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Esthetic Restorations and Smile Designing: A Review

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***Abstract*---**In modern practice of dentistry, it is no longer acceptable to just repair, individual teeth. The public still regards teeth as an important part of chewing, but today the focus of many adults has shifted towards the esthetics. According to the survey, appearance of teeth is found to be more important to women than men. The level of aesthetic requirement has increased over the past decade, and this has made it necessary for dentist to explore the field in order to satisfy the existing demands in the field. Dental art does not occur automatically. The dentist must purposely and carefully incorporate it into the treatment plan. This artistry tries to soften the marks imposed upon the face of time and enables people to face their world with renewed enthusiasm and confidence. Research in the field of esthetic dentistry still continues.

***Keywords*---**artistry, esthetics, repair, treatment plan.

Introduction

In the past 25 years, the focus of dentistry has gradually changed. Years ago, dentists were in repair business. Routine dental treatment involved excavating dental caries and filling of the enamel and dentinal defects with amalgam.[1] Beauty is a subjective term; likewise, dental esthetics has also got diverse opinion among different kinds of people. A study by PK Vallittu, et al revealed that there exists different opinion for the different group of peoples regarding their dental esthetics

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perception.[2] In modern practice of dentistry, it is no longer acceptable to just repair, individual teeth. 21st century is the true movement where esthetic dentistry began as there is more focus on creating beautiful, natural looking teeth.

Basic principles of esthetic dentistry

Physics of color

Sir Issac Newton found out that a beam of white light could be separated into component colors, or wavelengths, by passing it through a prism.[3] Without light, color does not exist. It is the interaction of light with the object that allows the perception of color.

- Hue
  "Hue" is the quality that distinguishes one family of color from another.[4]
- Value
  Value is defined as the relative lightness or darkness of a color or brightness of the objet.
- Chroma
  Chroma is defined as the saturation, intensity or strength of hue. As chroma is increased, value is decreased; chroma and value are inversely related.[5]

Color in dentistry

Pigment colors

Pigment colors are inherent hues of an object. In dentistry it is necessary to understand pigment colors as they are inherent in restorative matrerials.

- Primary colors: Red, yellow, blue
- Secondary colors: Orange, green, violet[6]

Complementary colors

Complementary pigment color pairs are blue/orange, red/green and yellow/violet.[6]

Contents

- Glass Ionomer Cement

GIC was introduced by Wilson and kent in 1972 as a translucent dental filling material.[6] The proper name for them, according to ISO, is "glass polyalkenoate cement" , but the term "glass-ionomer"(including hyphen) is recognized as an acceptable trivial name.[7]

Clinical implications
GICs are recommended as:[8]

- Cavity liner
- Cavity base
- Luting cement
- Fissure sealant[8]
- Restoration
- Crown cementation
- GIC in Endodontics
- ART[8]

- Composite

Composites are mixture of two materials in which one of the materials, called reinforcing phase, are embedded in the matrix phase. Composites are used because overall properties of the composites are superior to those of the individual components.[8]

Classification of Composites

- Based on the mean particle size of the major filler
- Based on filler particle size and distribution[9]
- Based on method of polymerization
- Based on mode of presentation
- Based on use
- Based on their consistency[9]

Recent advancements in composites

- Packable Composites
  Manufacturers have developed "condensable" or "packable" resin composites marketed as amalgam alternatives. An application technique similar to that used with amalgam can be used for the placement. Their ability to be bulk cured results in a more cost-effective treatment by reducing the time needed to place a restoration. Besides an improvement an improvement in handling, they were expected to exhibit excellent mechanical and physical properties owing to their high filler load and have minimal polymerization shrinkage and an increase depth of cure, upto 5mm.[9]
- Flowable Composites
  It is termed as "flowable composite" because of its low viscosity and ability to be syringed into a cavity preparation with a needle tip. Most of the flowable composites presently available are not filled, generally containing from 56% to 70% filler by weight. Accordingly, they have reduced mechanical properties such as a higher susceptibility to wear, a higher polymerization shrinkage, and lower flexural strength.[10]
- Ormocers
  Recently, a new organically modified ceramic packable restorative material that has been developed and it is also called as ormocer. The ormocer composite consists of inorganic-organic copolymers and inorganic silanated

filler particles. The newly designed inorganic-organic copolymers are synthesized in a "solgel," process from multifunctional urethane and thioether(meth)acrylate alkoxy silanes. The alkoxysilyl groups of the silane allow the formation of an inorganic Si-O-Si network by hydrolysis and polycondensation reactions, and the (meth) acrylate groups are available for photochemically induced organic polymerization. After incorporation of filler particles, the ormocer composites can be manipulated by the dentist as in conventional resinbased composite material. Packable composites and the packable ormocer both have less polymerization shrinkage and can be bulk-cure.[8]

- Nano Composites
  Nanotechnology provides composite resins with a dramatically smaller filler particle size that can be dissolved in higher concentrations and polymerized into the resin system.[11] Nanoparticle filled composites exhibit outstanding aesthetics, are easy to polish and posses an enhanced wear resistance.
- Antimicrobial composite
  Antimicrobial properties of composites may be accomplished by introducing agents such as silver or one or more antibiotics into the material. Silver and titanium particles were introduced into dental composites, respectively, to introduce antimicrobial properties and enhance the biocompatibility of the composites.[12] The antibacterial properties of these composites were based on contact mechanism rather than on leaching.
- Stimuli responsive composite
  Stimuli-responsive materials possess properties that may be considerably changed in a controlled fashion by external stimuli. Such stimuli may be for example changes of temperature, mechanical stress, pH, moisture, or electric or magnetic fields .[13] These composites may be very effective against secondary caries. They are used for treating the secondary caries in the posterior teeth region.
- Fibre Reinforced Composite
  Fiber-reinforced composites have numerous industrial and aerospace applications because they are light, strong and non-flammable. However, with respect to clinical dentistry, they are relative newcomers into the spectrum of prosthodontic treatment options. The main advantage of these fibre reinforced composite was they can be used in both direct and indirect restorations.[14]
- Self healing composite
  Materials usually have a limited lifetime and degrade due to different physical, chemical, and biological stimuli. These may include external static (creep) or dynamic (fatigue) forces, internal stress states, corrosionhealing synthetic materials reported interestingly shows some similarities to resin-based dental material; it was the epoxy resin composite.[15] If a crack occurs in the epoxy composite material, some of the microcapsules are destroyed near the crack and release the resin.

Ceramics

The terms ceramic and porcelain are often used interchangeably in dentistry. Ceramic comes from the Greek term *keramos* and means potter, referring to one's ability to heat clay to form pottery.[16] The word porcelain is said to have been

invented by Marco Polo in the 13th century from the Italian word *porcellana*, or cowrie shell. Polo used the cowrie shell to describe Chinese porcelain because it was similarly strong and hard while remaining thin and translucent.
Ceramics: - Compounds of one or more metals with a nonmetallic element, usually oxygen. They are formed of chemical and biochemical stable substances that are strong, hard, brittle,and inert non-conductors of thermal and electrical energy.[16]

Composition of dental ceramics

- Feldspar: 75-85%
- Silica (quartz): 12-22%
- Kaolin: 4%
- Glass modifiers eg. K, Na orbasic oxides: minute[17]
- Clour pigments eg.copper oxide, titanium oxide: Trace
- Zirconiaor tin oxide : Trace
- Uranium oxide: Trace

Silica

It is one of the most abundant elements on earth and can exists in 4 different forms:

- Crystalline quartz[17]
- Crystalline Cristobalite
- Crystalline Tridymite
- Non-crystalline fused silica[17]

Pure quartz crystals are used in dental porcelain. Act as a filler and strengthening agent. Because of its high melting point, it provides a high strength framework for the other ingredients during firing. The quartz may be replaced by alumina (AI2O3), which is called aluminous porcelain. The alumina particles are much stronger than quartz and have an increased rigidity. Since the fracture of porcelain is caused by propagation of cracks through the structure, the alumina crystals tend to obstruct the path of the cracks.[17]

Kaolin

Kaolin is a hydrated aluminosilicate (Al2O3.2SiO2.2H2O)Acts as a binder, increasing the ability to mould the unfired porcelain. It gives porcelain its properties of opaqueness. When subjected to high heat, it adheres to the framework of quartzparticles and also it improves workability.[17]

Feldspar

The feldspars are mixtures of potassium aluminosilicate and sodium aluminosilicate, also known as albite(Na2O.Al2O3.6SiO2).precursor of natural clay. [18] Types of feldspars- Albite (Na2Al2Si6O16), Orthoclase or microcline $k_2Al2SiO_{16}$). Feldspars are naturally occurring substances, so the ratio between

the potash (K2O) and the soda (Na2O) will vary. Soda: - lower the fusion temperature and Potash: - increases the viscosity of the molten glass. Potash Feldspar + Metal Oxides combined at 11500C – 15300C give rise to leucite formation and glass phase formation.[18]

Glass modifiers

Sintering temperature of crystalline silica is too high. Alkali metal ions such as Na, K & Ca acts as glass modifiers which lower the sintering temperature. [19] The three dimensional silica network contains many linear chains of tetrahedral Silica that can move easily. This ease of movement increases fluidity. This ease of movement increases fluidity (decreases viscosity), lower softening temperature, and increases thermal expansion. [19]

Classification of ceramics

According to mannapali[19]

- Based on fusion temperature:
  - High fusing porcelain—1300–1400°C
  - Medium fusing porcelain—1100–1300°C
  - Low fusing porcelain—850–1100°C
  - Ultra-low fusing porcelain—less than 850°C.

- Based on its use:
  Used for–
  - Artificial or denture teeth – mainly made from high fusing porcelain
  - Jacket crowns, bridges, inlays – medium fusing porcelain
  - Veneers over cast metal crowns (metal ceramics) – low fusing ceramics.
  - Used for titanium and titanium alloys – ultralow fusing.

- Based on processing methods: [19]
  - Condensation and sintering
  - Pressure molding and sintering
  - Casting and ceramming
  - Slip casting
  - Sintering and glass infiltration
  - Machining (milling by computer control)
  - CAD-CAM ceramics

- By type of crystalline structure:
  - Feldspathic porcelain:
  - Leucite reinforced:
  - Aluminous porcelain:
  - Glass infiltrated porcelain
  - Glass ceramic
  - CAD – CAM ceramics

- By substructure or core material: [19]
  - Cast metal
  - Swaged metal
  - Glass ceramic
  - CAD – CAM ceramic
  - Sintered ceramic core.

According to Craig's classification[19]

Classification By Applications

- 1 ceramics for metal ceramic crowns and FPDs
- 2 All ceramic crowns, inlays, onlays, veneers,, ceramic brackets

Classification by fabrication method

- Sintered porcelain
- Cast porcelain
- Machined porcelain[19]

- Soft machined:
- Hard machined:
- Slip cast
- Heat pressed :

Classification by crystalline phase[19]

- glassy phase (vitreous phase) :
- Crystaline phase
  - Feldspathic porcelain: It is redominately a glass material with an amorphous (non-crysalline) structure. Feldspathic porcelain is composed mainly of oxide components including silcon doioxide, aluminium dioxide. [19]
  - Leucite reinforced: It conists of 45%by volume of tetragonal leucite, and have high flexural strength (104MPa) and compressive strength.It also has increased resistance to crack propagation
  - Aluminous porcelain: It was developed by Mclean in 1965. It suses aluminousas a core structure. It has high modulous of elasticity, and high fracture toughness as compared to feldspathic porcelain. [19]
  - Glass infiltrated porcelain: It consists of a porous crystalline slip formed by fusion of metallic particles at high temperature. A glass coat is then fused over the porous slip to infilterate into pores and strengthen the structure.
  - Sintered porcelain: Sintering is the process by which a powder compact is transformed to a strong, dense ceramic body upon heating. [19]

Application of dental ceramics

Basically ceramics are used as indirect restorative materials such as crowns and bridges, laminates and veneers, Inlays/Onlays and dental implants. Recently ceramic braces are used in orthodontics. [20]

- Crowns and bridges: Crown is an extracoronal restoration which completely caps or encircles a tooth or an implant. On the other hand a bridge is a fixed replacement of missing teeth, with support from adjacent teeth. Both of these can be formed by ceramics. These are of either *Porcelain fused to metal* (PFMs) or *full ceramics*. In case of PFMs, a metal core is placed in the tooth surface and ceramic is built on it. This is done by initially preparing the metallic portion by conventional casting techniques. Then the ceramic powder is incrementally painted on it and sintered. This is followed by glazing. In case of full ceramics, the wax pattern is prepared for the crown, it is invested and mould space prepared by lost wax technique. The ceramic is fused and typically pressed into the mould space. [20]
- Ceramic teeth : Similarly, ceramic teeth are manufactured in various shades, shapes and sizes to be used incomplete dentures. Also, in case of gum recession, in fixed prosthesis, pink coloured ceramics are placed in the lost gum region to make it look natural.
- Laminate and veneers : As esthetics has become a matter of necessary concern . The laminate and veneers used in esthetic dentistry are also made of dental ceramics.They have gained increasing popularity for esthetic improvement of anterior teeth. [20]
- Inlays and onlays : An Inlay preparation involves occlusal an proximal surfaces of posterior teeth and may cap one or more cusps but not all of the cusps.

Onlay cavity preparation involves the proximal surfaces of a posterior teeth and caps all of the cusps. They work in similar fashion. These are made of many kinds of ceramics. They are fabricated by CAD/CAM technique.

- Implants : Implant is basically an artificial tooth root /post that is placed into bone to support a dental prosthesis such as crown, bridge.. Usually these are made from titanium and its alloys. Basic criteria for a material to be used as an implant is strength and bone biocompatibility. Recently Zirconia implants are introduced in to the market. With an increasing consciousness and fear for metal allergy, Zirconia implants are gaining momentum. Their advantage is their non allergic nature.[20] Their basic disadvantage over titanium is their brittleness. Also hydroxyapatite coated titanium implants are already into the market. These aim at better tissue response and osseointegration. [20]

Laminate veeners

A veneer is a layer of tooth colored material that is applied to a tooth for esthetically restoring localized or generalized defects or intrinsic discolorations.[20] or A veneer is a thin layer of restorative material placed over a tooth surface, either to improve the aesthetics of a tooth, or to protect a damaged tooth surface.

[20] Laminate veneers were fabricated as early as 1930"s by Pincus. He used the term "used air fired" porcelain for the laminate veneers. By 1955 Bunocore"s research into acid etching and the introduction of Bowen's resin Bis-GMA in the year 1960 resulted in the usage of composite as a veneering material. It had the drawback of reduced working time, lack of wear resistance and delamination. In 1975 with the advent of etching porcelain by Rochette, porcelain became the material of choice for laminate veneers.[21] Porcelain laminate veneers are among the most esthetic means of creating a more pleasing and beautiful smile. Porcelain veneers within reason allow for the alteration of tooth position, shape, size and color.

Types of veneers[20]

Veneers can be divided into two categories based method of fabrication

- fabricated composite resin veneers (i.e. free hand placed), and
- Indirectly fabricated veneers, such as preformed laminates or laboratory-fabricated acrylic resin, microfilled resin, or porcelain veneers.

Veneers can be divided into two categories based tooth preparation

- Partial veneers
  Partial veneers are indicated for the restoration of localized defects or areas of intrinsic discoloration. [20]
- Full veneers
  Full veneers are indicated for the restoration of generalized defect or areas of intrinsic staining involving the majority of the facial surface of the tooth. [20]

Direct Veneers:[21]

Direct veneers are made up of composite resin and are placed directly on the teeth by dentist on same appointment. Buonocore's research of the acid etch technique in 1955, combined with Bowen's later use of filled resins, provided the technology enabling mechanical bonding between etched tooth and filled resins (direct bonding). Although these were major breakthroughs in dental research by the early 1960s, little esthetic use was made of this bonding technology of nearly a decade. This was partially due to the limitations of the available self-curing resins, which did not allow sufficient working time for the dentist to recreate a labial surface before the composite resin chemically cured itself.

Indirect Veneers:
These veneers are fabricated in the laboratory fron porcelain or resin and then laced into oral cavity in next appointment. [21]

Smile Design

The concept of esthetics has fascinated mankind for centuries. The interpretation of what is "esthetic" is as broad an issue as one can envision. Our ultimate goal as clinician is to achieve a pleasing composition in the smile. [22] The two main

objectives in dental esthetics are:

- To create teeth of pleasing inherent proportions and of pleasing proportion to one another .
- To create a pleasing tooth arrangement in harmony with the gingiva, lips, and face of the patient. These two objectives established by using references and are reinforced with perspective and illusion.[23]

Principles Of Smile Design: The principles of smile design require an integration of the dental facial composition and the dental composition. The dental facial composition includes the lips and the smile as they relate to the face, and the dental composition relates more specifically to the size, shape, and positions of the teeth and their relationship to the alveolar bone and gingival tissues[24]

Beautiful Smile[25]

A beautiful smile is an added asset to a beautiful face. Goldstein (1998) described certain parameters of a beautiful smile which are described below:

- Facial Analysis:
  - Full Smile: Following parameters judge the beauty of a face in full smile.
    - Relationship between interpupillary line (AB) & occlusal plane of teeth (CD): Ideally these should be parallel to each other but may be canted to right or left side.
    - Midline relationship of teeth (Central incisor) to face (philtrum). In the most beautiful face, this relationship would be symmetrical; in others it may be to right or left of centre. [25]

- Profile*:* Following parameters are considered in a profile
  - Nasolabial angle-This is the angle between columella of nose & anterior surface of upper lip.
    0 = 90° (Normal)
    0 = <90° (Convex)
    0=≥90°(concave)
    In men the nasal-labial angle is generally 90° to 95°, whereas In women it is generally 100° to 105.9°.
  - Rickets E-Plane - It is drawn from tip of the nose to the chin. Then the distance between this plane & the lips is measured. Ideally the upper lip should be at a distance of 1-2 mm & lower lip at a distance of 2-3 mm from this plane. [25]

- Dentofacial Analysis: —It has following parameters:
  - Position of upper lip – while smiling, upper lip should be neither too high so that to expose the upper gums, nor too low so as to cover more than half of upper teeth. It should be ideally covering not more than ¼th of teeth.
  - Alignment of upper incisal edge to lower lip– The best position is a convex curve downwards, but it may be straight or even concave downwards.
  - Tooth-lower lip position **–** The teeth may be just touching the lower lip or

there may be a slight gap. [25]

- Number of teeth exposed during full smile*: The* smile may be canine to canine (6 teeth exposed); premolar to premolar (8-10 teeth exposed);molar to molar .
- Midline relationship of central incisors to philtrum – A midline through philtrum should ideally pass through the centre of two central incisors. However, it may pass right or left of the centre of central incisors. [25]
- Midline skewing to left or right – Ideally, there should be no skewing. But there may be left or right skewing.
- Bilateral negative space – under normal conditions, there is little space visible between angles of mouth & teeth while smiling is called as negative space. [25]

- Dental analysis
  - Proportions of central incisors – Height & width of central incisors is measured with callipers. The most ideal width to height ratio is 80%
  - Proportion of central incisor to lateral incisor to canine- The ideal ratio should be 1. 6: 1: 0. 6.
  - Interdental contact area and point - It is defined as the broad zone in which two adjacent teeth touch. It follows the 50:40:30 rule in reference to the maxillary central incisor. The increasing ICA helps to create the illusion of longer teeth by wider and also extend apically to eliminate black triangles. [25]
  - Incisal embrasures - The incisal embrasures should display a natural, progressive increase in size or depth from the central to the canine. So that the contact point moves apically as we proceed from central to canine. If the incisal embrasures are too deep, it will tend to make the teeth look unnaturally pointed. As a rule, a tooth distal to incisal corner is more rounded than its mesio-incisal corner. [25]
  - Zenith points - The most apical position of the cervical tooth margin where the gingiva is most scalloped. It is located slightly distal to the vertical line drawn down the centre of the tooth. The lateral is an exception as its zenith point may be centrally located. [25]

- Dento Gingival Analysis
  - Healthy gingiva - Healthy gingiva is usually pale pink in color, stippled, firm and it should exhibit a matte surface; located facially – 3 mm above the alveolar crestal bone and interdentally – 5 mm above, the intercrestal bone papilla should be pointed and should fill the gingival embrasure right up to the contact area.
  - Gingival level and harmony - Establishing the correct gingival levels for each individual tooth is the key in the creation of harmonious smile. The gingival margin of the lateral incisor is 0.5–2.0 mm below that of the central incisors. The least desirable gingival placement over the laterals is for it to be apical to that of the centrals and or the canines. [25]

Conclusion

Aesthetic dentistry has made huge steps in recent decades. Today due to modern technology, patients have a multitude of options for a beautiful smile and a harmonious faces. Whitening techniques, dental veneers, ceramic crowns, orthodontic treatments or implants are ways to improve the appearance of patients.
Aesthetic concerns are not the preserve of the modern era, cosmetic dentistry is known from ancient times. Dentistry began to approach science when materials have seen a new development. Mixed metallic non- metallic prosthesis represented the best option for the treatment of partial edentulous, because those provided good resistance, through metallic component and aesthetics through physiognomic component.

Mechanical and physical qualities of alloys were improved, especially surface qualities for obtaining physicochemical links performance in combination with aesthetic materials; also the chemical composition and heat treatment improved stability, so optimal biocompatibility. Porcelains are constantly evolving and disadvantages of first-generation in ceramic masses were completely removed, due to mechanical and optical properties of new ceramic mass that made them similar to dental hard tissues. A proper preparation of metallic surfaces could ensure optimum connection between the two components, metallic and non-metallic.

But, even so, these restorations were not satisfactory by aesthetically point of view. Aesthetic restoration has a special importance in dental treatment goals, especially fixed one. Therapeutic solution in achieving this goal is the realization of aesthetic prosthesis materials. Today, patients want to keep their beautiful appearance of the teeth as long time, to correct the effects arising as a result of aging, or to obtain a,beautiful smile as they have not had before.

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