Intracoronal, Esthetic, Pediatric dentistry

INTRODUCTION

The changed paradigm for pediatric restorative dentistry calls for developing dental materials that have the potential to improve aesthetics while simplifying clinical operations. Advancements in science and technology in conjunction with dental material research have provided the pediatric dentist with innumerable opportunities to apply significant developments in material science to the treatment process. However, the selection of the suitable material for an appropriate clinical situation depends on the requirements of the child patient, his cooperative potential, and the experience of the clinician, to ensure the most favorable function, performance, and esthetics.[1]

Amalgams have been used for several years in the dental profession, but an alternative to existing amalgam was desirable as its esthetic appeal was lacking.[2] Glass ionomer cement has been a multipurpose restorative for children, due to its continuous fluoride-releasing properties and biocompatibility, but it also has some limitations like reduced fracture toughness and wear resistance.[3] Hence there has been continued research to find a material that is not only fluoride-releasing, easy to use, and cost-effective, but also offers good mechanical properties and is esthetically pleasing to parents and patients.

In recent times, the demand for esthetic intracoronal restorations has increased radically due to enhanced esthetic awareness. Composite resin, glass ionomer cement, and their modifications, laboratory-processed inlays, onlays, overlays, and computer-assisted design–computer-assisted machining (CAD-CAM) milled restorations represent esthetic restorative solutions for intracoronal restorations in children.[2,4] Modern adhesive restorative materials and techniques take into consideration the conservation of tooth structure during preparation, and preservation of remaining tooth structure, and are capable of providing precise anatomical morphology with the desirable esthetics.[5]

The pediatric restorative dentist needs to be aware of the benefits and risks involved with restorative therapy (Table 1).[6]

There are several factors to be considered for the use of intracoronal esthetic restorative materials and the important characteristics of each material will facilitate the clinician working on child patients for appropriate material and case selection.

The aim of the review was to summarize the available literature on intracoronal restorations and provide academicians and clinicians with updated and evidence-based information and recommendations. Esthetic intracoronal restorative materials can be classified as direct and indirect restorative materials.

Table 1: Benefits and risks involved with restorative therapy.

S. no.	Benefits of restorative therapy	Risks of restorative therapy
1.	Maintenance of tooth vitality	Decreasing the lifetime of the teeth by increasing their fragility
2.	Prevents the spreading of infection towards the pulp	Recurrent lesions
3.	Removes cavities and defects to eliminate caries-susceptible areas	Exposure of pulp during the caries excavation process
4.	Restores integrity of tooth structure	Future pulpal complications
5.	Recurrent lesions	Iatrogenic damage to adjacent teeth

DIRECT ESTHETIC INTRACORONAL RESTORATIVE MATERIALS

Direct intracoronal restorative materials are easy to use, require single-sitting, and the procedure is more child-friendly. It does not involve any laboratory procedure; hence it is widely used in pediatric clinical practice.

Composite resins

Resin-based composites have been widely used as an esthetic material for restoring deciduous and permanent teeth. Resin-based composites are recommended for restoring class I and class II cavities in primary and permanent molars.[7] Marginal staining associated with different composites can be reduced by the use of dentine and enamel bonding agents.[7] They provide better esthetics and have superior fracture and wear resistance. Factors responsible for the longevity of composite resin restorations are the experience of the clinician, the size of the restoration, and the position of the tooth.[8] Limitations associated with the use of composite resins include susceptibility to water and saliva contamination, greater technical sensitivity, and a longer placement time.[9] Some precautions need to be taken during the placement of resin-based composites to minimize sensitivity to Bisphenol A.[10] However, they are not ideal for restoration in the primary molars with large multi-surface restorations, multiple carious teeth, and poor oral hygiene and isolation.[11]

Glass ionomer cements

Glass-ionomer cement (GICs) are direct restorative materials having an acid-base setting reaction in the presence of water and have been used as restorative cement, luting cement, and as a cavity liner or base since they were introduced as translucent cement in dentistry 50 years ago.[12] Inherent advantages of GICs are good fluoride-releasing capacity, adhesion to tooth enamel and dentine, and sensitivity to moisture.[13] GIC provides a cost-effective treatment and is considered to be an ideal restorative material for low-income and high-caries populations.[14] Drawbacks of conventional glass ionomer restorations include low compressive strength, poor wear characteristics, and brittleness.[12] They have undergone modifications with the incorporation of metallic ions or resin components, which have improved their mechanical properties and broadened their horizons for their utilization as an esthetic restorative material.[13]

Resin-modified glass-ionomer cement contains components of glass ionomer cement along with a monomer component, i.e.; 2-hydroxymethacrylate, HEMA, and an initiator system, i.e. camphoroquinone, and is found to be more efficacious in primary teeth.[14]

Zirconia-reinforced restorative glass-ionomer is a novel material that was introduced to overcome the shortcomings of restorative materials used previously. The powder component mainly consists of zirconia, ranging from 96.5% to 98.5%, and the liquid component consists of polyacrylic acid solution, ranging from 20-50%, and tartaric acid, 1-10%.[14] It is indicated for Class I and II cavities in primary and selected permanent teeth, repair of amalgam-restored teeth, core build-up, and repair of crown margins as it is more durable and has a high tolerance to occlusal load.[15] Giomers include glass ionomer particles that have been precured and ground up and are used as an additional dispersed phase in compomer materials.[16] Giomers have incorporated the favorable properties of composite resins and glass ionomer, i.e.; the esthetic and mechanical properties of composite resins and fluoride-releasing properties from glass ionomer components.[17] They have an extensive range of clinical applications and are preferred for cervical lesions.[17] Dietary habits such as consumption of acidic beverages, and dental procedures such as teeth whitening or prophylaxis methods tend to affect the giomers.[17] GICs are highly recommended for restoring Class I cavities in primary teeth, and resin-modified glass ionomers (RMGICs) may be utilized for restoring Class I and Class II cavities in primary teeth.[6,7]

Compomers

Compomers, or polyacid-modified composite resins, were launched in the mid-1990s as restorative materials.[18] They include 72% strontium fluorosilicate glass with an average glass particle size of 2.5 µm.[19] The physical properties of compomer are better in deciduous teeth in comparison to GIC and resin-modified GIC, but the cariostatic effects of compomer were found to be equivalent.[17] However, compomers will be preferred for restoring pediatric teeth because of their fluoride-releasing properties, esthetics, and ease of use.[19]

Ormocers

Ormocers or organically modified ceramics are novel packable restorative materials and were introduced to address some of the drawbacks and issues with conventional composites. It is a ceramic-based direct restorative material that is synthesized through a sol-gel process and contains three-dimensional cross-linked inorganic-organic copolymers and inorganic silanated filler particles.[20] It is an esthetic restorative material that emulates the clinical applications and indications of conventional composite resins and exhibits enhanced biocompatibility and physical properties.[20,21]

Alkasite restorative material

Cention N is a recently proposed bioactive tooth-colored material based on urethane dimethacrylate and is used for bulk placements in retentive areas without applying adhesive.[22] It is more affordable and user-friendly as compared to other restorative materials.[23] It is a subgroup of composite resin and belongs to a novel filler category called alkasite restorative material that can be applied with or without adhesive. It is radio-opaque, can polymerize by itself or with light, and releases substantial fluoride, calcium, and hydroxyl ions through alkaline glass fillers. The flexural strength is superior in comparison to composite resins and resin-modified glass ionomer cement.[22-25]

Bioactive materials

This is a recently recognized category of restorative materials capable of releasing mainly calcium, fluoride, and phosphate ions, and sometimes silver particles, antibacterial monomers, and strontium ions. They are recommended for use in cases of remineralization and pulp capping. These materials can facilitate ion exchange, thereby preventing adjacent tooth demineralization and enhancing remineralization. However, further research regarding their basic properties and long-term effectiveness is recommended.[26,27]

Biological restorations

Recent advances in novel restorative materials and techniques coupled with patients' and parents' awareness of esthetics have provided pediatric dentists with an option for biologically restoring teeth with the natural tooth. However, biological restorations have their pros and cons. They have great potential as an esthetic restorative option for the primary anterior teeth but further research is recommended to validate its use.[28]

In the future biological restorations can become an acceptable esthetic option for restoring teeth in children if educational interventions can be used to increase awareness among the general population.[29]

INDIRECT ESTHETIC INTRACORONAL RESTORATIVE MATERIALS

Recent developments in ceramic, adhesives, and polymer technologies have led to a variety of tooth-colored indirect restorations.[24] Indirect esthetic intracoronal restorative materials mainly consist of laboratory-processed CAD/CAM composites and ceramic inlays, onlays, overlays, and endo-crowns. In recent times, monolithic CAD/CAM restorations have increased dramatically and have replaced conventional composite buildups. A recent analysis of clinical longevity of indirect intracoronal restorations revealed that lithium disilicate and indirect composite materials demonstrated comparable survival rates in a short observation period, and intracoronal gold restorations were the preferred option as they were shown to have a higher rate of survival in comparison to indirect resin-composite restorations.[30]

Endo-crown is a conservative restorative option for the rehabilitation of compromised and endodontically treated posterior teeth in selected patients with acceptable long-term survival.[31] They may be considered a better alternative in comparison to conventional treatments using intraradicular posts, direct composite resin, or inlay/onlay restorations.[32] A high success rate of 94-100% has been reported with the use of endo-crowns.[31-33] A recent study revealed that the mechanical retention of endo-crowns is increased by increasing the central cavity depth and by adding ferrule.[34] Endo-crowns are now considered a reliable option for molar restoration.[31,33] Further studies are required to confirm the feasibility of endo-crowns and the preferred material of choice.[35] The procedure for producing indirect restorations has become more convenient, time-saving, and precise with the introduction of chairside CAD/CAM fabrication equipment in comparison to the traditional methods utilizing impressions and cast models.[36]

Indications

The main indications include cases where esthetics is the primary concern, large defects, and replacement of large, compromised existing restorations.[37]

Contraindications

The contraindications for indirect tooth-colored restorations include teeth with heavy occlusal forces, difficulty in isolation, and deep subgingival restorations.[37]

Formulated by the International Association of Pediatric Dentistry (IAPD) and the American Academy of Pediatric Dentistry (AAPD), are of paramount importance and should be considered by clinicians while formulating the treatment plan for pediatric patients. They have been summarized in Table 2 and 3.[6,7]

Table 2: IAPD recommendations for intracoronal restorative materials.

S. no.	Indications for restorations in children	Restorative material recommended	Global agreement
1.	Interim therapeutic restorations (ITR) or atraumatic restorative treatment (ART)	High-viscosity glass ionomer cement	100%
2.	Primary and permanent posterior teeth requiring single surface restorations	Glass ionomer and resin-modified glass ionomer	87%
3.	Restoration based on clinical judgment and shared decision-making	Dental amalgam	70%

Table 3: AAPD recommendations for intracoronal restorative materials.

S. no.	Indications for restorations in children	Restorative material recommended
1.	For primary and permanent teeth with minor, non-cavitated interproximal caries lesions as a supplement to preventive treatments; White spot lesions	Resin infiltration
2.	Class I and class II cavity restorations in primary and permanent teeth; Risks and benefits of amalgam restorations to be reviewed by the provider with patients	Dental amalgam
3.	Class I and class II cavity restorations in primary and permanent teeth	Composites
4.	GIC- class I cavity restorations in primary teeth; RMGIC- class I cavity restorations, and class II restorations in primary teeth (expert opinion); High-viscosity glass-ionomer cement- In ITR/ART, and to temporarily restore single-surface primary and permanent teeth; ITR for caries control in child patients with multiple open carious lesions, before definitive restoration of the teeth.	Glass ionomer cement (GIC)
5.	As an option for restoring class I and class II cavities in the primary dentition; Several enamel defects	Compomers
6.	Used for remineralization and pulp capping	Bioactive materials

Recent developments in material science offer immense potential in novel dental materials for various intracoronal applications. Tooth-colored materials will always be desirable for smaller areas of decay involving one or two surfaces.[38]

A lot of easy-to-handle, esthetic materials with improved physical properties will be developed for use in posterior tooth restorations. Laboratory-made or CAD-CAM milled restorations will become cost-effective and will be the choice of treatment for carious lesions involving multiple surfaces. Unlimited options will be available for esthetic restoration of young permanent dentition. Biological restorations with natural teeth have immense potential to restore primary anterior teeth and traumatized permanent teeth. Nanotechnology will assist in improving the mechanical properties of composites and glass ionomer cement, thereby enhancing their antimicrobial and biomineralizing properties.

Limitations

It was a technique-sensitive clinical procedure.

CONCLUSION

The treatment of decayed teeth in children poses a challenge to pediatric dentists. Selecting a suitable restorative material is one of the primary requirements for successful pediatric restorative dentistry. A lot of variables affect the selection and outcome of restorative treatment in pediatric patients, and the most important ones include the clinician's preferences, the child patient's behavior, and the esthetic demands of the parents and patient.

Esthetically desirable, biocompatible, easy-to-handle restorative materials with improved physical and mechanical properties and higher fluoride release have revolutionized pediatric restorative dentistry. Pediatric dental professionals should be updated on the clinical applications of novel restorative materials, and make evidence-based decisions. We recommend more clinical trials on these novel esthetic restorative materials for their efficient and safe use in pediatric dental patients.

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