Republic of Iraq
Ministry of Higher Education
And Science Research
University of Baghdad
College of Dentistry

Operative Treatment of Dental Caries in Primary Dentition

A Project Submitted to
The College of Dentistry, University of Baghdad, Department of Pedodontics in Partial Fulfillment for the Bachelor of Dental Surgery

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(May, 2022)

Certification of the Supervisor

I certify that this project entitled "**Operative Treatment of Dental Caries in Primary Dentition**" was prepared by the fifth-year student **Maryam Abdulameer Hassan** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Assist. Lecturer Asmaa Mohammed Khammas

Date

Dedication

To my mother, who raised, you deserve to be proud and delighted.

I love you so much you deserve all the happiness in the world.

To my dad, who ignited the passion of art in me, your soul has been with me through all this way.

To my family who supported me.

To my doctors.

To my friends Fatima, Mina, Farah, Kawther this year and every year has been amazing with you.

Acknowledgements

My faithful thanks and all gratefulness to **"Allah"**, God of the world, Most Gracious, Most Merciful for leading and helping me to perform this project.

My thanks to **Prof. Dr. Raghad Abdulrazaq**, Dean of the College of Dentistry for providing the opportunity to pursue my study.

Deep thanks to **Prof. Dr. Ali I. Al-Bustani**, the associate dean for scientific affairs.

My sincere thanks to **Prof Dr. Ahlam T. Mohammed**, Head of Pedodontics Department, and all professors and seniors in the department for their pleasant cooperation.

This research would not have been possible without the exceptional support of my supervisor, **Dr. Asmaa Mohammed Khammas**. Her enthusiasm, knowledge and exacting attention to detail have been an inspiration and kept my work on track from the beginning to the final draft of this paper.

I am also grateful to my family for their support and encouragement throughout my study.

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BC	bioceramic
BISGMA	bisphenol A-glycidyl methacrylate
FDA	Food and Drug Administration
GIC	Glass ionomer cement
INC	incorporated
LC	Light cured
MTA	Mineral trioxide aggregate
PRIMM	Packable rigid inorganic matrix material
RMGI	Resin modified glass ionomer
SSC	Stainless steel crown
UDMA	Urethane dimethacrylate
YAG	Yttrium aluminum garnet

Introduction

Since the beginning of the history of dentistry, the treatment of the dental caries has been focused on the restorations of the cavities using many techniques and materials, which have presented a great evolution throughout time. However, patients still presented the development of carious lesions at the margins of the restorations, called secondary caries, as well new lesions on other dental surfaces **(Fejerskov and Kidd, 2008)**.

Dental caries has been a highly prevalent and costly disease in the world. Representing the most common infectious disease in the paediatric population. The disease is increasingly isolated in specific teeth and tooth morphology types in both primary and mixed dentitions, with pits and fissures being the predominant decayed sites **(Pizzo et al., 2009)**.

Materials such as glass-ionomers, resin-ionomers, resin-ionomer products, and improved resin-based composite systems have been developed which are having profound impact on the restoration of primary teeth. The principal advantage of these materials is that they require less retention form, and this is particularly important in primary teeth to conserve the relatively thin enamel that could help prevent subsequent caries invasion of dentin **(Anderson, 2002)**.

Restoration of primary teeth differs from restoration of permanent teeth, due in part to the differences in tooth morphology. The mesiodistal diameter of a primary molar crown is greater than the cervicoocclusal dimension. The buccal and lingual surfaces converge toward the occlusal. The enamel and dentin are thinner. The cervical enamel rods slope occlusally, ending abruptly at the cervix rather than being oriented gingivally and gradually becoming thinner as in permanent teeth **(Waggoner, 2005)**.

Restorative treatment is based upon the results of a clinical examination and is ideally part of a comprehensive treatment plan **(Mathur et al., 2016)**.

Aims of the study

This review aims at achieving a better understanding of:

- The methods used in caries removal in pediatric patients
- Restorative materials and techniques used with primary teeth

Chapter one
Review of literature

1. Caries removal methods:

There are different techniques presently available for caries removal and cavity preparation produce residual dentin substrates of different natures and thus different receptiveness for adhesion **(De Almeida Neves et al., 2011)**.

1.1 Conventional

Conventional caries removal and cavity preparation entail the use of high-speed handpiece and burs which undoubtedly improved the speed and efficiency of cavity preparation but has many inevitable disadvantages **(Bussadori et al., 2005)**:

1. Perception of unpleasantness by the patients.
2. Use of local anesthesia.
3. Deleterious thermal effects.
4. Pressure effects on the pulp.
5. May result in removal of healthy dentin, resulting in an excessi loss of sound tooth structure.

The low-speed handpiece (500-15,000rpm) is most frequently used primarily for caries removal and occasionally for polishing and finishing procedures. As with high-speed instrumentation, light pressure and brushing strokes should be used when using the low-speed handpiece. Use of hand instrumentation is minimal in most operative preparations in the primary dentition and is usually limited to final caries removal **(Kupietzky et al., 2010)**.

1.2 Air abrasion

Air abrasion for restoration preparation removes tooth structure using a stream of aluminium oxide particles generated from compressed air or bottled carbon dioxide or nitrogen gas. The abrasive particles strike the tooth with high velocity and remove small amounts of tooth structure. Efficiency of removal is relative to the hardness of the tissue or material being removed and the operating parameters of the air abrasion device **(White and Eakle, 2000)**.

Specific indications for use of air abrasion include caries removal; removal of small existing restorations; preparation of tooth structure for cutting or etching for the placement of composites, porcelain and ceramics; and as an adjunct to the conventional handpiece bur **(Rainey, 2002)**.

1.3 Chemomechanical

Chemomechanical caries removal characterized by removal of infected tissue via gentle excavation and the use of a material that acts on the pre-degraded collagen of the lesion, promotes its softening, doesn't affect the adjacent healthy tissues and avoids pain stimuli (chemical action) thus results in reduced fear and anxiety which are known barriers to the receptivity of dental treatment and in detriment to oral health **(Ganesh and Parikh, 2011)**.

Chemomechanical caries removal concept includes the early detection of lesions, individual caries risk assessment, non surgical interventions and modified surgical approach which includes smaller tooth preparations with modified cavity designs and adhesive dental materials and repair rather than replacement of failing restorations. The goal is to preserve the natural tooth structure **(Garg et al., 2015)**.

1.1.4 Laser techniques

The use of lasers for cavity preparation and caries removal is based on the ablation mechanism, in which dental hard tissue can be removed by thermal and/or mechanical effect during laser irradiation **(Neves et al., 2010)**.

Depending on laser wavelength and tissue characteristics, laser irradiation can be absorbed, scattered, reflected or transmitted into dental tissues **(Ana et al., 2006)**. These effects must be well known by professionals to help them choose the best equipment for a specific clinical application and to avoid thermal and mechanical damages to the target and surrounding tissues. Depending on the clinical situation, dentists need different laser wavelengths and irradiation parameters to obtain distinct effects on the same tissue **(Niemz, 2004)**.

An erbium: YAG laser can be used in restorative dentistry for minimally invasive preparation of pits and fissures, cavity preparation of all classes, treatment of deep dentinal caries, and laser-assisted pulp capping **(Martens, 2011)**.

2. Cavity design preparation

Tooth preparation is the mechanical alteration of a defective, injured, or diseased tooth such that placement of restorative material re-establishes normal form including esthetic corrections, where indicated. Generally, the objectives of tooth preparation are **(Jain and Jain, 2017)**

1. Conserve as much healthy tooth structure as possible
2. Remove all defects while simultaneously providing protection of the pulp-dentin complex
3. The form of the tooth or the restoration will not fracture and the restoration will not be displaced
4. Allow for the esthetic placement of a restorative material where indicated.

G.V. Black presented a classication of tooth preparations according to diseased anatomic areas involved and by the associated type of treatment. Black's classication originally was based on the observed frequency of caries lesions in various surface areas of teeth. hese classiications were designated as Class I, Class II, Class III, Class IV, and Class V. Since Black's original classiication, an additional class has been added, Class VI **(Lamacki, 2016)**.

All preparations required to treat pit and fissure caries are termed Class I preparations. These include preparations on the occlusal surfaces of premolars and molars, occlusal two thirds of the facial and lingual surfaces of molars, and the lingual surfaces of maxillary incisors **(Price et al., 2010)**.

Preparations required to correct caries lesions that develop in the proximal surfaces of posterior teeth are termed Class II preparations **(Wiegand and Attin, 2007)**.

Preparations required to correct caries lesions that develop in the proximal surfaces of anterior teeth that do not include the incisal edge are termed Class III preparations **(Rasiines Alcaraz et al., 2014)**.

Preparations required to correct caries lesions or other defects that develop in the proximal surfaces of anterior teeth that include the incisal edge are termed Class IV preparations **(Rasiines Alcaraz et al., 2014)**.

Preparations required to correct caries lesions or other defects that develop in the gingival third of the facial or lingual surfaces of all teeth are termed Class V preparations **(Price et al., 2010)**.

Preparations required to correct caries lesions or other defects that develop in the incisal edges of anterior teeth or the occlusal cusp tips of posterior teeth are termed Class VI preparations **(Rasiines Alcaraz et al., 2014)**.

Much of the rationale supporting the development of tooth preparation techniques was introduced by Black.1 Modications of Black's principles of tooth preparation have resulted from the inluence of Bronner, Markley, J. Sturdevant, Sockwell, and C. Sturdevant **(Jain and Jain, 2017)**.

Tooth preparation design takes into consideration the nature of the tooth (the structure of enamel, the structure of dentin, the position of the pulp in the pulp–dentin complex, the enamel connection to the dentin) and the nature of material to be used for restoration of the defect **(Ritter and Swift, 2003)**.

3. Isolation of teeth in Pediatric Patients

Any operative procedure needs adequate space over the operating field. There must be proper control of moisture, good accessibility and visibility as well as spacious for instrumentation around the working area. For easy manipulation this kind of environment is necessary. Isolation of the working area includes isolation from saliva, blood, gingival crevicular fluid and soft tissues like lips, cheeks, gingiva and tongue **(Zou et al., 2016)**.

3.1 Types of Isolation in Pediatric Patients

There are many types of isolation in pediatric dentistry **(Keys and Carson, 2017)**:

3.1.1 Fluid Absorbents

According to **(Wang Y, 2021)** these are:

a. Cotton Rolls.

b. Gauze or Throat Shields.

c. Absorbent Paper.

3.1.2 Saliva Ejectors

3.1.3 Rubber Dam

It is known that the use of rubber dam isolation (RDI) shortens the treatment time and provides optimal moisture control during restorative procedure **(Soldani and Foley, 2007)**.

3.1.3.1 Rationale

The rubber dam is useful for **(Brill WA, 2001)**:

1. The clean and visible field is maintained
2. Aspiration of foreign bodies is prevented
3. Clinician protection
4. The risk of cross-infection to the root canal system is reduced
5. Soft tissues are retracted and protected
6. By minimizing patient conversation and the need for frequent rinsing efficacy is increased

7. Medicaments are applied without the fear of dilution
8. Properties of restorative materials are improved.

3.1.3.2 Contraindication

But it is contraindicated in **(Brill, 2001)**:

1. A child with Upper respiratory tract disorder, congestion of nasal passage or nasal obstruction.
2. If there is any fixed orthodontic appliance.
3. Any recently erupted tooth that can not hold a clamp.
4. Allergy to latex.

3.1.3.3 Disadvantages

Some of its disadvantages **(Alhareky et al., 2014)**:

1. Trauma to tissue.
2. Patient acceptance.
3. Latex allergy.
4. Trauma to tissues.
5. Pressure marks on face due to frame.
6. The build-up of saliva.
7. Psychological intolerance.

3.1.3.4 Benefits to the Child

As glasses are used to protect the eyes, thus rubber dam is used to protect the airways and the esophagus. By doing this a good analgesia has been obtained, the child can feel distanced from the operation. Sometimes it is useful to show the child his isolated tooth in the mirror **(Mittal and Sharma, 2012)**.

3.1.3.5 Benefits to the Dentist

Correctly placed rubber dam allows the operator a better view of the area to be treated by gently pulling the cheeks and tongue away from the operative area **(Mittal and Sharma, 2012)**.

3.1.3.6 Armamentarium

According to **(Ammann et al., 2013)** these are:

1. Rubber dam Sheet
2. Rubber dam Frame
3. Rubber dam Punch
4. Lubricants
5. Clamps
6. Rubber dam forceps

3.1.3.7 Modifications of rubber Dam Isolation

There are different ways to use rubber dam according to **(Ahmad, 2009)**:

1. Hatdam is a clear plastic form shaped like a hat without a top which is trimmed and fitted around the crown that can not be clamped, to hold the rubber dam in place. And we may use it in a regular way or a split-dam technique **(figure 1)**.
2. Cushioning metal clamp jaw is made up of Ferrite-N which can be pressed in the embrasure area. The material is light-cured, over which the clamp is seated.
3. Cushees are soft thermoplastic cashew-shape nodules which are slipped over tooth attachment blade of the clamp before clamp application.
4. Fiber optic clamps are used in the endo illuminator system.
5. Liquid dam is a resinous material applied to the gingival aspect of the tooth surface used to blockout undercuts before take impression

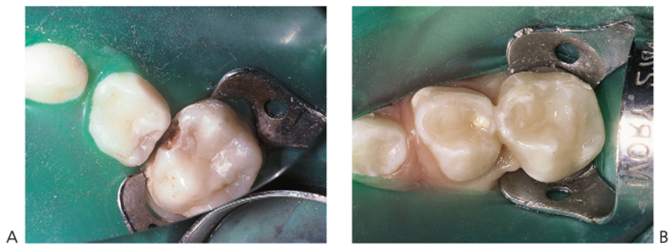

Figure1: Two methods for using the rubber dam in children. (A)Traditional (B)Split-dam technique (Yengopal et al., 2009)

4. Bases and liners

The term liner is relatively a thin layer of material which is used to protect the pulp and dentin. It provides a barrier against remaining reactants diffused from restoration and/or oral fluids and may enter leaky tooth restoration interfaces **(Anusavice, 2003)**.

The greatest need for liner is in case with metallic restorations, Which preparations is extended pulpally, example is amalgam, cast gold and with other indirect restorations. It can be classified as thin film liners which further divided into solution liners and suspension liners. And thicker liners which is basically used for pulpal medication and thermal protection and is also known as cement liners **(Craig and Powers, 2002)**.

4.1 Cavity Varnish

It is applied in case of shallow cavities. Especially under the cavity walls of amalgam and cast metal restorations. In case of composites and glass-ionomer cements the application of cavity varnish can be avoided **(Craig and Powers, 2002)**.

Varnish coatings are formed by drying the solutions of copal or other resin dissolved in a volatile solvent. The most widely used varnish is copalite. The constituents of this are 10% copal resin and organic solvents such as ether, alcohol and acetone. Medicinal agents such as chlorobutanol, thymol, and eugenol also have been added. To produce the thin film layer the resin component kept low. Because thin film provides flexibility and dry easily as compared to thick films **(Ferracane, 2001)**.

This provides better sealing of the dentinal tubules and leads to good marginal adaptability, especially in the case of silver amalgam restoration till the corrosion products fill the gap. It has been seen that only 2 to 3 layer of varnish is formed over the smear layer along the tooth preparation wall, and that’s why single coating of varnish covers only 55% of the surface. A second layer of varnish is recommended to produce sealing up to 80 to 85% **(Nikahde et al., 2019)**.

4.2 Cavity Sealers

It is a material that provides better sealing and bonding at the restoration and cavity wall interface. The example of cavity sealers includes dentin bonding agents which replaces the cavity varnish **(von Fraunhofer, 2006)**.

4.2.1 Functions of Varnish and Sealer

There are **(Craig and Powers, 2002)**:

1. It prevents microleakage.
2. It prevents post-operative sensitivity by not allowing the ingress of fluids from the cavity margin
3. It also prevents the penetration of the toxic material into the dentin from the restorative material and also prevents discoloration.
4. Suspension liners: It contains calcium hydroxide, zinc oxide eugenol

4.3 Conventional Calcium Hydroxide Liners

Ca (OH)2 (Calcium hydroxide) is the material introduced in clinical dentistry in 1921 by Hermann. It is the gold standard material used for pulp protection in case of direct and indirect pulp capping treatment procedures. It is used as liners or sub base **(Arandi, 2017)**.

The calcium hydroxide material is categorized as low strength base, so it required a suitable high strength base to increase the compressive strength before placement of final restoration **(Nikahde et al., 2019)**.

Calcium hydroxide liner has the antibacterial properties. Due to these properties of liners, it inhibits the bacterial growth under restorations. As the bacterial overload due to caries decrease the extent of pulpal inflammation is reduced. The set material has higher solubility in aqueous medium **(Murray, 2002)**.

4.4 Light Cured Calcium Hydroxide

It is available as single constituent liner. It contains Ca (OH)2 which is hardened by visible light cure through polymerization reaction. It is mainly introduced to overcome the drawbacks of the traditional chemical cure calcium hydroxide. It is set on command with the light cure unit. It provides improved strength, decreased solubility in acids and less solubility in water **(Arandi, 2017)**.

4.5 Zinc Oxide Eugenol

Cement used extensively date back since 1890. It was introduced due to its easy handling characteristic and manipulative even in the presence of moisture and well tolerated by the pulp tissue **(Paul, 2015)**.

The zinc oxide eugenol has excellent thermal properties and is approximately the same as human dentin. It was marketed as cavity liner but not as base. The zinc oxide eugenol base is not used under the composite restoration because eugenol inhibits the polymerization reaction **(Weston, 2015)**.

4.6 Zinc phosphate cement

It is the oldest luting cement introduced way back in 1800s by Dr. Otto Hoffman. It has excellent clinical performance, in spite of many inherent drawback such as chemical irritation to the pulp, lack of adhesion, lack of antibacterial action and high solubility in oral fluids. It has two component powder and liquid **(Tomer et al., 2016)**.

4.7 Glass-Ionomer Cement

Glass-ionomer cement (GIC) was first introduced by Wilson and Kent in 1972. The other name of GIC includes polyalkenoates, dentin substitute, and man-made dentin **(Sidhu and Nicholson, 2016)**.

It bonds well to enamel and dentin and released fluoride from the glass component of the cement. Due to this it helps to reduced dentinal hypersensitivity **(Strober et al., 2013).**

4.8 Resin Modified Glass Inomer Cement

Resin-modified glass ionomers (RMGI) were introduced to improve mechanical properties, reduce setting time, and lessen moistness sensitivity. Simply RMGIs are a hybrid of glass-ionomers and composite resin **(Weston, 2015)**.

4.9 Mineral-Trioxide Aggregate

Mineral trioxide aggregate (MTA) is an exclusive material with numerous exciting clinical uses. MTA has potential and is one of the most versatile materials of this century in the field of dentistry. MTA materials have been shown to have a biocompatible nature. MTA materials have been shown to have excellent potential as pulp-capping and pulpotomy medicaments **(Mostafa and Moussa, 2016)**.

4.10 Biodentine

It is calcium-silicate based material which became commercially available in 2009 (Septodont) and it was specifically designed as a “dentine replacement” material. It has a wide range of applications such as endodontic repair (root perforations, apexification, resorptive lesions, and retrograde filling material in endodontic surgery) and pulp capping which can be used as a dentine substitute material in restorative dentistry. The Biodentine is available in powder and liquid form **(Kaur, 2017)**.

Fast setting time 45 minutes is the unique feature of this material. It has positive effect on vital pulp cells and stimulates the tertiary dentin formation **(Malkondu, 2014)**.

4.11 Theracal LC

It is introduced to overcome the drawbacks of Biodentine that is poor micromechanical bonding with the resin composite restoration. Theracal LC is Resin-Modified Calcium Silicate Pulp Protectant/Liner. It is categorized as fourth generation calcium-silicate based material. It provides calcific barrier to protect the underlying pulp-dentin complex. The material sets by polymerization reaction using light activation **(Arandi and Rabi, 2018)**.

Due to this clinician can place and condense permanent restoration immediately in single sitting. The material also has thixotropic behavior. The proprietary hydrophilic resin formulation creates a stable and durable liner or base. The PH of Theracal LC is alkaline in nature and is 10.66 at 3 hours and no significant reduction seen at 24 hours **(Torabinejad et al., 2018)**.

4.11.1 Advantages

And there are **(Gurcan and Seymen, 2019)**:

1. It is help in the formation of reparative dentin.
2. It has low solubility as compared to Biodentine, calcium hydroxide, ProRoot MTA, MTA Angelus.
3. It acts as remineralizing agent
4. It has better bond strength compared to Calcium hydroxide, Biodentine and comparable with GIC.
5. It has anti-bacterial property.

4.11.2 Disadvantages

It contains polymerizable methacrylate monomers. So, avoid prolonged or frequent contact with skin, oral soft tissues, and eyes. Theracal LC is not suggested for use with patients who have a history of severe allergic reaction to methacrylate resins **(Karadas et al., 2016).**

4.12 Endosequence BC liner

It is a bioceramic cements that have been used for pulpal or root defect repairs in adult or pediatric teeth. It is also indicated as liner or base over the access openings in primary and permanent dentition covering any of standard dressings, spacers or obturation materials. Initial setting time is 20 seconds and initial self-curing time at 37 degrees Celsius is 2.5 to 3 minutes **(Jitaru et al., 2016)**.

4.13 Resin-based flowable composite liner

There has been many advantages and improvement taken place in composite resin restoration. High polymerization shrinkage is the still biggest issue. Due to increases in polymerization shrinkages it causes two main problems. That is bond failure between the restoration and tooth margin which further leads the microleakage as major consequences. For avoiding such problems and reliving stress cause due polymerization **(In Asiri et al., 2016)**.

5. Restorative materials

There are many restorative materials that can be used in primary teeth with varying degrees of success **(Roberson, 2006)**.

5.1 Amalgam

From the time of its introduction, there have been a lot of criticism against amalgam, especially regarding its biocompatibility and safety. But there is no conclusive evidence of health hazards being linked to amalgam **(Osborne et al., 2002)**.

5.1.1 Modifications

It has three modifications according to **(Raghu and Srinivasan, 2007)**:

1. **Mercury-free direct filling amalgam alloys**

   Mercury-free direct filling amalgam alloys consist of silver-tin (Ag-Sn) alloy particles that can be cold welded to form a compaction to form a restoration.

2. **Gallium based alloys**

   Gallium alloys have been developed as alternatives to mercury in amalgam. By addition of small amounts of indium and/or tin to gallium, an alloy which is liquid at room temperature is produced.

3. **Indium in mercury**

   interest has increased in admixed amalgam containing 10% to 15% indium in the mercury.

5.2 Glass-ionomer cement:

Adhesion of restoration to tooth substance is an important objective in Dentistry. It is believed that a restoration should resemble the tooth in all aspects. It should possess identical properties and should adhere tenaciously to the surrounding enamel and dentin. The glass-ionomer cement is developed in this direction as the property to adhere with the tooth structure **(Kirthika et al., 2021)**.

Glass-ionomer cements, are restorative materials which are made up of calcium, strontium aluminosilicate glass powder (base) combined with a water-soluble polymer (acid). When the components are mixed together, they undergo a setting reaction involving neutralization of the acid groups by the powdered solid glass base **(Nagaraja and Kishore, 2005)**.

5.2.1 Modifications of GIC

These are **(Najeeb et al., 2016)**:

1. Anhydrous: In this modification the liquid is delivered in a freeze-dried form that is then incorporated into the powder. The liquid to be used is clean water only, and this may enhance shelf-life and facilitate mixing.
2. Resin-Modified: These are materials which have a small quantity of a resin into the liquid formula. Less than 1% of photoinitiators are allowed for the setting reaction to be initiated by light of the correct wavelength **(Krämer et al., 2018)**.
3. Nano-ionomer: The Nano-ionomer delivers greater wear resistance, esthetics and polish compared to other glass-ionomers, while offering fluoride release similar to conventional and resin-modified glass ionomer **(Aparajitha et al., 2021)**.
4. Compomer: This is the term developed by the manufacturer with a term to incorporate some of the properties of glass-ionomer with a composite resin. A compomer is a composite resin that uses an ionomer glass which is the major constituent of a glass ionomer as the filler **(Zimmerli et al., 2010)**.

5. Ceramic reinforced glass-ionomer: Ceramic reinforced posterior GIC features stronger compressive, flexural and tensile strengths as compared to amalgam **(Wan Jusoh et al., 2021)**.

5.3 Composite resins

Introduction of this filled resin material in 1962 became the basis for the restorations that are generically termed composites. Composites are presently the most popular tooth-colored materials, having completely replaced silicate cement and acrylic resin **(Roberson, 2006)**.

5.3.1 Types of Composites

According to **(Ferracane, 2011)** these are:

1. Traditional composites: The fillers in these composites are relatively large in size, they are also called "macrofilled composites". Traditional composites are only employed in stress-bearing Class IV cavities.
2. Small particle composites: small particle composites have improved surface smoothness and superior properties than those of the traditional composites.
3. Microfilled composite resins: Microfilled composite resins were developed to overcome the surface roughness and low translucency of traditional and small particle composite resins. The fillers used in these are colloidal silica.
4. Hybrid composite: These were developed to achieve better surface smoothness than small particle composites while maintaining their desirable properties. This category of composite resins can be employed for both anterior and posterior situations. Hybrid composite resins have two kinds of filler particles: colloidal silica and heavy metal glasses.

5.3.2 Properties

These are **(LeSage, 2007)**:

1. Mechanical properties: Flexural strengths of various composites are similar although microfilled and flowable composites exhibit 50% lower values than hybrid and packable composites due to their lower filler content.
2. The Coefficient of thermal expansion: Composite resins have a higher coefficient of thermal expansion than that of tooth structure. This means that they expand and contract more than enamel and dentin when subjected to temperature changes.
3. Wear: Wear of composite resins occurs while they are in function due to masticatory forces, abrasive foods, tooth brushing and as result of chemical degradation in the oral cavity.
4. Water Sorption: Water is absorbed by the resin component; so, when the resin content is high, the water sorption is increased.
5. Solubility: Water solubility of composite resins varies from 0.5 to 1.1 mg/cm2. Inadequate polymerization of composite increases solubility.
6. Marginal Integrity: Composite resins exhibit good marginal adaptation if margins are on enamel and dentin.
7. Radiopacity: Resins are inherently radiolucent, modern composite resins have glass fillers containing heavy metal atoms like barium strontium and zirconium which provide radiopacity.
8. Esthetics, color and color Stability: Composite resins are highly esthetic and can simulate the appearance of natural teeth. They are available in a variety of shades, tints and opaque resins for different applications.
9. Polymerization Shrinkage: Polymerization shrinkage usually does not cause significant problems with restorations cured in preparation having all-enamel margins. When a tooth preparation has extended onto the root surface, however, polymerization shrinkage can cause a gap formation at the junction of the composite and root surface. The V-shaped gap occurs

because the force of polymerization of the composite is greater than the initial bond strength of the composite to the dentin of the root.

5.3.3 Modifications of composite resins

1. Packable/Condensable or Polymeric Rigid Inorganic Matrix Material (PRIMM): This system is composed of a resin matrix, and an inorganic ceramic component. Resin is added into the fibrous ceramic filler network. The filler consists of aluminium oxide and silicone dioxide glass particles or barium aluminium silicate or strontium glasses **(Ilie and Hickel, 2011)**.
2. Flowable Composite: Flowable composites were developed mainly in response to fulfill special handling properties for composite resins rather than any clinical performance criteria. Since the filler content is reduced in these composites there is a lack of sufficient strength to withstand high stresses and because of the increased resin content these composites exhibit more polymerization shrinkage and have lower elastic moduli and high fracture toughness **(David et al., 2021)**.
3. Indirect Composite Resins: Because of the major clinical problems clinicians have experienced with direct posterior composite resins, the indirect inlay or onlay systems were introduced **(Angeletaki et al., 2016)**.
4. Art glass: Art glass is a non conventional dental polymer. It is most commonly used in inlays, onlays and crowns. The resin matrix consists of bisphenol A-glycidyl methacrylate (BISGMA) and Urethane Di methacrylate (UDMA). Art glass is considerably more wear resistant than conventional light cured composites, good marginal adaptation, esthetics and superior proximal contact **(Sergi et al., 2020)**.
5. Belleglass HP: Belleglass HP was introduced by Belle de St. Claire in 1996 as an indirect restorative material. Its resin matrix consists of BISGMA and fillers **(Ellakwa et al., 2003)**.
6. Nanocomposites: Nanoparticle filled composites exhibit outstanding esthetics. They are easy to polish and possess an enhanced wear.

Nanoparticle fillers include colloidal silica or Ormocers. These may show an enhanced fracture toughness and adhesion to tooth tissue **(Chen, 2010)**.

7. Antimicrobial Materials: Antimicrobial properties of composites may be accomplished by introducing agents such as silver or one or more antibiotics into the material **(Yin et al., 2020)**.

6. Crowns in pediatric dentistry

6.1 Stainless-steel crowns

Rehabilitation of grossly lost tooth structure in primary/young permanent teeth by means of stainless-steel crowns has become a viable assistance to the pediatric dentist ever since Rocky Mountain company introduced them in 1947 but familiarized by Humphrey and Engel in 1950s. Stainless steel is composed of iron, carbon, chromium, nickel, manganese and other metals **(Donly and Godoy, 2002)**.

The distinctive anatomical characteristics of primary teeth, petite lifespan of primary teeth in the oral cavity, short attention span of the child, prolonged duration and intricate treatment planning involved in preparation of Willets inlay/cast crown restorations favors SS crowns as an alternative in Pediatric dentistry **(Randall, 2002)**.

6.1.1 Advantages

These are **(Seale NS, 2002)**:

1. These crowns are far superior to multisurface amalgam restorations with respect to life span, replacement, retention and resistance.
2. They are accepted both by patient and dentist.
3. They are also more cost effective because of comparatively simple procedures involved in restoring even severely affected primary molars.
4. Can be completed in a single appointment
5. Less time consuming than cast restorations
6. No need for laboratory procedures

7. Less sensitive to moisture
8. Less prone to fractures
9. Longevity
10. Durable as compared to multi-surface restorations
11. Premature contacts are well tolerated by the child

6.1.2 Indications

According to these are **(Mount and Tandon, 2009)**:

1. Extensive Caries
2. Rampant Caries
3. Following Pulp Therapy
4. Developmental Enamel Defects
5. Severe Bruxism
6. Fractured Incisors
7. Space Maintainer
8. Abutments to the Prosthesis

6.1.3 Contraindications

These are **(Marwah, 2014)**:

7. Primary molars close to exfoliation
8. Primary molars with more than half the roots resorbed
9. Teeth that exhibit mobility
10. Teeth which are not restorable
11. Patients with known nickel allergy

6.1.4 Modifications of Stainless-Steel Crowns

1. Facial cut out stainless steel crowns

This involves placement of composite material in a labial fenestration of SSC **(Motisuki et al., 2005)**.

2. Veneered Stainless-steel crowns

Here the composite resins and thermoplastics are bonded to the metal. This type of preveneered crown was developed to serve as a convenient, durable, reliable, and esthetic solution to the difficult challenge of restoring severely carious primary incisors. Various commercially available veneered SSCs include Cheng crowns, Kinder crowns, Nu- smile and Whiter biter, pedo compu crowns and Dura crowns **(Aiem et al., 2016)**.

a. Cheng Crowns

Cheng Crowns made their public debut in 1987. These are stainless steel pediatric anterior crowns faced with a high-quality composite, mesh-based with a light cured composite. It presents a unique solution for natural-looking Stain-resistant Crowns. It is available for the right and left central and lateral as well as cuspids.

Most crown procedures can be completed in one patient visit and with less patient discomfort **(Al Shobber and Alkhadra, 2017)**.

b. Kinder crowns

Kinder crowns offer the most natural shades and contour available for the pediatric patient. The great depth and vitality from the lifelike composite reveal a natural smile without the bulky “Chiclet” look of other restorations. They come in 2 aesthetically pleasing shades, Pedo 1 and Pedo 2. Pedo 2 shade is the most natural shade While Pedo 1 shade is for those cases when the bleached white shade is wanted **(Kratunova and O'Connell, 2015)**.

c. Pedo Pearlstm

These are beautiful heavy gauge aluminum crowns coated with Food and Drug Administration (FDA) food grade powder coating and epoxy-resin. They serve as ultimate permanent crown for primary teeth. And they are Universally used on either side, Easy to cut and crimp, without chipping or peeling. **(Usha et al., 2007)**.

d. Dura crowns

Crowns can be crimped labialy and lingually, can be easily trimmed with crown scissors, easily festooned and has got a full-knife edge. Study has shown that these crowns with veneer facings were significantly more retentive than the nonveneered ones when cement and crimping were combined **(Shah et al., 2004)**.

6.2 Strip crowns

The bonded resin composite strip crown is perhaps the most esthetic of all the restorations available to the clinician for the treatment of severely decayed primary incisors. However, strip crowns are also the most technique-sensitive and may be difficult to place **(Abu-Hussein et al., 2015)**.

Composite strip crowns are composite filled celluloid crowns forms. They have become a popular method of restoring primary anterior teeth because they provide superior aesthetics as compared to other forms of anterior tooth coverage **(Mortada and King, 2004)**.

Composite strip crowns rely on dentin and enamel adhesion for retention. Therefore, the lack of tooth structure, the presence of moisture or hemorrhage contributes to compromised retention. They are less resistant to wear and fracture more readily than other anterior full coverage restorations.

A study in 2002 found that composite strip crowns had a failure rate of 51%, compared to an 8% failure rate of stainless-steel crowns **(Tate et al., 2002)**.

6.3 Polycarbonate Crowns

These are heat molded acrylic resin used to restore primary anterior teeth. It is esthetic than SSC, easy to trim and can be adjusted with pliers. These crowns do not resist strong abrasive forces thus leading to occasional fracture, hence it is contraindicated in cases of Severe bruxism and deep bite **(Lee, 2002)**.

6.4 Pedo jacket

It is a tooth colored copolyester material which is filled with resin and left on tooth after polymerization instead of being removed. It does not split, stain or crack. Crowns can be easily trimmed with scissors **(Waggoner, 2005)**.

6.5 New millenium

These crowns are made up of Lab enhanced composite resin material. No long-term studies are available regarding these crowns **(Macdonald et al., 2007)**.

6.6 zirconia crowns

Zirconia seems to satisfy both esthetic and mechanical needs as a core material for all ceramic restorations **(Guazzato et al., 2005)**.

Zirconia has better mechanical properties compared with other ceramics, such as alumina, glass ceramics, and lithium disilicate. It is aesthetically superior and can be used in anterior, premolar, and molar areas. Zirconia crowns have shown a good marginal adaptation, giving the clinician an aesthetic alternative to metal ceramic crowns **(Chazine et al., 2011)**.

It has good chemical and dimensional stability, along with mechanical strength and toughness, coupled with a young's modulus in the same order of magnitude of stainless-steel alloys was the origin of the interest in using zirconia as a ceramic biomaterial. No complications were found in 88% of the crowns over a 5-year period, and just 9% were judged as failures. Longer term success rates remain to be determined **(Lops et al., 2012)**.

6.8 Hall technique

The Hall Technique offers an effective approach to manage carious lesions in primary molars where no carious tissue is removed but the lesion is sealed under a preformed metal crown (PMC). This biologically based concept of caries control aims to influ- ence the carious lesion and biofilm activity at the tooth level, separating the lesion and cariogenic biofilm from the oral environment **(Innes et al., 2006)**.

6.8.1 Characteristics

These are **(Evans et al., 2000)**:

1. None of the carious lesion is removed.
2. The carious lesion is sealed under a PMC using glass ionomer cement.
3. No local anesthesia is required and no tooth preparation is carried out.

6.8.2 The Hall Technique in Five Steps (Innes et al., 2006)

Step 1: Assess Crown Morphology, Contact Areas, and Occlusion

Step 2: Size the Hall Crown **(figure 2)**

Step 3: Clean the Tooth and Fill the Crown

Step 4: Fit and Seat the Crown

Step 5: Remove Excess Cement and Check Occlusion

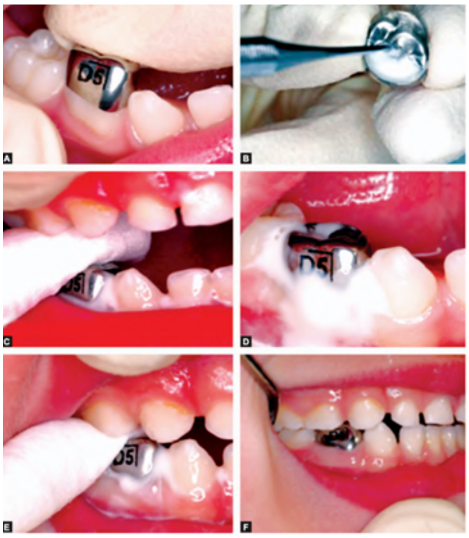

Figure 2: Procedure of placement of SSC using Hall technique (Dean et al., 2011).

Chapter two

Conclusion

Many restorative options exist for treating primary teeth. Finally, the choice of restorative technique depends upon the operator preferences, esthetic demands by the parents and child's behavior that affect the ultimate outcome of whichever restorative material chosen.

Last decade showed a significant growth in the range of tooth-colored materials available to restore primary and mixed dentition in children. An improved conventional glass ionomer cement, composite resin, resin-modified glass ionomer cement, light cured glass ionomer cement, silver reinforced glass ionomer cements and polyacrylic acid modified composites (compomers) have become available in addition to amalgam and stainless-steel crowns.

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